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AGRICULTURE **YEAR BOOK** 2014

Editorial note of Dr. Khan



Dear Readers,

It is again that time of the year, while keeping with our tradition; we present to you the latest edition of the Agriculture Today Year Book. The seventh edition of the year book is the result of the unfaltering support, constant encouragement and faith reposed on us by our loyal readers. Our readers have been the reason for the unopposed presence of the magazine, Agriculture Today, in the Indian scene for more than a decade. The magazine, over the years, has become the platform to discuss and debate topics of agricultural relevance.

Agriculture Today Year Book of 2014 features articles penned by the some of the most eminent personalities in Indian agriculture. These articles represent different facets of Indian agriculture, introduce many new concepts and initiatives and also have identified several areas of concern in Indian farming. The year book, has thus tried to strike a right balance with combination of data, analysis and information.

I would like to thank all the eminent writers for their valuable contributions for the Year Book 2014. Their timely and appropriate contributions were influential in making this year book a reality. I trust that the Year Book will serve as a useful guide and reference to all those related to the agriculture sector, including government officials, policy makers, scientists, agribusiness companies, NGOs, institutions, agri researchers, professionals, planners, students etc. We have lent our best of efforts to create this year book. Nonetheless, there is further scope for improvement which we promise to refine in the next edition of 2015. I request all our esteemed readers to impart their valuable support by sending in comments and suggestions.

I take this opportunity to express our gratitude to Prof. MS Swaminathan, Chairman and all the members of the organizing committee of the Agriculture Leadership Summit 2014 for their valuable guidance. I am also thankful to my colleagues specifically Ms. Anjana Nair, Pinaki Ranjan Dey and Abdul Rehman for their untiring efforts in compiling and editing the Agriculture Year Book 2014.



Dr. MJ Khan

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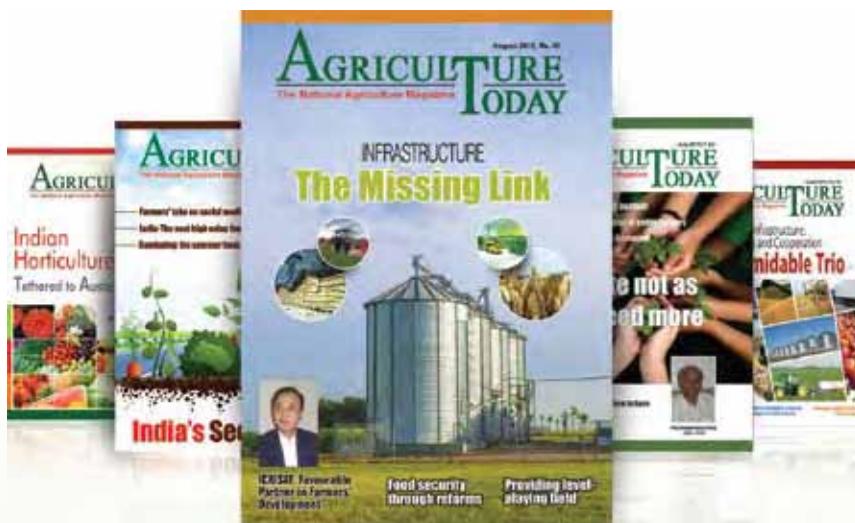
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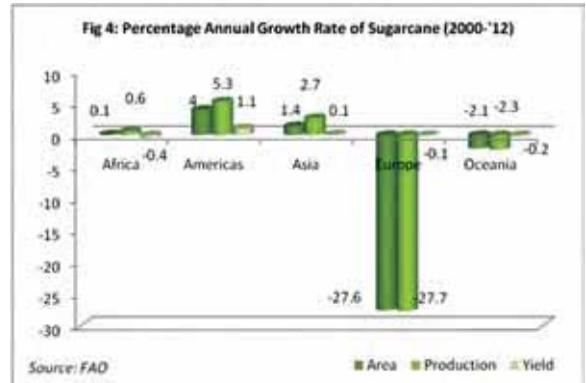
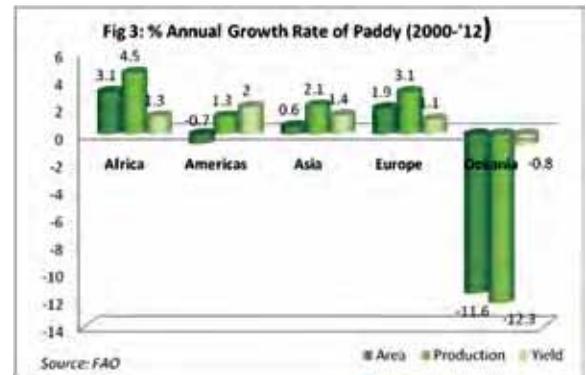
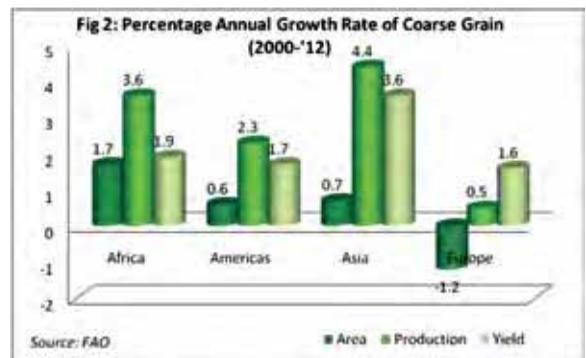
*Agriculture-
International Scenario*

In the span of a twenty years period between 1992 and 2012, global per capita net food production increased by 25.5% from USD 86.4 in 1992 to USD 108.5 in 2012. The highest increase was recorded in the Asian region from USD 75.75 (1992) to USD 116.25 (2012) marking an increase of about 35% during the entire period (Fig 1). However, the European region posted a decrease of 5% in the net per capita food production. In 1992, the per capita food production in Europe was USD 104.3 which declined marginally over the years to USD 99 in 2012. The steepest decline was between 1992 and 1993 when the per capita food production in Europe fell from USD 102 in 1993 to USD 95.6 in 1994.

Between 2000 and 2012, the African region posted the highest increase in the area of coarse grain cultivation by 1.7% and increase in total production by 3.6%. However, the highest percentage increase in yield was posted by the Asian region in coarse grains by 3.6% in the period between 2000 and 2012. Interestingly in Europe, despite a net decrease of 1.2% in the total area under cultivation of coarse grains, there was an increase in the production and yield by 0.5% and 1.6% (Fig 2). Countries like India could emulate this when one considers the growing pressure on availability of cultivable land in the backdrop of urbanisation and industrial growth.

Study of data between 2000 and 2012 related to area, production and yield of paddy globally reveals that the Oceania region witnessed a sharp decline in the total area under paddy along with production. Area and production of paddy in the Oceania region dropped by 11.6% and 12.3% respectively during the period between 2000 and 2012 (Fig 3). The yield also witnessed a decline by 0.8%. The Americas witnessed an increase in production despite a decrease in the area under cultivation during the same period. The area under paddy cultivation the region decreased by 0.7% between 2000 and 2012 but the production and yield increased by 1.3% and 2% respectively during the same period. Globally, the highest increase in paddy cultivation area and production was recorded by the African region with an increase of 3.1% and 4.5% respectively in the area and production respectively.

The total acreage and production of sugarcane appears to have reduced significantly over the last decade or more. Between 2000 and 2012, area and production along with yield decreased in Europe as well as in the Oceania region. Europe experienced a very high negative growth in area and production during the period. The area under sugarcane decreased by 27.6% while the production decreased by 27.7%. Oceania experienced a decrease of -2.1 and 2.3 in area and production

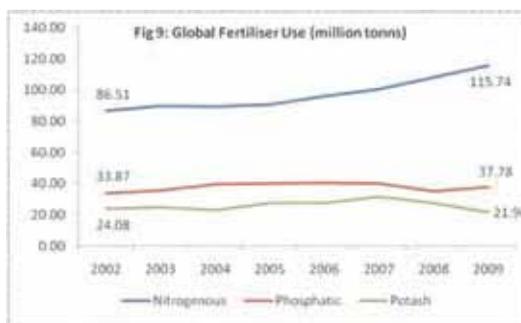
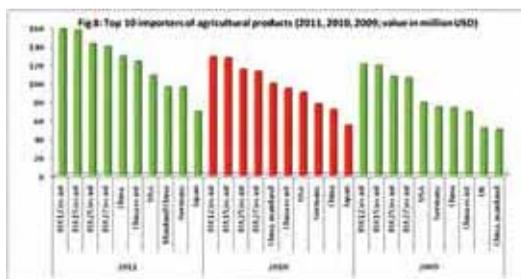
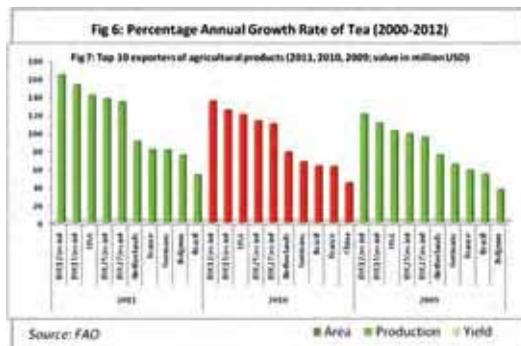
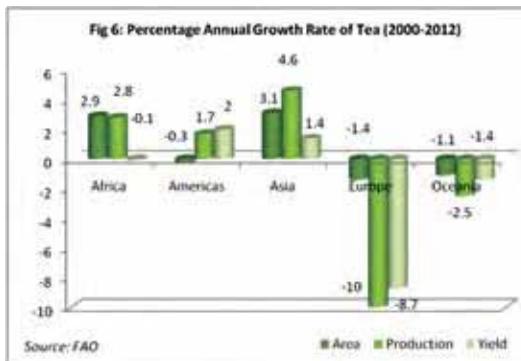
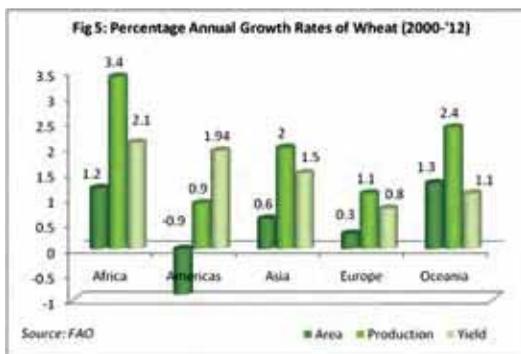


respectively.

Globally, except the Americas, all other region witnessed positive growth in area of wheat with the African region witnessing the highest growth of 1.2% between 2000 and 2012. African region also posted the highest growth in production of wheat during the same period at 3.4%. African region as whole though posted negative growth in area under wheat, it could increase its net production by 0.9% and yield by a substantial 1.9% (Fig 5).

Taking a look at the global status of a commercial crop like tea in terms of area, production and yield, the highest increase was posted by the Asian region followed by the African region (except yield). In Asia, good days of tea production seems to have come back with an increase of 3.1%, 4.6% and 1.4% growth in area, production and yield respectively (Fig 6). Africa witnessed a growth of 2.9% and 2.8% respectively in area and production though the yield witnessed a minor negative growth of -0.1%.

For three consecutive years (2009, 2010, 2011), European Union (Group of 12 countries), European Union (Group of 15 countries) and USA were the top three global exporters of agriculture products. Germany as a country was the 8th largest exporter during the three consecutive years. France improved its position from being 9th in 2010 to 7th largest exporter in 2011. Over all, various groups of countries in the European Union emerge as the top exporters of agricultural products. It is important to note that from the Asian



countries, its only China which could secure the 10th largest exporting nation of agriculture products in 2010 but could not come into the league in 2009 or in 2011 (Fig 7).

Many of the top exporting countries are also the top importers of agricultural products. As seen in Fig 8, European Union Group of 12, 15 25 countries, USA, Germany etc. who were the top exporters can also be seen as some of the top importers. Asian countries like Japan and China can also be seen amongst the top 10 importing countries of agricultural products. Germany as a country has been steadily able to decrease its import of agricultural products between 2009 and 2011.

One of the major and important agricultural inputs is of course fertiliser. Fertiliser use globally has increased over the years when one looks at the combined figure of all the nitrogenous, phosphate and potash fertilisers. However, among the three major plant nutrients, global use of nitrogen providing fertilisers has increased almost 38% during the period from 2002 to 2009. It increased from 86.51 million tonnes in 2002 to 115.74 million tonnes in 2009. Use of phosphate fertiliser fluctuated on an overall basis but between 2002 and 2009, increased marginally from 33.87 million tonnes to 37.78 million tonnes. However, use of potash fertiliser showed a negative growth during the same period. Between 2002 and 2009, potash fertiliser use decreased by about 9% from 24.08 million tonnes to 21.96 million tonnes.



PROF. M.S. SWAMINATHAN

New Technologies for a Small Farm Productivity Revolution

It is 61 years now in 2014 since the beginning of the new genetics based on the discovery of the double helix structure of the DNA molecule by Watson, Crick and Wilkins. It is also 31 years since the production of transgenic plants started, thanks to the work of Marc Von Montagu, Jeff Shell, Mary del Chilton and several others. The first patent for a living organism went to Dr. AnandChakraborty who developed through recombinant DNA technology an organism for cleaning up oil spills. The science of molecular genetics has been applied with great benefit in the fields of medicine, industry, environment and agriculture. In the case of medicine, both scientists and consumers have been experiencing many beneficial fall-outs of these advances such as new vaccines, insulin and genetic medicine. The major concern in medical genetics is one of ethics, as for example, the application of recombinant DNA technology for reproductive cloning. Therapeutic cloning, on the other hand, has been welcomed. In the case of environmental biotechnology, there is great interest in bioremediation methodologies since there is growing pollution of ground and river water.

In food and agricultural biotechnology, thanks to functional genomics, proteomics, and recombinant DNA technology, we are able to address simultaneously the quantitative, qualitative and sustainability aspects of crop production. The rigorous biosafety and environmental safety tests carried out so far have not provided any scientific evidence for adverse impact on human or environmental health. Public institutions are developing a wide array of valuable genetic combinations, of great importance to increasing small farm productivity and profitability and safeguarding environmental health by reducing the need for applying toxic pesticides. By helping to manage biotic and abiotic stresses, genetically modified crops provide opportunities for avoiding damage by drought, high temperature, flood and sea

level rise caused by global warming and climate change. Through an intelligent integration of Mendelian and molecular breeding we are now in a position to avoid threats to sustainable food security. Through a combination of pre-breeding and participatory breeding with farm families, we can combine genetic efficiency and genetic diversity, thereby avoiding the danger of genetic homogeneity.

In the case of agricultural technologies which carry both benefits and possible risks, it is important to have regulatory mechanisms which can help to analyse risks and benefits in an impartial, transparent and professionally competent manner. The same is true in the case of nuclear energy. India is showing the way to the development of an effective regulatory system designed to ensure that the bottom line should be the economic well-being of farm families, food security of the nation, the protection of the environment and the health security of the consumer through the Biotechnology Regulatory Authority Bill introduced in Parliament. Unfortunately the validity of this Bill from the point of view of debate and decision has now expired with the conclusion of the term of the current Lok Sabha. This gives the Indian Council of Agricultural Research (ICAR), the Department of Biotechnology (DBT), the Indian Council of Medical Research (ICMR), The Council of Scientific and Industrial Research (CSIR), the University Grants Commission (UGC), Ministry of Environment and Forests (MoEF) and other agencies a wonderful opportunity to go through the text of the Bill once again, taking into account the numerous comments, criticisms and suggestions which have been received, and get a new Bill prepared for introduction as soon as the new Parliament begins its work. While it may take time to set-up a Parliament-approved National Biotechnology and Biosafety Regulatory Authority, guidelines for safe field testing should be developed. Enforcement of procedures for the release of GMOs for commercial cultivation through the proposed Act may take time but

field testing under well-defined safeguards should go on. There are numerous GM varieties in the breeders' assembly line, and they should be tested in the field without further delay. Meanwhile, procedures for their release can be finalised through appropriate legislation.

The Agricultural Biotechnology Committee which I chaired in 2003 and which submitted its report early in 2004 had recommended both a Parliament-approved regulatory agency as well as the necessary infrastructure for conducting all-India coordinated trials with GMOs. Such a special coordinated trial to be organised by ICAR should have as its coordinator an eminent biosafety expert. The necessary precautions, such as the needed isolation as well as demonstration of the importance of refuge, should be undertaken under this coordinated project. Ten years have passed since this recommendation was made and we should lose no further time in implementing it. We should place in position a trial and safety assessment system which answers the concerns of anti-GMO experts and environmental organisations. The present moratorium on field trials with recombinant DNA material is serving as a serious handicap as well as a disincentive in harnessing the benefits of the wide array of transgenic material currently available with various public and private sector research organisations and universities. Many of the GMOs in the breeders' assembly line have excellent qualities for resistance to biotic and abiotic stresses as well as improved nutritional properties. Much of this work has been done in institutions committed to public good. Also much of the work has been done by brilliant young scientists who are getting discouraged because of the lack of a clear official signal on the

future of genetic modification.

While urgent steps are needed for putting a widely accepted regulatory system in place, full advantage should be taken of the molecular marker-assisted selection procedures of breeding. The designed goals can be achieved through marker-assisted breeding. Varieties developed through marker-assisted selection are accepted for organic certification. Agriculture is a State subject and it is very important that the State Agricultural Universities



and State Departments of Agriculture are involved in the design and implementation of the field trials. It takes nearly 10 years for a new variety to be ready for recommendation to farmers. Therefore speed is of the essence in organising field trials and gathering reliable data on risks and benefits.

Return from investments in biotechnology research is high. The public sector institutions should accord priority to the development of high-yielding climate-smart and disease-resistant varieties, while obviously the private sector will only produce hybrids whose seeds will have to be bought every year by farmers. Public and private sectors should develop a joint strategy which will help to ensure the inclusiveness of access to improved technologies

among all farmers, small or large. The public sector R&D institutions should give high priority to the breeding of varieties which can help farmers to minimise climate and market risks.

There is need for pan-political support for promoting the safe and responsible genetic engineering research. Every research institution should have a Project Selection Committee which will examine carefully whether recombinant DNA technology is necessary to achieve the desired breeding goal. In many cases, marker-assisted selection would be adequate for developing a variety with the necessary characters. Recombinant DNA technology should be resorted to only when there is no other way of achieving the desired objective.

Human populations are increasing and may reach 8 billion by 2030. We have no option except to produce more food and other farm products from less land and irrigation water. The population in developing countries is predominantly young, with nearly 70 percent of the population being below 35 years. Youth will be attracted to choose farming as a profession only if farming becomes both economically rewarding and intellectually satisfying. We will be doing a great injustice to the younger generation of farmers, if we close the gates to the scientific transformation of crop yield and quality and to the conservation and enhancement of the ecological foundations essential for sustainable agriculture like soil, water, forest, biodiversity and climate. Conservation of biodiversity has received added momentum due to biodiversity being the feedstock for the biotechnology industry. To quote Jawaharlal Nehru: 'The future belongs to science and to those who make friendship with science.'



RAJ PARODA

Innovation Led Agricultural Growth: Challenges And Opportunities

The Asia-Pacific is an agriculturally vibrant region. With 38 per cent of total agricultural land, it houses 80 per cent small holder farmers supporting 74 per cent of world's agricultural population. The region encompasses 39 countries, including 19 commonwealth members with two world's most populous countries, China (1.3 billion) and India (1.1 billion). With 3.5 billion people, the region accounts for about 58 per cent of the world's population. Agriculture (crops, livestock, fishery, forestry, and the associated natural resources endowments) is the main source of livelihood for nearly 2 billion people. The region is the largest supplier of the world's food and agricultural products. The region has witnessed several innovations in agricultural development. One of the most evident "Green Revolution" was brought out by a science-led synergistic approach capitalizing genetic potential, irrigation, fertilizer, appropriate policies and farmers' hard work. This innovation led to an unprecedented transformation in food security and rural development in the region. Since mid-sixties the Asian cereal production had almost doubled – reaching nearly 1 billion tonnes, recording an annual growth rate of 3 per cent. The increased agricultural productivity, rapid industrial growth and expansion of the non-formal rural economy resulted in quadrupling per caput GDP, thus halving the level of poverty in the region. However, continuing to secure such gains is becoming a major challenge especially in the context of declining factor productivity, deteriorating natural resources as well as impact of global climate change.

The Challenges Ahead

• Food Demand vs. Farm Holdings

Food insecurity and poverty, accounting for two-third of the world's hungry and poor, exacerbated by the soaring food and fuel prices, global economic downturn and volatile markets have surfaced as major development

related concerns in the region. The problem has further been intensified with sharp rise in the cost of food and energy, depleting water resources, diversion of human capital from agriculture, shrinking farm size, soil degradation, indiscriminate and imbalanced use of chemical inputs and overarching effects of changing climate. The per caput land availability for agriculture in the region (0.3 ha) is almost one-fifth of that in the rest of the world (1.4 ha). The region's agrarian landscape is predominantly smallholder farmers (~80 per cent of the world's small and marginal farmers). Now more than 650 million people, half of the world's poor (income <US\$ 1/day), are getting hungrier and poorer day by day. It is estimated that by 2050, the food grain requirement in the Asia-Pacific region would be around 70 per cent more than the current demand. A low investment in agricultural research for development further complicates the problem. The future dependence on imported fossil fuels raises concern about price volatility and shocks, and supply disruptions in agriculture production. Therefore, ensuring the availability of and economic access to food, in both quantity and quality (nutrition), for the poorest of the poor in the developing countries of the region remains a daunting challenge. In this direction, the 'GCARD Road Map' developed through interaction of diverse stakeholders in 2010 highlights the urgent changes required in Agricultural Research for Development (AR4D) globally, especially to address the needs of resource-poor smallholder farmers and consumers. It envisages major thrust on "Innovations for greater impacts on small holder farmers". In order to meet future food demand and to attain successfully the Millennium Development Goals (MDGs), especially when world leaders held "Rio+20" in 2012 to review the current status, it has been recognized that improving efficiency and resilience of agriculture around the farming systems would be the only way to move forward.

• Poverty and Malnourishment

According to FAO, the number of undernourished people in the world has increased during the last decade and the number of hungry for the first time has crossed 1 billion mark. Almost two-third of the world's hungry (642 million) and 67 per cent of the world's poor have their homes in the region. The gains made in the 1980s and early 1990s in reducing chronic hunger have been lost and the hunger reduction target of 50 per cent by 2015 under MDG now remains elusive. Despite the fall in international food and fuel prices since late 2008, the prices in domestic markets have remained 15-25 per cent higher in real terms than the trend level-resulting in further distress for the poor. The region is home to 70 per cent of the world's undernourished children and women. These numbers have remained stubbornly high and even increased lately. During the past one year, the number of hungry in the region has increased by 10.5 per cent, thus derailing the progress further. Lack of economic access, not the physical access, is thus a major challenge before the policy makers of the region.

• Natural Resource Degradation and Climate Change

The ever increasing population growth is interlinked with fast declining and degrading land, water, biodiversity, environment and other natural resources which are 3-5 times more stressed due to population, economic and political pressures in the Asia-Pacific compared to the rest of the world. The region has already reached the limits of land available for agriculture and hence no further scope exists for horizontal expansion. Inefficient use and mismanagement of production resources, especially land,



water, energy and agro-chemicals, has vastly reduced fertility and damaged our soil health. To a greater extent, lack of political will and appeasement policies to provide free or cheap food as well as water, energy etc. have further increased the problem. Moreover, while maintaining a steady pace of development, the region will also have to reduce its environmental footprint from agriculture. The reduction in water availability and increase in animal and plant diseases will primarily affect poor countries and the small island states that have limited capacity to respond and adapt against such negative impacts. Regrettably, man-made disasters in some countries (like Aral Sea in Central Asia) could even exacerbate the natural ones.

Opportunities to Harness

• Genetic Resource Management

Agricultural biodiversity is a key resource for achieving food and nutritional security. The Asia-Pacific region has rich diversity of fauna and flora including agroforestry species and is the centre of origin of many important crops, livestock and forest tree species. This rich genetic resource serves as a gold mine for specific/unique traits for use in germplasm improvement, through breeding and biotechnology applications, in order

to develop varieties possessing high productivity, better nutritional quality, resistance to biotic (diseases and insect pests) and abiotic (drought, frost, flood, salinity) stresses and high adaptation to climatic change variations. In fact, earlier Green Revolution was made possible due to exploitation of dwarfing and photosensitive genes in wheat and rice. Accordingly, germplasm conservation can significantly help in achieving both sustainable agricultural growth and development. It is, therefore, necessary that each country builds an effective national agricultural research system (NARS), including Gene Bank, to conserve valuable genetic resources for posterity as well as use for increased productivity and sustainability. New science like biotechnology, ICT, nanotechnology offers ample opportunities in this regard.

• Outscaling Innovations and Natural Resource Management

One of the main causes of slow growth in agriculture is relatively slow dissemination of emerging technologies relevant to the needs of smallholder farmers. Innovations in agriculture are needed now to meet the major challenge of increasing resource scarcity and bringing structural transformation in the socio-economic context so as to reduce cost on inputs and ensure

improved livelihood of resource poor small holder farmers. Therefore, for liberation from hunger and poverty, while sustaining our natural resource base, the policy makers must ensure renewed thrust and funding support on agricultural research for development through policy reorientation, greater support for agricultural research for development (AR4D) and much needed institutional reforms.

Some new innovations such as: hybrid technology in maize, rice and other crops, Bt Cotton, GM corn, rice, brinjal etc. need to be out scaled. Good agricultural practices such as conservation agriculture (CA), balanced use of fertilizers, small farm mechanization for resilience, micro-irrigation, integrated pest management, scientific land use for crop diversification etc. would contribute considerably in arresting natural resource degradation, helping climate change adaptation and mitigating as well as increasing farm productivity and profitability. One such successful example in the region is of conservation agriculture (CA) in the Indo-Gangatic Plains, led by regional NARS (Bangladesh, India, Nepal and Pakistan) and facilitated by CIMMYT, which has led to a cost benefit ratio of 1:19 (investments of US\$ 3.5 million led to an output equivalent of US\$ 64 million) through adoption of zero tillage for planting wheat over 2.5 million ha area. The area under CA could easily be increased by almost four fold (10 million ha) provided concerted efforts are made in a mission mode approach to outscale innovation for greater impact. Another successful example of innovation is laser land levelling adopted over 2.5 million ha in north-west India, primarily due to custom service windows. In Haryana alone it has led to saving of 1 billion m³ water annually.

Efforts be also made to capture farmer led innovations in agricultural practices and blend them with modern science through refinement and validation in participatory mode. For addressing the issues of resource fatigue and bridging the existing yield gaps, the recommendation domains of the best-bet management technologies, resource mapping and characterization using new tools and techniques, like remote sensing and GIS, would help considerably. Documenting success stories of potential innovations around climate smart technologies, stress tolerant high yielding genotypes/hybrids, better breeding and feeding of livestock breeds, conservation agriculture, water use efficiency through laser land levelling, micro-irrigation systems, use of customized or need based nutrients etc. and replicating them in similar ecologies, production systems and farmer's conditions would accelerate agricultural growth through effective regional partnership, capacity development and institutional reforms.

• Making Gray Areas Green

In order to combat the twin problem of meeting food, nutrition and energy needs on one hand and increasing population and depleting natural resources on the other, there seems to be an urgency now to attain Evergreen Revolution. Special emphasis needs to be given to rainfed agriculture, which is critical for sustainability, improved livelihood and enhanced income of resource poor farmers. For better risk management, diversified agriculture- such as silvipastoral approach through crop-livestock integration, arid agri-horticulture and agro-forestry practices will have to be adopted. Accordingly, a paradigm shift is needed now in

rainfed agriculture towards greater resilience by adopting practices around integrated natural resource management (INRM). Establishment of Rainfed Area Development Authorities, on lines similar to that in India, will help a great deal in this regard.

• Empowering Women and Youth for Inclusive Growth in Agriculture

It is now well recognized globally that women empowerment is quite important for both agricultural growth and household nutrition security. Late Prime Minister of India, Pandit Jawaharlal Nehru had said: "In order to awaken the people, it is the women who have to be awakened. Once she is on move, the family moves, the village moves, and the nation moves". Globally, about 43 per cent are women engaged in agriculture. In India, 60 per cent of farming operations are performed by women. Therefore, agriculture can be a primary driver for the empowerment of women and vice versa. Innovations and opportunities at the village level will not only meet the multiple needs of women and their families, but would also ensure inclusive development. However, women in agriculture are invariably deprived of access to agricultural knowledge, credit, technology to overcome their drudgery and market related services. Often, they are deprived of right to land and resources. All these adversely impact their livelihood and performance. The State of Food and Agriculture 2010-11 Report of the FAO has already indicated that reducing the gender gap between male and female farmers could raise yields on farms operated by women by 20- 30 per cent. As a consequence, it is estimated that engendering agriculture would lead to reduction



of undernourished people globally by 12- 17 per cent, which translates into 100-150 million fewer people living in hunger.

• Strengthening Collaboration and Partnerships

Regional and global networks and partnerships for knowledge sharing and enhanced capacity development of different stakeholders is a must for outscaling of innovations in similar ecologies. It has been increasingly realized that under the changing scenario of production to consumption, the linear approach in technology development and deployment will not serve the purpose to address Millennium Development Goals (MDGs). Therefore, for inclusive growth in agriculture through large scale uptake of new technologies, a major shift in our approach from R&D to AR4D, involving greater participation of different stakeholders, will be the key factor for future success. The past experiences from the regional organizations/programs like APAARI, SAARC, ASEAN, Rice-Wheat Consortium (RWC), Cereal Systems Initiative for South Asia (CSISA) etc. reveal that regional partnership is important to catalyse adoption of new technologies and sharing knowledge for

greater mutual benefits.

The Asia-Pacific Association of Agricultural Research Institutions (APAARI) has been instrumental in promoting regional cooperation for agricultural research and has organized a series of expert consultations on emerging issues vis-à-vis agricultural research for development (AR4D) such as: food crisis and bio-fuel; productivity enhancement; biotechnology and biosafety; post-harvest management; conservation agriculture; climate change; women and youth etc. CARP had been an active partner from very beginning in these initiatives.

• Knowledge Sharing and Capacity Building

APAARI has been supporting a major program known as Asia Pacific Agricultural research Information System (APARIS) under which more than 40 success stories from the Region have been published and disseminated widely. We need to learn from each other's successes as well as failures so as to avoid reinventing the wheel and rather take advantage of innovations that have already made large scale impact in similar ecologies elsewhere. Details of these success stories can be accessed from the

APAARI website: www.apaari.org

APAARI has also come out with some important regional declarations such as: Tsukuba Declaration on Climate Change, Suwon Framework on Agro-biodiversity, Bangkok Declaration on Strengthening Agriculture Research for Development etc. All these have received considerable attention of policy makers.

The Way Forward

Agriculture in the Asia-Pacific must liberate the region from the twin scourges of hunger and poverty and that of malnutrition of children and women. The region must continue to feed the world with adequate food supply. Accelerated science and innovation-led agricultural growth must be inclusive and should address the needs and aspirations of resource-poor smallholders in the Asia-Pacific region. Under the growing challenges of resource degradation, escalating input crisis and costs with overarching effects of global climate change, the major gains in food grain production would largely depend in future on a paradigm shift from integrated germplasm improvement to that of integrated natural resource management. The future AR4D efforts by NARS be reoriented towards farming system's approach. More importantly, it must bridge the income divide between farmers and non-farmers and benefit equally the producer and consumers. To ensure this, the developing countries in the Asia-Pacific must triple their investments in AR4D, so that we address our future challenges effectively and ensure food, nutrition and environment security for all in the region.

The writer is Executive Secretary Asia-Pacific Association of Agricultural Research Institutions (APAARI)



Centre for Agriculture and Rural Development

We bring hope

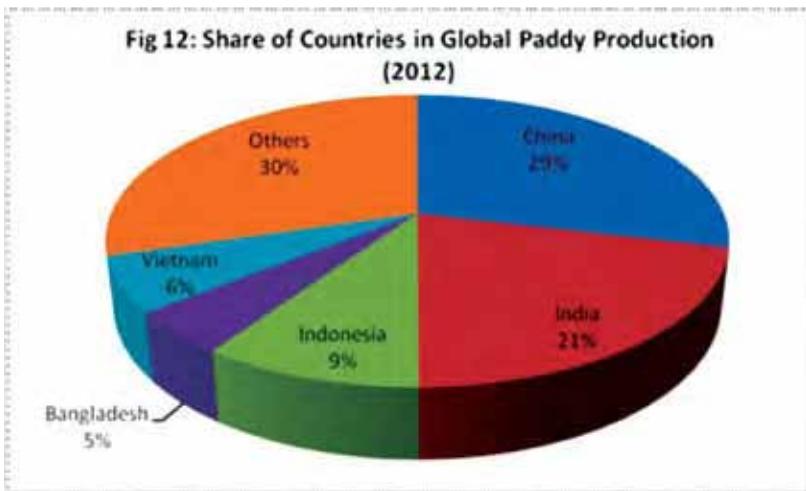
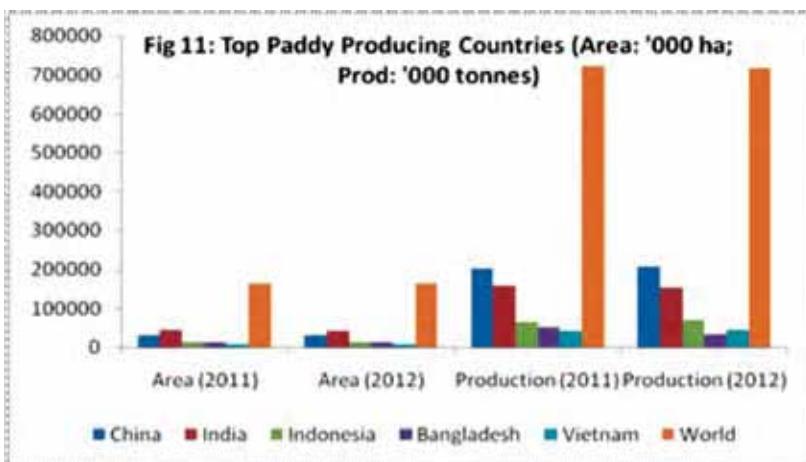
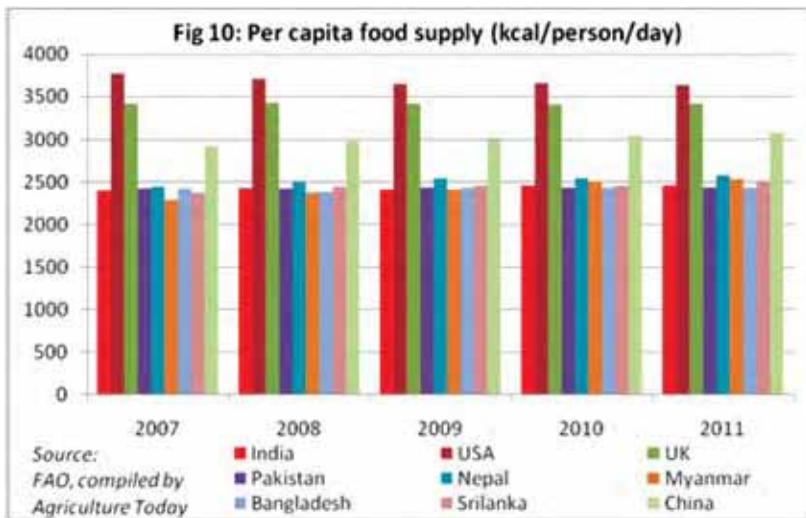


*Globalisation-Localisation-
Customisation of Agriculture*

OVERVIEW

In 2007, India's per capita food supply was less than other SAARC countries like Pakistan and Nepal and other Asian countries like China apart from being far behind developed countries like USA or the UK. In 2007, per capita food supply in India was 2395 kcal/person/day while the same for Pakistan and Nepal was 2420 and 2444 kcal/person/day respectively. The same in 2007 in China was 2915 kcal/person/day. However, between, 2007 and 2011, the per capita food supply in India increased by almost 3% to 2459 kcal/person/day while that in Pakistan its very marginally increased to 2428 kcal/person/day and in Nepal it increased by 5.5% to 2580 kcal/person/day. In USA, between 2007 and 2011, it decreased by 3.4% to 3639 kcal/person/day while in the UK it marginally decreased to 3414 kcal/person/day.

With the above discussion of per capita food supply in the backdrop, let us now turn our focus on India's global ranking as producer of some major and important agriculture crops. In 2012, India was the second largest producer of paddy globally ranking after China and was the largest in terms of net area under paddy (Fig 11). The other major producers of paddy are Indonesia,



Bangladesh and Vietnam in that order in 2012. India shared 21% of the global paddy production in 2012 (Fig 12). In 2011 and 2012, net area under paddy for India was 43970 and 42500 thousand hectares respectively whereas for China, it was 30311 and 30557 thousand hectares respectively. However, in terms of total production, China was much ahead than India as India's paddy production in 2011 and 2012 were respectively 157900 and 152600 thousand tonnes respectively while for China it was 202667 and 206085 thousand tonnes.

India was also the second largest producer of wheat globally in terms of production in 2011 and 2012, though similar to paddy, it had the largest area under wheat cultivation in the world. China was the largest producer with second largest area under

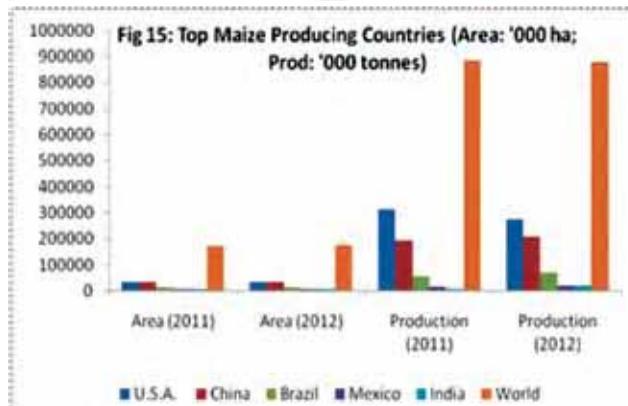
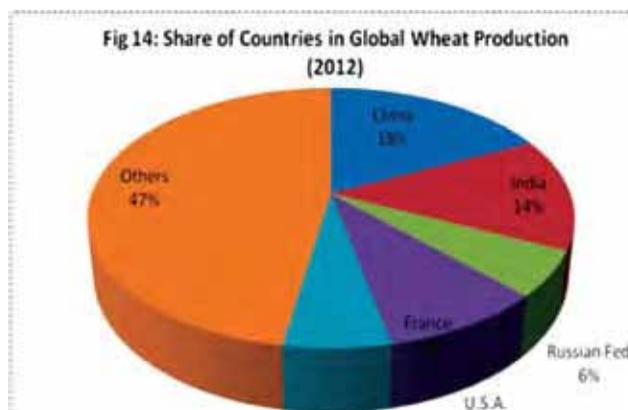
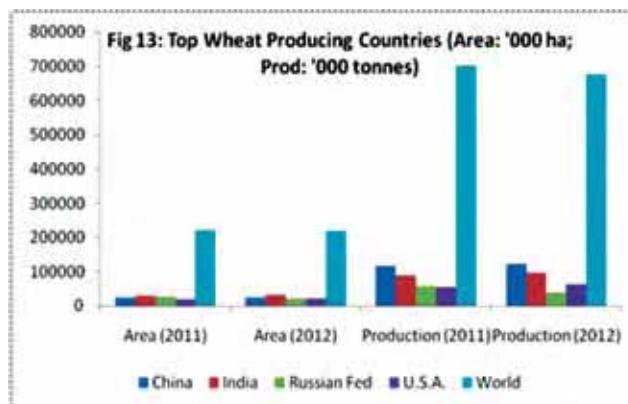


wheat cultivation Russian Federation and the U.S.A. were the other major wheat producing countries. The net cropped area under wheat for India was 29069 and 29900 thousand

hectares in 2011 and 2012 respectively. The same figure for China during in the same years was 24270 and 24139 thousand hectares. India's wheat production was 86874 and 94880 thousand tonnes respectively for 2011 and 2012.

The wheat production figure for China in 2011 was 117410 thousand tonnes and in 2012 was 120580 thousand tonnes. India's share in 2012 for global wheat production was 14% while for China, it was 18%. Russian Federation and U.S.A. had 6% and 9% shares respectively.

India ranked fifth in 2012 in global maize production. U.S.A. was the leader in 2012 with 273832 thousand tonnes. However, the total maize production of U.S.A. in 2012 was about 13% less than what it produced in 2011 (313949 thousand tonnes). China is the second largest producer of maize in the world after U.S.A. followed by Brazil and Mexico (Fig 15). India's share of world's total maize production was just 2% in 2012 (Fig 16).





WILLIAM D DAR

Making Smallhold Agriculture More Resilient and Profitable

Fast changing global agriculture and socio-economic environments under a climate change regime today pose major challenges and structural constraints to smallholder farmers. With the rise of urban populations, there will be in the foreseeable future, greater demand for alternative uses of land. Alongside the requirement to produce 70 per cent more food for a global population of 9.1 billion by 2050, urban sprawl will eat up more cultivable land even as farm size will continue to shrink.

Worldwide, about half a billion farms are smaller than 2 hectares, and these farms are getting smaller in many countries. Small farms are estimated to produce four-fifths of the developing world's food (FAO 2011). Moreover, they are home to approximately two-thirds of the world's 3 billion rural residents, the majority of people living in absolute poverty, and half of the world's undernourished people (IFPRI 2005).

Indian agriculture is no exception with 80 per cent of the farms under smallholders. The drastic decline in the holding size is due to the

rapid growth of population in the rural areas, breakdown of joint family systems leading to subdivision and fragmentation of holdings, explosive urban growth which is not labour intensive, formal and informal barriers to rural-urban migration, and distortionary land policies.

While technology adoption on small sized farms is encouraging, smallholder farmers face many disadvantages in the market place due to stiff competition from their large counterparts. The major challenge is to devise appropriate strategies and interventions to enhance the productivity of smallholder agriculture, increase the profitability of smallholder farmers, and link them to consumption centres to reduce poverty and improve food security.

We at ICRISAT believe that smallholder agriculture can be made more productive, profitable, and resilient if the constraints towards optimal factor and product combination are eased through credit, market reforms, infrastructure, factor supplies and sustainable use of natural resources.

Inclusive Market Oriented Development



(IMOD) is the framework of our research-for-development to bring change in smallholder agriculture and enable farmers to reap the economic benefits while managing the risks involved.

Why Small and Marginal Farmers

The majority of Indian farmers are smallholders (owning less than 2ha) who account for 85 percent of all holdings. Operating on 44 percent of the land area, their contribution to agriculture, food, employment, income and savings cannot be discounted. Thus, the sustainability of Indian agriculture pivots on the economic performance of smallholders.

The proportion of the population largely dependent on agriculture is still around 56 percent but due to subdivision and fragmentation of holdings, the size of holdings is falling, and simultaneously the number of holdings is rising. This has repercussions on the 'economically viable size of holding'. The average size of the holdings has shrunk from 2.30 ha to 1.16 ha between 1970 and 2010 reflecting the poor economic viability of the smaller holdings.

India is shifting from a country of 'small farmers' to a country of 'marginal farmers'. With the increasing rate of peri-urbanization and urbanization, time is not far off when it will further shift into a country of 'landless laborers'.

Demand Drivers

Population growth, rapid urbanisation, a fast growing middle class population, growing urban markets, expanding trade, rise in real incomes, change in consumption pattern towards high value products are the drivers of increased demand



for agricultural and livestock products.

Small farmers produce the bulk of the food, perishables and livestock products and their role to feed the growing population and to meet the market demand is ever more critical.

Growth drivers

For small farmers especially in rainfed areas, augmenting and sustaining agricultural productivity, employment and income are crucial drivers of growth. The role of small farms in development and poverty reduction is well recognized and global experience of growth and poverty reduction shows that GDP growth originating in agriculture is at least twice as effective in reducing poverty as GDP growth originating outside agriculture. However, sustained poverty reduction through inclusive growth is challenging given the limits to irrigation, infrastructure and technology, despite scale neutralization of technologies, since labour is becoming scarce all over the country.

Smallholders would be able to make efficient production choices if their constraints towards optimal factor and product combination are

eased through credit, market reforms, infrastructure, factor supplies and sustainable use of natural resources. The 'paradox of plenty' has ably demonstrated that a shift in production does not necessarily lead to higher incomes, if there is limited access to output markets, imperfect credit, and labour markets that weaken their earning capacity. Despite higher yields and bumper crops, smallholder farmers can remain trapped in the perpetual web of subsistence farming.

What are the key challenges and structural constraints of smallholder farmers in maximising profitability and strategies to make smallholders agriculture more remunerative, resilient and sustainable?

The emerging challenges

In the semi-arid regions, smallholder farmers are witnessing several challenges to their livelihood strategies. These include limited access to both input and output markets, lack of entrepreneurship to convert agriculture into a business proposition, climate change leading to frequent drought and floods, lack of productivity enhancing technologies, poor infrastructure,

high marketing and transport costs, limited resources such as land, labour and capital. In addition, they are also highly vulnerable to climatic changes, price shocks and financial risks. These emerging challenges lead many smallholder farmers to pursue livelihood strategies that involve lower-risk and subsistence agricultural activities. Thus, poverty continues to persist, trapping smallholders in a vicious circle of poverty with limited opportunities to undertake more productive and innovative activities.

Given the biophysical and socioeconomic constraints, the key challenge that needs to be addressed is how to make smallholder farming more resilient and profitable. On the one hand, smallholder agriculture must have resilience to shocks that threaten crop yields, household food security, and livelihoods. On the other hand, agriculture must also be profitable for smallholders enabling them to sell small quantities in distant markets. These challenges are connected because a lack of resilience results in sudden drop in production, whereas processors and consumers require consistency of supply. Consequently, profitability requires resilience.

In the face of these emerging challenges, smallholder farmers who have the potential to become profitable need access to the right set of productivity-enhancing tools, such as technology and capital, to become profitable and resilient participants within the agricultural sector.

IMOD Strategy for Small Holder development in SAT Regions

The structural adjustment and



economic liberalization program initiated in India during the 1990s downsized or dismantled many agricultural support programs and institutions. Trade liberalization and market reforms opened opportunities for the private sector which tend to exploit economies of scale, reduce transaction costs, and maximize profits. All these changes hit the poor hard as smallholder farming families not only found themselves at a disadvantage in the market place but also lost many of their supporting institutions and services.

IMOD is an instrument to bring change in smallholder agriculture and enable them to be transient and commercialized in markets that bring

rewards along with balancing against the risks involved. The instrument guides us towards the processes that bring in such enablers and incentives while more efficiently managing the risks. Under IMOD pathways of development, smallholders are provided differential treatment according to their level of agriculture and economic development and assisted in commercialization of farm activities through appropriate institutional development and appropriate technology.

Further, IMOD provides smallholders with strategies and options to become food-secure through both increased production and incomes. Unlike the conventional value chains which benefitted mainly the well-to-

do resource rich farmers and middlemen, the IMOD strategy harnesses markets to benefit the poor.

ESCAPING SUBSISTENCE FARMING: CASE STUDIES **Micro-dosing and small seed packs**

Supply of small quantities of fertilizer and small-sized packets of seeds to resource poor smallholder farmers especially women for their home gardens and field crops can improve food production and boost nutrition of the farm family significantly. More than 400,000 farmers benefited from micro-dosing and are currently testing and adopting it in the semi-arid regions of India and sub-Saharan Africa. This is a very encouraging story and supports the success of IMOD development pathway adopted by ICRISAT for the prosperity of smallholder agriculture.

State powers up its agricultural engine

Government support also plays an important role in igniting the IMOD engine of transformation of smallholder agriculture. With the Government of Karnataka as partner, Bhoochetana (Land Rejuvenation) is one of the most successful of such initiatives to overcome micronutrient deficiencies of agricultural soils. The aim is to boost yields by 30 per cent on 3.7 million ha through targeted fertilizer dissemination and other soil and water management interventions. This program is helping more than four million dryland farm families in Karnataka state of India. Similarly, effective partnerships with national and local agencies catalysed community action in watershed management and improved productivity and profitability of smallholder

agriculture in India, China, Thailand, Vietnam and in several West African countries. By reducing water related risk, this IMOD strategy enabled the cultivation of more diverse, higher-value, nutritious crops such as vegetables and fruits on more than 2.4 million farmers (12 million people in farming households) in Asia. Net crop income and cow milk yield almost doubled on an average on the beneficiary farm household.

Revitalizing the value chain for rainy season sorghum in India

One of the most successful IMOD projects which helped smallholder sorghum growers in India is the use of rainy-season sorghum for cattle and poultry feed, processed foods and alcohol. The coalition approach and strategic partnership helped to discover weaknesses in grain grading. It improved sorghum demand and utilization efficiency through linkages to input and credit agencies, and marketing outlets. As a result of breeding and dissemination of better-quality cultivars, formation of farmers group, training farmers in integrated crop management, and helping farmers improve their

on-farm storage of grain, sorghum grain and fodder yields rose by 25-50 per cent for the participating farmers. Income per hectare from the improved sorghum crop has nearly doubled, from \$162/ha to \$365/ha.

In the HOPE (Harnessing Opportunities for Enhancing Productivity of sorghum and millet) project in Maharashtra villages during post rainy season, some of the small farmers realised a net return of \$ 162/ha from chickpea plus 200 Kgs of sorghum (\$ 65) plus 100 Kgs of safflower seed (\$ 62) from chickpea-based mixed cropping systems using improved technologies. This has strengthened the food, nutrition and financial security of the small farmers.

The Agribusiness and Innovation Platform (AIP) of ICRISAT, following a public-private partnership model, fosters innovative agri-enterprise to bring R&D innovations of ICRISAT and partners to the marketplace for greater IMOD impact. It has attracted US\$5.5 million over the past four years including support for 108 joint ventures. Through its NutriPlus initiative, AIP incubates partners that develop, test and market innovative processed food products from staple grains that can



increase incomes for smallholders.

Typology of Development Pathways for smallholder farmers

Considering the huge size and spread of smallholders in Indian economy, heterogeneity in the resource endowments, diversities in biophysical, agro-ecological and socio-economic and production systems, there is no single or unique strategy to make smallholder agriculture sustainable and profitable. There must be different development options or pathways reflecting the nature of resource endowments, market opportunities and the availability of labour relative to land.

We have designed a typology that reflects the diversity of possible livelihood strategies and development pathways for smallholder's farmers. This typology distinguishes between 1) commercialised smallholders with profit potential, 2) subsistence farmers with profit potential, 3) subsistence farmers without profit potential

For smallholders to produce more value, they must choose high value enterprises or find a way through sorting, grading, processing, storage

or transportation to move crops with low local value to markets where they have high value.

For smallholder farmers with profit potential, their ability to be successful is hampered by such challenges as climate change, price shocks, limited financing options, and inadequate access to healthy and nutritious food. By overcoming these challenges, smallholders can move from subsistence to commercially oriented agricultural systems, increase production, profits, and operate at an efficient scale.

Policy Implications

In India, smallholder farmers have to play a bigger role in meeting the future food and fodder demand (derived demand from livestock sector) for a growing population. They need an enabling policy environment that stimulates market-led commercial agriculture triggering further investments on farm leading to adoption of productivity enhancing technologies for higher income and improved livelihood strategies. The smallholder farmers need to be supported by appropriate price support, public investments on infrastructure, watershed, productive social safe-

ty nets, improving risk-mitigation and adaptation strategies through weather linked crop insurance, linking agriculture, nutrition, and health, promoting pro-smallholder value chains, and increase smallholder-friendly financing and investment through institutional innovations.

There is apparently no single silver bullet to making smallhold agriculture more resilient and profitable. The pathway to impact is, however, clear. It must utilize and promote scientific innovation across agricultural value chains focused on smallholder farming within an inclusive and market oriented framework. It must adopt sustainable on-farm intensification by diversification while managing soil, water and micro-nutrient resources, use of improved crop varieties, and better on-farm practices. It must provide access to markets and promote higher value enterprises. It must embrace a policy environment that makes the smallholder farmer not just a beneficiary but a co-author of his development trajectory to resiliency and profitability.

The author is Director General, International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT)



JOIN AIREA

Join the voice of India's rice industry



All India Rice Exporters Association



All India Rice Exporters Association (AIREA) is the apex and only representative body of Indian rice exporters and the Indian rice industry, across the world. Its members include rice exporters, millers and trade facilitators from both the private sector and the public / cooperative sector. The association is consulted by the Ministry of Commerce, Government of India, and by many foreign buyers and foreign trade associations.

- AIREA interacts with various Ministries and Departments of the Government of India and overseas delegates and importers. The organisation is consulted in all important policy matters concerning rice production, exports and trade in India.
- AIREA works in close association with APEDA (Agricultural & Processed Food Products Export Development Authority), the nodal organisation under the Ministry of Commerce, Government of India.
- AIREA uses effective networking and communication strategies to keep all its members updated on all aspects of rice trade and industry by evaluating markets, production, competition, legislation, etc. via regular circulars.
- Importers from the USA, UK and Gulf countries regularly contact AIREA for rice import enquiries and to assess the credentials of Indian rice companies.
- The association organises, participates in, and facilitates entry for its members in national and international exhibitions, expositions, seminars and workshops to help popularise all varieties of Indian rice, with a particular focus on Basmati.
- AIREA provides a channel to promote and enhance the Indian rice business across global markets, thereby aiding the growth of India's rice exporting industry. Today, 90% of Basmati export is done by AIREA members.

All India Rice Exporters Association

81/2 Adchini, Sri Aurobindo Marg, New Delhi 110017, India

Phone +91 11 4107 1555 • **Telefax** +91 11 4107 0555

Email airea.delhi@gmail.com, info@airea.net • **Web** www.airea.net



J.S. MISHRA I.A.S.

Micro, Small and Medium Enterprises - Panacea for Unemployment in India

Unemployment is a bane of many problems and the cynosure of attention from all quarters. Franklin D. Roosevelt has very rightly marked "Not only our future economic soundness but the very soundness of our democratic institutions depends on the determination of our government to give employment to idle men".

Unemployment data of different countries:

World is suffering from a huge unemployment problem. But the unemployment problem is not the result of deficiency of effective demand but a product of shortage of capital equipments and other complementary resources accompanied by high rate of growth of population. Unemployment rates in some countries are given as under:

Unemployment in India

Present unemployment problem in India is mostly structural in nature. This unemployment problem of the country can now be broadly classified into rural unemployment and urban unemployment.

Rural Unemployment in India is more pronounced in rural areas and is of two types namely 'seasonal unemployment' and 'disguised or perennial unemployment'.

Seasonal Unemployment: Agriculture, through a principal occupation in the rural areas of the country, is seasonal in nature. It cannot provide work to the rural population of the country for the whole year. In the absence of multiple cropping and subsidiary occupations in the rural areas, a large share of rural population has to sit idle for about five to seven months in a year. Seasonal unemployment is also prevalent in some agro-based industries viz., tea industry, jute mills, oil pressing mills, and rice mills etc.

Disguised or Perennial Unemployment: Indian agriculture also suffers from disguised

or perennial unemployment due to excessive pressure of population on the land. In disguised unemployment, it seems apparently that everyone is employed but in reality sufficient full time employment is not available for all.

Urban Unemployment: Urban unemployment has two aspects: the industrial unemployment and educated or middle class unemployment.

Industrial Unemployment: In the urban areas of the country industrial unemployment is gradually becoming acute. With the increase in the size of urban population and with the exodus of population in large numbers from rural to the urban industrial areas to seek employment, the slow pace of industrialization in the country could not provide sufficient employment opportunities to these growing numbers of urban migrants. Thus the rate



Sl. No	Country	Unemployment rate (%)
1.	Japan	3.9
2.	China	4.1
3.	Bangladesh	5.0
4.	United States	6.1
5.	United Kingdom	6.4
6.	Australia	6.4
7.	India	8.8
8.	Nigeria	9.9
9.	Algeria	10.2
10.	Italy	13.0

Source : Wikipedia the free encyclopedia

of growth of employment in the industrial sector could not keep pace with the growth of urban industrial workers leading to a huge industrial unemployment in the country.

Educated or middleclass unemployment: Another distinct type of unemployment which is mostly common in almost all the urban areas of the country is known as educated unemployment. This problem is extremely acute among the middle class people. With rapid expansion of general education in the country, the number of out-turn of educated people is increasing day by day. But due to slow growth of technical and vocational education it has led to a peculiar educated unemployment problem in the country.

Some measures have been taken by Government of India to generate additional employment opportunities in services and manufacturing sectors particularly in labour intensive manufacturing sectors such as food processing, leather products, footwear and textiles, and also in services- sector such as tourism, hospitality and real estate. It calls for well thought- out fiscal incentives to foster capital intensive infrastructure investment; removal of distortions that hinder competition and prevent entry of other players and also discourage graduation from unorganized to organized sector. It is imperative to give greater emphasis on vocational training and skill development so that the employability of youth can be adequately enhanced. According to the 11th Five Year Plan strategy, Village and Small Scale Enterprises (VSE) had to provide most of the new employment during the eleventh Plan. Some direct employment was also to be available in the social

Employment in Organized Sector-Public and Private

(Employment in millions)

Sl.No.	Sectors	2009-10
1.	Agriculture,	244.85
2.	Manufacturing	50.74
3.	Mining	2.95
4.	Electricity, Gas and water Supply	1.25
5.	Construction	44.04
6.	Services	116.34
	Total	460.17

sector like health and education.

MSME and its role

The role of Micro Small and Medium Enterprises (MSMEs) in the economic and social development of the country is well established. The MSME sector is a nursery of entrepreneurship, often driven by individual creativity and innovation. This sector contributes 8 per cent of the country's GDP, 45 per cent of the manufactured output and 40 per cent of its exports. The MSMEs provide employment to about 60 million persons through over 26 million enterprises producing over six thousand products. The labour to capital ratio in MSMEs and the overall growth in the MSME sector is much higher than in the large industries. Cutting across all sections of production and services, MSME sector is truly a strategic asset for the

economy of the country.

It is envisioned that the sector will have a healthy growth with a large number of enterprises being set up and their graduation by up scaling into small and medium enterprises. This would be accompanied by enhancement of their contribution to the GDP, manufacturing output, employment and exports. For those already established, their upward graduation to next higher levels of investments and market shares would be welcomed. On an organizational level, transition of the sector from a predominantly unorganized to the organized sector, would be welcomed. Manufacturing enterprises constitute 31.8 per cent of the Micro, Small and Medium Enterprises (MSME) sector and service enterprises account for the remaining 68.20 per cent. About 55.30 per cent of these enterprises are located in rural areas. The MSME sector showed consistent growth of more than 11 per cent every year till 2010-11, whereas in 2011-12 the growth rate was 19 per cent and in 2012-13 about 14 per cent.

Two potent tools for sustainable Employment Generation under MSME Schemes Prime Minister's Employment Generation Pro-

Levels of funding under PMEGP

Categories of beneficiaries under PMEGP	Beneficiary's contribution (of project cost)	Rate of subsidy (of project cost)	
		Urban	Rural
Area (location of project/unit)			
General category	10%	15%	25%
Special (including SC/ST/OBC/ Minorities/Women, Ex-Service-men, Physically handicapped, NER, Hill and Border areas etc.	5%	25%	35%

Note : (i) The maximum cost of the project/unit admissible under manufacturing sector is Rs. 25 lakh.
(ii) The maximum cost of the project/unit admissible under business/service sector is Rs. 10 lakh.
(iii) The balance amount of the total project cost will be provided by banks as term loan.

Performance under PMEGP			
Year	Margin Money utilization (Rs. in crores)	Number of Units established	Employment - opportunities (in lakh persons)
2009-10	742.76	39502	4.20
2010-11	905.41	49819	4.82
2011-12	1057.83	55135	4.95
2012-13	1080.66	57884	4.28
2013-14	1075.54	50460	3.68

Source :KVIC Annual Report & KVIC Website.

gramme (PMEGP)

The Prime Minister's Employment Generation Programme (PMEGP) scheme was launched during the year 2008-09 (September, 2008), by merging the erstwhile Rural Employment Generation Programme (REGP), implemented by KVIC and PradhanMantriRojgarYojana (PMRY) implemented by DICs. This is a 'Credit Linked Subsidy Programme' for generation of employment opportunities through establishment of micro enterprises in rural as well as urban areas. KVIC is the Nodal agency at the National level for implementation of the programme.

PMEGP has emerged as the flagship scheme of the Ministry of

MSME. It is pertinent to mention that PMEGP will contribute significantly to the creation of first generation entrepreneurs in the unorganized sector who can eventually graduate to the organized sector.

Objectives of the PMEGP Scheme

- To generate employment opportunities in rural as well as urban areas of the country, by setting up new self-employment ventures/projects/micro enterprises.
- To bring together widely dispersed traditional artisans/rural and urban unemployed youth and giving them self-employment opportunities



to the extent possible, at their place.

- To provide continuous and sustainable employment to a large segment of traditional and prospective artisans, rural and urban unemployed youth in the country, for better livelihood and also to arrest the distressful migration of rural youth to urban areas.
- To increase the wage earning capacity of artisans and contribute to increase in the growth rate of rural and urban employment.
- To facilitate participation of the financial institutions for higher credit flow to micro enterprises.

Salient features of PMEGP

- The Scheme is implemented through KVIC and State/UT Khadi and V.I. Boards in Rural areas and through District Industries Centres in Urban and Rural areas in ratio of 30:30:40 between KVIC / KVIB / DIC respectively.
- No income ceiling for setting up of projects.
- Assistance under the Scheme is available only to new units to be established.
- Existing units or units those have already availed any government subsidy either under state/central government schemes are not eligible.
- Any industry including coir based projects excluding those mentioned in the negative list.
- Per capita investment should not exceed Rs. 1.00 lakhs in plain areas and Rs. 1.50 lakhs in hilly regions.
- Maximum project cost of Rs. 25.00 lakhs in manufacturing sector and Rs. 10.00 lakhs in service sector.

Physical Performance

The scheme registered an impressive performance. It has not only enabled the first generation entrepreneurs to set up their units, but also created a nation-wide entrepreneurial wave in every nook and corner of the country. The performance of the scheme is under.

Seeing the success of the programme in 12th Five Year Plan, an all time high allocation of Rs. 8060.00 cores as margin money and entrepreneurship development etc. has been allocated to set up 3.87 lakh units and generate about 30.57 lakh employment opportunities in the country.

Scheme of Fund for Regeneration of Traditional Industries (SFURTI)

To make the traditional industries more productive and competitive and facilitating their sustainable development, government of India had announced the scheme - "Scheme of Fund for Regeneration of Traditional Industries (SFURTI)" in October, 2005, with an initial allocation of Rs. 100 crores. Pursuant to this announcement, a central sector scheme titled the "Scheme of Fund for Regeneration of Traditional Industries (SFURTI)" was started.

Objectives of the SFURTI

- To make traditional industries more competitive with more market-driven, productive, profitable and sustained employment opportunities for traditional industry artisans and rural entrepreneurs
- To strengthen the local governance systems of industry clusters, with the active participation of the local stakeholders, so that



they are enabled to undertake development initiatives by themselves

- To build up innovated and traditional skills, improved technologies, advanced processes, market intelligence and new models of Public-Private Partnerships, so as to gradually replicate similar models of cluster-based regenerated traditional industries
- To organize the traditional industries and artisans into clusters to make them competitive and provide support for their long term sustainability and economy of scale
- To enhance marketability of products of such clusters by providing support for new products, design intervention and improved packaging and also the improvement of marketing infrastructure
- To provide common facilities and improved tools and equipments for artisans
- To strengthen cluster management systems with the active participation of the stakeholders, so that they are able to appreciate the emerging challenges and op-

portunities and respond to them in a coherent manner

- In addition to upgrading the skill and technology and providing reasonable wages, most of the clusters made remarkable achievement such as creation of website, publishing product-catalogue, obtaining ISO certification and export license etc.

The SFURTI has proved to be a revolutionary scheme for strengthening the traditional artisan base in the country and quite successfully creating both natural and induced clusters. It has provided employment to the artisans in the remotest corners of the country and saved many indigenous crafts and skills and made them not only remunerative but also fashionable.

As we all are aware that India is a land of diverse cultures and traditions with varied skills and handicrafts. According to office of Development Commissioner, Government of India, about 3000 clusters with district and product-wise details have been identified in the country. In these areas, traditional handicrafts and handloom products are being

produced by traditional artisans but the skill, technology, marketing and packaging etc. need to be improved and upgraded to protect and revive these age old skills and crafts of the Country.

In addition to above, Khadi and Village Industries Commission (KVIC) of government of India has also already implemented 76 clusters under the SFURTI programme. There is tremendous scope to identify and implement the development of at least one cluster in each district in India as almost every district in the country has some special skill and peculiar craft having the potential to provide employment opportunities to the people at their door step. It will not only strengthen the artisan base and support livelihood opportunities for existing artisans, but also may prove a game changer alongwith PMEGP in mitigating the curse of unemployment and in near future tackle quite effectively the migration of rural youth to the urban centres as well as provide remunerative employment in rural areas itself. It can also be a potent tool to sort out the problem of unemployment in urban areas and especially the people living in slums and sub-urban areas.

Hon'ble Prime Minister of India Shri Narendra Modi has called for a roadmap by underlining the directions in his speech delivered from the Red Fort on 68th Independence Day:

"I want to create a pool of young people who are able to create jobs and the ones who are not capable of creating jobs and do not have the opportunities, they must be in a position to face their counterparts in any corner of the world while keeping their heads high by virtue of their hard work and their dexterity of

hands and win the hearts of people around the world through their skills. We want to go for the capacity building of such young people. My brothers and sisters, having taken a resolve to enhance the skill development at a highly rapid pace, I want to accomplish this".

"Therefore, I want to appeal the entire people world over, from the ramparts of Red Fort, "Come, make in India", "Come, manufacture in India". In fact he extended a warm invitation to all to come and be a partner in changing the fate of unemployed people and make them productive



and useful for society.

Hon'ble Prime Minister further added, "I, therefore, urge upon the youth, in particular our small entrepreneurs that they would never compromise, at least on two counts, first, zero defect and second again ensure zero defect. We should manufacture goods in such a way that they carry zero defects, so that our exported goods are never returned to us."

As is evident from the above brief analysis, micro, small and medium enterprises play a pivotal role in the march of the country towards growth and prosperity. Instead of looking for Govt. and private sector for jobs which do not exist, youth should take the initiative in setting up micro, small and medium enterprises and achieve the

motto of 'Made in India' products with 'zero defect', generating employment opportunities not only for themselves but also for millions of others by setting up their own micro, small and medium enterprises.

It is said the journey of a thousand miles starts with the first step. The first step has to be taken by the unemployed themselves by resolving to stand up and do something themselves for themselves as well as the other unemployed people in the country. There are various schemes of Govt. of India and State Governments as well as of the various banks and financial institutions to render assistance to those who are willing to help themselves.

"Who is there to take up my duties?"

asked the setting sun.

The world remained dark and silent.

With joined palms said the earthen lamp,

"I will do what I can, my master!"

- Rabindranath Tagore

As is evident from the above brief analysis, micro, small and medium enterprises play a pivotal role in the march of the country towards growth and prosperity. Instead of looking for Govt. and private sector for jobs which do not exist, youth should take the initiative in setting up micro, small and medium enterprises and achieve the motto of 'Made in India' products with 'zero defect', generating employment opportunities not only for themselves but also for millions of others by setting up their own micro, small and medium enterprises.

The author is Former Chief Executive Officer, Khadi and Village Industries Commission



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B. GANGWAR



N. RAVISANKAR

Farming System Approach for Providing Sustainable Livelihood to Small Holders

Indian agriculture is dominated by small farm holders constituting 86 per cent households. The small farm (< 2 ha area) households (family size of 5-6 members) are often subjected to hardships due to negligible or low marketable surplus leading to distress and driving away to off-farm activities. Crop+animal production systems constitute the backbone of agriculture throughout the tropical regions and are highly significant in South East Asia where annual crops (rice, maize, pulses, oil seeds, vegetables) are integrated with livestock (buffalo, cattle, goat, sheep, pig, poultry, duck) and fish (capture and culture). In India too, crop and livestock cannot be separated for small holders as crop + livestock is the pre-dominant farming system existing in the country and livelihood of around 117 million marginal and small farm holdings revolves around this system. Commodity based research results have proven successful and beneficial mostly to medium and large size farm holders as they have more access to modern inputs, technology and finance. Technology infusion in a system approach is essential for small holders as their naturally integrated system has low rate of

recycling within the farm and heavily depends on costly market inputs. Besides ever growing population, the consumption pattern in rural and urban areas is fast changing thanks to the rising income and economic liberalization. The share of calories by food crops are already declining and it is expected to be below 50 per cent by 2050 indicating the increase in requirement of non-grain crops and animal products. Integrated Farming System (IFS) is considered to be powerful tool and holds the key for ensuring income, employment, livelihood and nutritional security in a sustainable mode for small and marginal farmers who have 44 per cent of total operational area. Integrated system meets the above goals through multiple uses of natural resources such as land, water, nutrients and energy in a complementary way thus giving scope for round the year income from various enterprises of the system.

Retaining experienced and young farmer in agriculture: National Sample Survey report indicates that more than 40 per cent of the farmers are willing to quit agriculture if better livelihood options through off-farm



employment are provided. Moving away of rural youth and experienced farmers from agriculture should be considered as important national issue. India's population is likely to rise from 1.21 billion in 2010 to 1.48 billion by 2030, and further to 1.6 billion by 2050. It is very important to note that, India will have the largest number of people in the working age group of 15-59 years. According to Census of India's population projections, Uttar Pradesh, Bihar, Madhya Pradesh and Rajasthan will account for more than 50 per cent of the increase in India's working age population and these states account for large number of operational holdings with almost equal share of operated area. These youth should be considered as innovators and change agents. Professional and business oriented farming system models development will be important to meet the challenge of retaining youth in agriculture.

SWOT analysis of small holders:

Availability of sufficient man power within the family, hard working nature with full time devotion for farming are considered to be the strength of small farms in India. However, the fragmented holdings, low level of literacy and low risk bearing ability due to poverty are often their weaknesses that expose them to vicious cycle of farming. The opportunities available are low interest loan and subsidy schemes from government agencies, presence of more than one enterprise and also easy addition of livestock through family labour. The threat will be weather vagaries and any failure in technology will affect the economy and irreparable loss. Considering the SWOT, diversification of small farms is essential mainly for reducing risks (associated with biotic and abiotic



Stall-fed goat for Any Time Money (ATM)



Utilization of homestead area for vegetable production at Kakdwip (West Bengal)

stresses, market price fluctuations and high input costs), meeting the requirement of family and market (food, fodder, fuel, fiber and fertilizer on one hand, soil nutrients on the other hand and demand of diversified products in the market) and for sustainable improvement of income, employment and standard of living.

Farming System Approach and its objectives:

Farming system can be simply defined as a positive interaction of two or more components within the farm to enhance productivity and profitability in a sustainable and environmental friendly way. A judicious mix of two or more of these farm enterprises with advanced agronomic management tools may compliment the farm income together with recycling the farm residues. The selection of enterprises must be based on the cardinal principles of minimizing the competition and maximizing the complementarity between the enterprises. In general, farming system approach is based on the following objectives:

- Sustainable improvement of farmhouse hold systems involving rural communities
- Farm production system improvement through enhanced input efficiency
- Raising the family income
- Satisfying the basic needs of farm families

Farming System Steps: Embedded general principle is an essential five-step procedure for farming system research and adoption

1. Classification: Classification is concerned with the geo-referenced identification of homogenous group of farmers with similar natural and socio-economic characteristics. It forms the basis for the setting of priorities and for targeting of research and extension to particular farm types.

2. Diagnosis: Diagnosis has to do with identifying the limiting factors, constraints and development opportunities of particular target farm types.

3. Experimentation and recommendation: Recommendations made from the knowledge, but in field situations which involves experimentation, either at the farm level or at the research station or at both, as a pre requisite.

4. Implementation: Implementation commitment is usually found in farming systems programmes directly through support to the extension agencies.

5. Evaluation: Evaluation is an important component and will lead to reappraisal preferably GPS location basis

Farming Systems Typology: Although, several farming system

exists in India, crop + dairy is the most pre-dominant system in the country and being practiced by 86 per cent farm households. The benchmark data collected from On-Farm Research mandated districts under AICRP on Integrated Farming Systems reveals that existence of more than 11 types of farming systems with number of components as high as five in a district [eg. crop + dairy + goat + sheep + poultry (2.7 %) in Warangal district of Andhra Pradesh & Crop + horticulture + dairy + fish + poultry in Angul district of Odisha (11.1 %)]. Even though, the number of households having the farming systems with more components are less, their presence in the farmers' field indicates that such systems are possible. Though the various types of farming systems exists in the country, integration of output of one component as input of other component within the system is either completely lacking or at a level of partial integration. Scientific integration of components is key for improving the 4 Rs (Reduce, Recycle, Reuse & Renew) and will hold key in realizing the targeted monthly net income of Rs. 25000 per ha in irrigated and Rs 10,000 per ha in rainfed systems. Achieving the targeted income is essential to provide a decent livelihood to millions of small holders in the country.

Farming System Models and Interventions: On-station IFS models results indicate that out of 31 models, 11 models could result in > 2 lakhs per year per ha as net income within two years of its start. Some successful models are Crops (0.50 ha) + Horticulture (0.10 ha) + livestock (2 cows) + Fish (0.10 ha) + Goat (20 +1) +Poultry (100 no's) + Duckery (30 + 5) at Patna (Bihar) which gives



Small scale mushroom production for diet diversification

Rs 3.03 lakhs/ha/year which is 348 per cent increase over prevailing farming system of crop + livestock (2 cows) only. Similarly, crops (0.81 ha) + horticulture (0.06 ha) + livestock (6 cows) + Fish (0.10 ha) + poultry (200 no's) + mushroom farming system at Varanasi (Uttar Pradesh) resulted in Rs 2.60 lakhs/ha/year which is 81 per cent higher than existing system. These systems have not only improved the income of household, but also improved the recycling of resources within the farm by 60 to 80 per cent compared to existing system. Due to the presence of more and more components, regular monthly income could be provided to the household for meeting the social, religious and health care needs of the family. Low and no cost interventions made in farming systems perspective using holistic approach in selected households of on-farm research resulted in 6.8 times increase in net returns within a year. Successful farming systems practiced by farm households needs to be replicated through appropriate policy of government. The results of on-farm

farming system interventions also reveal that the value of household consumption can be increased by 51.4 per cent due to the improved farming systems. The per day profit of marginal and small households can be increased by 69 per cent with an additional employment of 54 man days/year through interventions in various modules such as crop, livestock, processing and optional in farming system mode.

Household food and nutritional improvement: Every farm household in India should be self-reliant in 5F's (Food, Fodder, Fuel, Fiber and Fertilizer). The bench mark data from on-farm experimental marginal and small households indicates that they are spending 42 and 35 per cent of their earning towards purchase of food commodities to meet the household requirement. The food commodities purchased from outside the farm are costlier than those produced within the farm indicating a net loss in the earnings. A household having seven member non-vegetarian family (4 adults and 3 children) with 1 each

of buffalo and cattle in eastern Uttar Pradesh requires around 1095, 186, 91, 429, 98, 566, 76, 18000, 3600 kg of cereals, pulses, oilseeds, vegetables, fruits, milk, meat, green and dry fodder respectively where as the existing farming system of crop (rice, wheat, mustard, sorghum, chickpea and berseem) + livestock (1 each buffalo and cattle) in 0.76 ha produces sufficient cereals (4609 kg), oilseeds (111 kg), milk (1274 kg) and dry fodder (3700 kg) for the family but it is deficient in pulses (only 29 kg available in existing system) and green fodder (only 1.4 t available in existing farm) with no availability of vegetables, fruits and meat. Hence, suitable interventions in farming systems perspective are essential to meet the household need of balanced nutrition.

Green farming systems: Organic or green farming is a holistic way of agriculture, which tries to bridge the widening gap between man and nature. The concepts and principles of organic farming differ on many accounts with conventional or modern farming. Organic production systems aim at achieving optimal

ecosystems, which are socially, ecologically and economically sustainable. Although the organic agriculture practices cannot ensure that products are 'completely free' of harmful residues, as they may possibly trespass into the inorganic production systems through general environmental pollution also, but this is one of the major aims of organic farming and all feasible methods are used to minimize pollution of air, soil, water and farm products. The spread of organic farming on 1-5 per cent area in the high productive zone and large spread in the hill states would help to strengthen the organic movement. It will further strengthen our export-oriented programme under WTO regime. However, to make organic farming economically viable, issues like improving the productivity, reducing production costs, ensuring competitive price of organic produce to the grower in domestic and international markets, area approach of process certification are to be addressed at national level.

Bio-intensification to produce more from less: Due to fragmentation of land holdings and the average

holding size of marginal farm being only 0.32 ha, the strategy should be to produce more from less specially to ensure high income for small holders. The various land configurations evolved over the years offers scope for growing more than two crops at the same time in the same piece of land. Ten bio-intensive complementary cropping systems evaluated by the authors for higher productivity and profitability reveals that bio-intensive System of raising maize for cobs + vegetable cowpea in 1:1 ratio on broad beds (BB) and Sesbania in furrows during kharif and mustard in furrows and 3 rows of lentil on broad beds in rabi while 3 rows of green gram on beds in summer was found to be remarkably better than others which produced highest yield of 24 t/ha as rice equivalent with productively of 50.2 kg grain/ha/day and profitability of Rs.500/ha/day. The complementary effects could be reflected in the system as in broad bed and furrow (BBF) system, the furrows served as drainage channels during heavy rains in kharif which were utilized for in situ green manuring with 35 t/ha green foliage incorporated after 45 days of sowing. 30 per cent of irrigation water could be saved as water was applied only in furrows.

Intensification and diversification of existing farming systems with location specific scientific integration of components are essential to make agriculture profitable and there by sustainable providing decent livelihood to millions of small holders in India. Innovative and inclusive approach is very essential to succeed.

The writers are Director, and Principal Scientist, ICAR-Project Directorate for Farming Systems Research, Modipuram, Meerut



Integrated organic farming system model at Umiam (Meghalaya)



PROF. M. MONI

e-Governance in Farming Sector: Reforms through Information and Communication Technology (ICT) in India

Indian Agriculture sector is the largest employer in India's economy but contributed around 13.7 per cent in 2012-13. Rural India has about 70 per cent of India's population, as its demographic dividend, and is in need of better roads, potable water, education, health, supply chain, electricity, broadband, job creation, security and linkage to input and output markets, and technology. To make farming competitive and profitable, there is an urgent need to step up investment, both public and private, in agro-technology development and creation of new / modernisation of existing agri-business infrastructure. Rural India has enormous budget outlay for its development and its "Per Village Capita" Development Fund can usher in "sustainable development and inclusive growth" if Integrated Land Use Planning is adopted. Rural India has sustainable lifestyles but strives to have sustainable development and growth.

India emerges as an investment destination for agribusiness and food processing sector, in view of the sound factors viz., supply-side advantages, supply demand growth, conducive policy environment, increasing investments, and strategic location. Agribusiness means: inclusion of the farmer-crop insurance, financial inclusion,

improving price discovery mechanisms and delivering better value to the farmers; promoting value addition in crops-developing appropriate agronomic package for crops towards higher value addition; supply aggregation models for farmers - strengthening agri-clinics and farmer cooperatives. India has to advance in value-chain in fruit sector (as in Chile); to show its success in upgrading its production and subsequently the exports levels (as in China); and to attain global leadership in technological solutions (as in Israel -e.g. green house production technology).

According to UNESCO, e-Governance is the public sector's use of information and communication technologies with the aim of improving information and service delivery, encouraging citizen participation in the decision-making process and making government more accountable, transparent and effective. e-Governance facilitates interaction between different stake holders in governance, through conceptual framework viz., G2G (Government to Government), G2B (Government to Business), G2C (Government to Citizen) and G2E (Government to Employee). Expanded reach of government - both spatial and demographic - is the corner stone of e-Governance. The National e-Governance Programme (NeGP), approved with the project cost of Rs. 23000 Crores in May 2006, hasn't yet "expanded reach of Government", both spatially and demographically, in the Agricultural sector till December 2013.



Agricultural Informatics - An Emerging Area of Academic Research and Development

Over the last few decades, several research and development efforts have been made to exploit the potential of Information and Communication Technologies (ICTs) to improve the efficiency of production in agriculture and

to achieve sustainable development. Linking agriculture systems to sustainable development has challenged the efforts in adopting disruptive technologies that has provided opportunities to foray into the area of Agricultural Informatics. Globally, Agricultural Informatics, as an area, has been focusing on creating new breed of human resources to take up the renewed challenges in conceptualizing, developing, deploying and managing farmer-centric intelligent supply chains, proactive environmental impact oriented interventions, while ensuring sustainable agricultural systems. In India, there is huge potential to leverage on a mix of emerging and existing technologies for effective and inexpensive ICT penetration in agricultural development for productivity increase and farmer's income rise; and also to be the "global leader" in innovating solutions for problems of stagnation in agricultural sector, through research, education, development, extension and training in Agricultural Informatics.

Mckinsey Global Research Institute (MGI)'s Research Report titled "12 Technologies to empower India" (2014) identifies 12 technologies in six sectors (Health care, Education, Financial services, Agriculture, Infrastructure and Government Services) which can create \$550 Billion to \$ 1 Trillion of additional impact per year in 2025 and for the Agriculture Sector: "80 – 90 million acres of farmland can benefit from precision farming methods (using sensor and GIS-based soil, and water Data to guide farming decision), which would be taught by community agricultural extension workers using smart tablets; 90 to 100 million farmers can benefit from real-time market information delivered on mobile devices; IT systems

and digital communication can vastly improve PDS food procurement, storage and distribution processes, benefitting 300 million to 400 million individuals who depend on subsidized grains. The estimated collective impact of technology interventions in Agriculture is \$45 Billion to 80 Billion in 2025".

NDA-II Government's Priority Agenda

I wish to refer to the Hon'ble President of India's Address to the Joint Session of Parliament on 9th June 2014 and the Hon'ble Prime Minister's Speech in the parliament on 11th June 2014, which have stressed upon : (a) development through good governance, (b) Improving supply-side constraints on Agro and Agro-based products, (c) modernization of farming practices, (d) national land use policy, (e) availability of real-time data on agricultural products, (f) farm health management (soil health card), (g) "lab to land", (h) "per drop more crop", (i) multi-skill development, (j) Youth led development, (k) Internet connectivity to villages, and (l) digital India. While addressing the Agricultural scientific community on the 86th Foundation day of ICAR, at the NASC Complex in Delhi, on 29th July 2014, the Hon'ble Prime Minister of India, Shri Narendra Modi, had emphasized: (a) creation of a talent pool of young, educated and progressive farmers, and agricultural research scholars in all districts of the country", (b) Development of a digitized database of all agricultural research in the country, (c) Reaching out Agriculture technology to the farmers".

The Bharatiya Janata Party (BJP)'s 2014 Parliamentary Election Manifesto has also committed highest priority to agricultural growth, increase

in farmer's income and rural development, and use of IT for Agriculture for real-time information through the National Rural Internet and Technology Mission". As per the published reports, providing irrigational support to agriculture ("Pradhan Mantri Krishi Sinchayee Yojana"), extending rural credit, providing back-end support to the agriculture sector and informing farmers of the new innovations and new markets through the proposed Kisan channel, are part and parcel of the support package that the NDA-II Government wants to provide to the farming community.

Digital India Programme, as launched by the NDA-II Government on 20th August 2014, promises to transform India into a connected knowledge economy offering World-Class Services at the click of a mouse. "When we move a mouse, whole world moves" – Hon'ble Prime Minister, Shri Narendra Modi, said in Tokyo (Japan) during his official visit, on 2nd September 2014. The Digital India Programme is envisaged to provide "thrust to Nine Pillars of Growth Areas" viz., Broadband Highways, Universal Access to Mobile Connectivity, Public Internet Access programme, e-Governance : Reforming Government through Technology, e-Kranti (empowerment) : Electronic Delivery of Services, Information for All, Electronic Manufacturing, Jobs in IT Sector, and Early Harvest programmes.

ICT4Ag: A Digital Spring Board for Sustainable Agricultural Productivity

During my long tenure at National Informatics Centre, I was instrumental in visualizing and operationalizing "district information system" project of NIC (DISNIC) in 28 development sectors (Agriculture, Animal husbandry, Fisheries, Industries, Education,

SC Development, ST development, Health, Transport, Rural development, etc.), in about 512+ districts, way back in 1987-95, along with the establishment of NICNET facilities in all District Collectorate of the Country. This happened to be the first e-Government / e-Governance Programme in India and in the World. During 1995 – 2013, I was instrumental in visualizing and implementing ICT projects Viz., AGMARKNET, AGRISNET, SEEDNET, FISHNET, FERTNET, PPIN, APHNET (NADRS), WeatherNet etc., strengthening “ICT in Agriculture” in India, in collaboration with the Ministry of Agriculture.

Our Hon’ble President of India, during his inaugural address in the Asia-Africa Agri Business, on 4th February 2014, has said that (a) as demonstrated by the Action Plan for ICT for Agriculture, launched in 1995, India has recognized ICTs to be powerful catalysts for sustainable agricultural development, (b) there is need for ICT to facilitate the development of extension services, value chain, production and marketing systems, and agriculture risk management, (c) the ICT for Agriculture Plan calls for strong cooperation between Asia and Africa, and (d) during the ICT4Ag Conference, held in Kigali, Rwanda, from the 4th to the 8th of October 2013, stakeholders “highlighted the need to have a South-South Cooperation Programme on ICT for Agriculture”.

The AGMARKNET Project was operationalized in view of “Onion Crisis” happened during the then NDA-I Regime. This database can be a very big information source for the proposed “Kisan TV Channel” in India, which has information about

300 commodities (including around 2000 varieties) from about 3200 agricultural produces wholesale markets in India. Agriculture TV Channel through Cable TV (in Dindigul – Tamil Nadu), and Green TV Channel from Ahmedabad (Gujarat) have shown the way in India.

Measures for industrious consideration by the NDA-II Government

I wish to suggest the following measures for industrious consideration by the NDA-II Government, as Agriculture is an “Engine of sustainable and inclusive economic growth, inflation management and rural development”:-

Capacity Building for Sustainable Agricultural and Rural development at Grass-roots level

o Development of Natural Resources Accounting using GIS technology by associating “geographers” in each Panchayat, to be the basis for agricultural and rural development planning and programmes; Sustainable Natural Resources Management (NRM) is the backbone for the food security, nutrition security and environmental security at grassroots. This means that “environmental geography” has to gain its importance and to “catch up”. This means requirement of about 2.50 lakh Geography Experts, one for each Gram Panchayat, to provide advisory services on Natural Resources Management, by maintaining spatial data system and non-spatial data system in the Cloud Network through NFON of Panchayats;

o Capacity Building of Block level Officers of Agricultural Departments (Agriculture, Horticulture, Floriculture, Marketing, Animal husbandry and Fisheries etc), and Rural Development Departments, on Integrated Land Use Planning for sustainable agricultural and rural development, on priority basis, during the 12th Plan period, numbering about 25000; This was discussed in a National Seminar on the subject, organized at NIRD (Hyderabad, India) in June 2012.

Adoption of e-Governance in farm sector

Operationalization and Strengthening of Digital Network for Farmers (DNF) – AGMARKNET, AGRISNET, FISHNET, APHNET, PPIN, VISTARNET, AgRIS, FERTNET, CoopNet, etc.:-

- ❖ ICT Enabled Extension Services (Inputs, on-Farm, Off-Farm and Non-farm activities)
- ❖ ICT enabled Supply-Chain and Value-Chain Project for 300 Agricultural commodities – Agri-Business Network;
- ❖ Agricultural Marketing Information System Project
- ❖ Farm Health Management Information System Project to operationalize OneHealth/Eco Health Concept
 - Plant Health
 - Animal Health including Fish Health
 - Soil Health
 - Water Health
- ❖ Agricultural Resources Information System & Micro-level Planning (Farmhouse hold – Farm level)
- ❖ Networking of all Agricultural Co-operative Societies for providing State-of-the-art of “delivery of ser-

vices” – CoopNet;

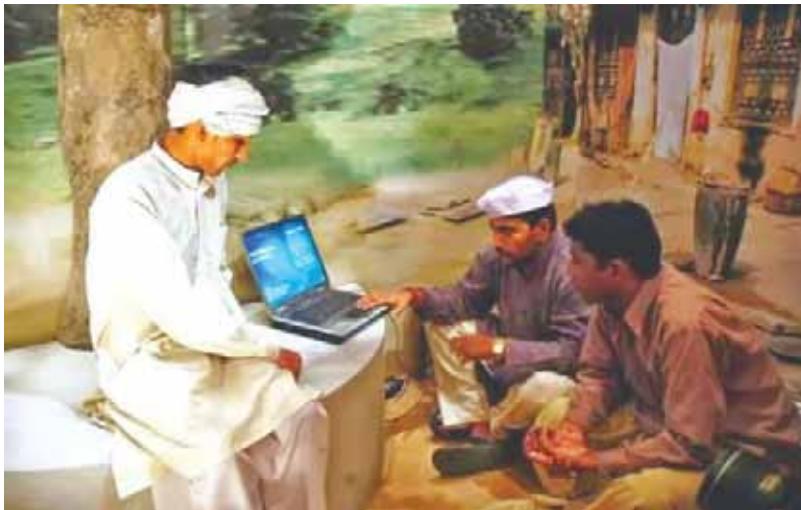
- o Establishment of a National Centre for Farm Health Management Research Studies under National Academy of Agricultural Sciences - Farm Health Management, ipso facto, includes (a) Soil Health Management, (b) Plant Health Management, (c) Livestock Health Management, (d) Fish Health management, and (e) Water Quality Management. Loss due to non-availability of scientific storage structures, distress sale, and pests and Diseases are becoming uncontrollable through inappropriate management services and actions, in the entire life-cycle of agricultural productions;

- o Implementation of Recommendations of National Mission on Sustainable Agriculture (NMSA) 2008;

Establishment of Agricultural Polytechnic and Agricultural ITIs in every Block to undertake “Competency Building” of YOUTHS in Agricultural entrepreneurship under PPP Model – one in each Block, in the form of Agriculture Polytechnics, Horticulture Polytechnic, Livestock Polytechnics, Fisheries Polytechnics etc. For e.g., Fisheries Polytechnics in the State of Manipur, Livestock Polytechnics in the Bundelkhand Region of Uttar Pradesh, Horticulture Polytechnic in Kanyakumari District;

Establishment of KrishiTV Channel in 22 languages (24X7) on priority basis on PPP model (recommended since 2007 – 11th Plan Working Group Report on Agricultural Marketing);

Establishment of National Centre for Agricultural Informatics and Computing linking it up with State Centres of IT in Agriculture (SCITAs) and District Centres of IT in



Agriculture (DCITAs);

Networking and Establishment of commodity wise FPOs (Farmer Producer Organizations) in every village and commodity wise Farmer Producer Companies (FPCs) in every district, to strengthen Agricultural Marketing and promoting of “good agricultural practices” in production of agricultural produces; Competency Building of Members of FPOs and FPCs in “Good Agricultural Practices” on priority basis;

Promotion and Government Support for M.Tech in Agricultural Informatics programme, initiated by the Centre for Agricultural Informatics and e-Governance Research Studies of the SHOBHIT University, for training about 100,000 agricultural graduates by 2020, through “Engineering e-Governance Research in Campus” Programme in NARS Institutions and in 4500 Engineering Colleges [who teach “Informatics and Computing”] of the country.

- The Hon’ble Prime Minister, during his maiden speech in the Parliament on 11 June 2014, has mentioned, among the other important issues related to the Agricultural sector, particularly

about the “non-availability of real-time data on agricultural products” for decision support in the Government. In this regard, it is relevant to see the following recommendations of the Report of the Sub-Group-5 : “IT and IT Usage in Agriculture Data, Agro-Climatical level and Small Area Farm Business” (April 2011), under my Chairmanship, suggested and presented to Prof. Y. K. Alagh, Chairman of the “Committee on Statistics of Agriculture and Allied Sector”, constituted by the National Statistical Commission, Government of India, during April 2011 :-

- ICT enabled Supply-Chains: ICTs Diffusion and Infusion have many potential applications spanning the breadth of the agricultural industry, at all scales of organization from farmer to cooperative and professional bodies, from farm machinery vendors, fertilizer and chemical companies, insurance, regulators, and commodities, to agronomists, consultants, and farm advisors, through “Access layer”, “Distribution layer” and

- “Network layer”;
- Overhauling existing Indian Agricultural Statistical System through ICT enabled process from “Farm-Household” and “Farm-level” to Panchayat, Block, District, State and Centre, by bringing the NARS Institutions (95 ICAR institutions, 50 State Agricultural Universities / Central Agricultural University (Public and Private), 300 Agricultural Colleges, 127 Zonal Agricultural Research Stations and 2200 Research Stations, 600 Krishi Vigyan Kendras), about 500 Departments of life sciences (Botany and Zoology) and about 250 Departments of Geography and Spatial Informatics. This will facilitate implementation of the World Bank-FAO’s Global Strategy to improve agricultural and Rural Statistics;
- Establishment of a National Centre for Agricultural Informatics and Communication with a mandate to undertake agricultural Informatics development, regional planning, research, education, training and extension for achieving sustainable agricultural development and getting 3600 view of Indian Agriculture;
- Restructuring of Directorate of Economics and Statistics (DES) by inducting ICT Professionals at appropriate level to make the Directorate ICT-enabled and to build Decision Support Systems (DSSs) based on database systems, experts systems and knowledge bases, by applying economic and statistical modeling and



- techniques. The restructured DES is expected to understand Cloud Computing which represents the confluence of technology and business developments in the Internet, Web services, computing systems, and applications that have evolved over the past few decades;
- Networking of all Agricultural Commodities and trade related organizations to strengthen the database and also for effective sharing rather than each one building “agricultural statistics” for their planning, management and administration;
- Necessary deterministic and desired focus to Agro-Climatic Regional Planning (ACRP), with renewed characteristics in the country (Section-6).
- Undertaking steps to implement the recommendations of National Mission on Sustainable Agriculture (NMSA) (Section-7) with appropriate funding of about INR 3000 Crores, to strengthen grass-roots level Informatics development for sustainable agriculture;
- Strengthening of “Digital Networks for Farmers (DNF)”, as spelt out in Section-9, by enlarging

- their scope (i.e. AGMARKNET to cover about 7500 Agricultural Wholesale Markets, 22000 Rural markets);
- Enlarging the basket of services under NeGP-A so as to bridge the existing gap of agricultural statistics in the country;
- Establishment of Agricultural TV Channel in 22 Languages;
- Development of Portals on 300 agricultural commodities in Indian languages, facilitating associated services to the farmers; each commodity has its own marketing channel.
- Formulating steps to implement the proposed National Agricultural Prices and Marketing Information System (NAPMIS) (Section-9 (e));
- Mobile based Application to automate Agricultural Information Flow System to e-bridging the Farmers and other stakeholders and also to promote ICT in Small Area farm business;
- Networking of all 5726 (as of 2008) Agri-Clinics and Agri-Business Centres (ACABCs) to strengthen Agricultural statistics and validation of ground truths;
- Need for establishing Farmers SHGs with a focus to achieve “financial Inclusion” of small and marginal farmers, and also the Networking of about 76708 Farmers Club established by various banks through NABARD funding;
- Implementation of Agricultural Resources Information System (AgRIS) and DISNIC-PLAN programme for establishing grass-roots level Informatics for sustainable agricultural development

- through Information modeling;
- Database development on the Water Availability and Requirement (WAR) at village levels, to facilitate water budgeting;
 - Establishment of Unified ICT Infrastructure up to Block Level for Database Development and Decision Support System (Chapter-15);
 - Establishment of Farmers' Service Centres (FSC) to be a "technology front", as per the Recommendation of the Dr. Rangarajan Committee on Financial Inclusion, to be financed by banks;
 - Regulatory Changes required in the existing "The Collection of Statistics ACT, 1953" for submission of data by institutions (public, private and cooperative), periodically for database development in various sectors, for strengthening the e-Governance programme in the Agricultural Sector;
 - Undertaking steps to achieve "data interoperability", in view of different agencies collecting data in different formats at different time intervals using different sample size, in the agricultural and allied sector;

The Report of Task Force on "IT in Agriculture", under my Chairmanship, submitted to the State Commission on Agricultural Research, Reforms and Development, Government of Jharkhand, in July 2007, had dealt with short-term, medium-term and long-term ICT adoption in the state. Indian Agricultural sector needs competent technical manpower in the area of Agricultural Extension to meet the changing needs of the stakeholders (i.e., farmers). The Agricultural Research & Education System (Agricultural Colleges, ICAR Institutes, Central and State Agricultural Uni-

versities, Krishi Vigyan Kendras and Zonal Research Stations), Agricultural Management and Administrative System of the Central and State Governments (which have up to block level agricultural offices), Agricultural Risk Management System (NABARD System, Finance, Insurance and Credit delivery systems) shall have an "integrated service approach" and a single window clearance (end-end solutions) for farmers for their farming activities. Existing and operational "Vertical silos" in Agricultural Services sub-sectors are necessarily to be re-engineered for seamless integration.

Farmers require technologies and best practices to sustainably exploit his agricultural resources for productivity increase and thereby income rise. The delivery of services to farmer shall be based on "Watershed Model" (many inlets but one outlet), wherein the Block level Agricultural Office (BAO) shall be converted to function as "Farmer Service Centre" with Government notified "Citizen Charter". The Mobile Phones and e-Post can bring a lot of changes to the Farming community with respect to "Information access and delivery". Information and content development (farm-specific and farmer-specific) has challenges and need to be overcome.

The National Animal Disease Reporting System (NADRS) of the Department of Animal Husbandry, Dairy and Fisheries (DADF) with 7034 nodes throughout the country, inaugurated in February 2013, has lost its steam now. The 12th Plan Period requirements for this project, submitted by me, when I was the Deputy Director General (Agricultural Informatics) NIC, are required to be approved at the earliest so as to enrich the NADRS Project in Country.

Many African and Asian Countries are looking towards India to understand the "best practices adopted" in designing and operationalizing the NADRS project, for implementation in their countries.

The agricultural sector has remained as an important contributor to the Indian economy. However, its sustainability is challenged by increasing population growth, decrease in land holding size for agriculture and environmental change. There are worldwide efforts in creating pool of knowledge to sensitize stakeholders involved in the entire spectrum of agriculture sector, generate human resource to support the sector with explicit knowledge, link farmers with academia, practitioners, policy makers and researchers in extending extension services in the supply chain. Social Media Network (LinkedIn) can link them together. The Measures suggested are required to be given appropriate attention by the Ministry of Agriculture to usher in ICT for effecting "e-Governance: Reforms through Information Technology", in the Indian Agricultural sector. India has the potential to lead "South-South Cooperation in ICT for Agriculture", as highlighted by our Hon'ble President of India in the Asia-Africa Agribusiness Forum held in February 2014 at New Delhi. I have already written to the Hon'ble Union Minister of Agriculture, Shri Radha Mohan Singh, on the above measures, vide my letter no: SHOBHIT University/MM/CAleGRS/2014-5 on 30th June 2014. Unfortunately, there is no acknowledgement from the Hon'ble Minister yet.

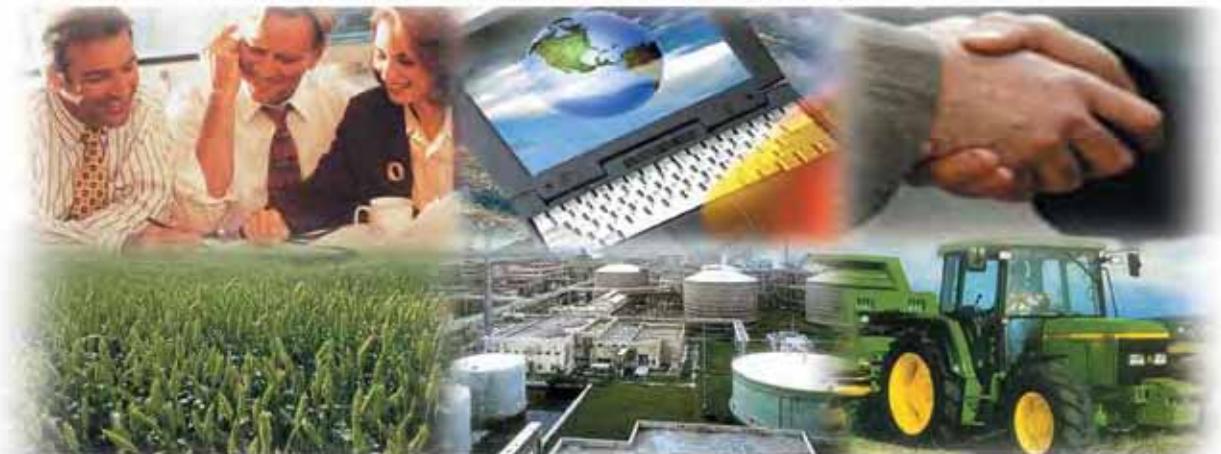
The writer is the Former Director General, National Informatics Centre, Government of India

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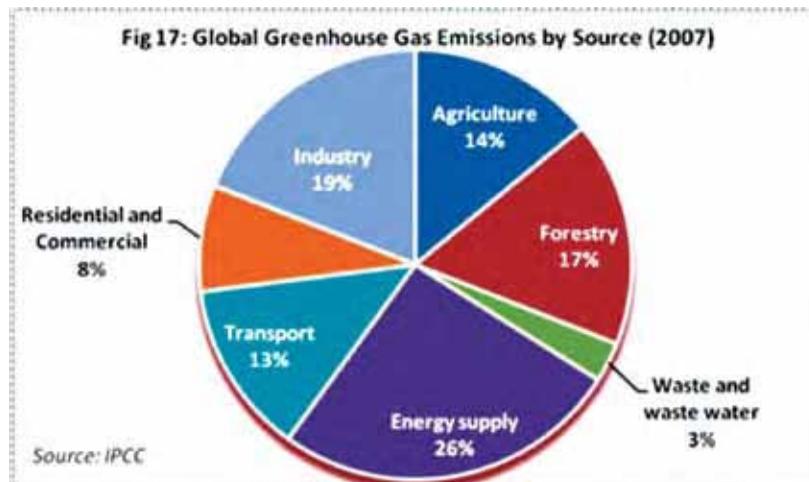
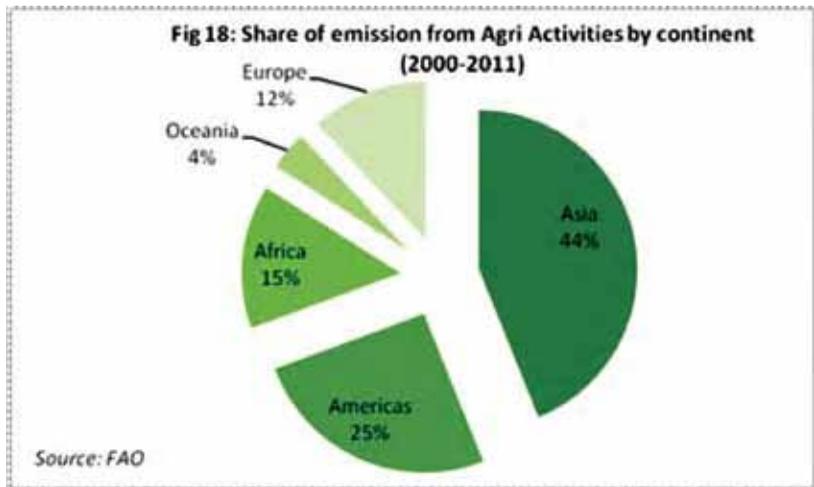
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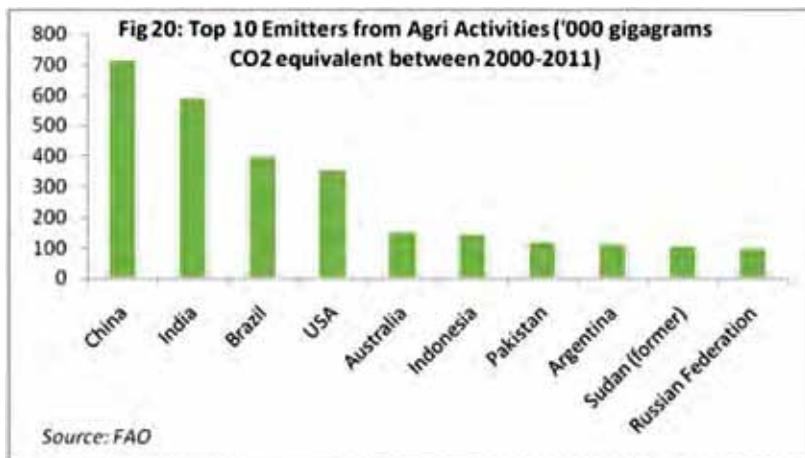
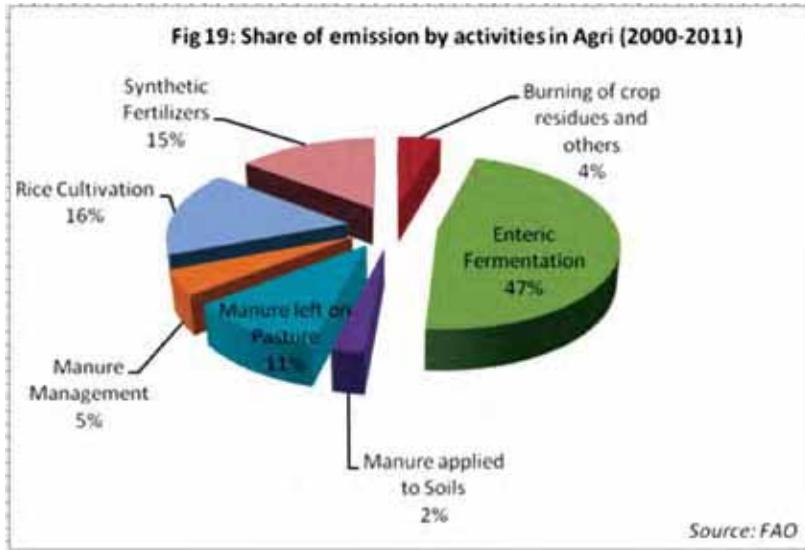
*Global Warming and
Sustainable Agriculture*

Agriculture is one of the largest contributors of green house gas emission and global warming. In 2007, from all the data collected from different sectors starting from 2004, it emerged that agriculture activities produces 14% of the total greenhouse gass (GHG) emissions (Fig 17). Emissions from various energy supply operations were the highest emitter with 26% of the share followed by industry. However, various forestry related activities do result in a significant emission of greenhouse gasses as a separate source. Forestry contributes 17%. In effect, therefore, together agriculture and forestry emits 31% of total global GHG emissions.

Specifically focussing on agriculture sector and share of GHG emissions by various regions, as seen in Fig 18, Asia contributes 44% of the global emissions accrued from various agriculture activities estimated over a long period between 2000 and 2011. Share of the Americas in the emission is 25%, followed by Africa (15%), Europe (12%) and Oceania (4%).

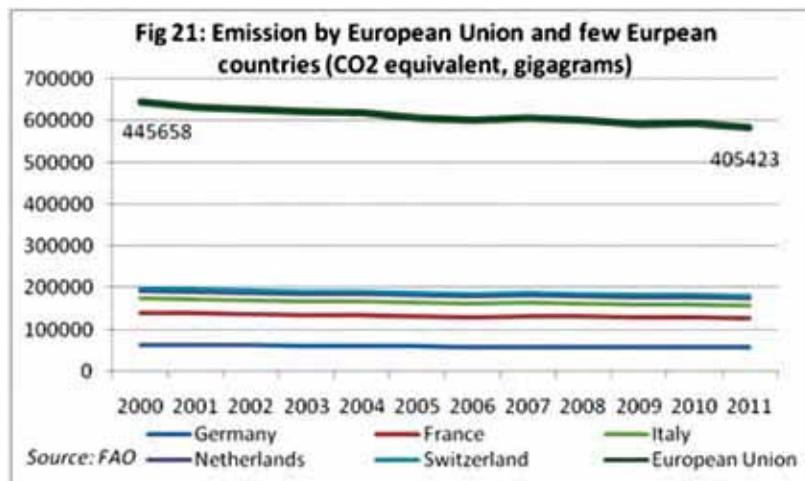


Within Agriculture, as seen in Fig 19, share of the total GHG emissions from agriculture sector as a whole is huge (Fig 19). Livestock, especially cattle, produce methane (CH₄) gas as part of their digestive activity. This process is called enteric fermentation, and when estimated during the period from year 2000 to year 2011, constituted almost half (47%) of the total emissions from the Agriculture sector. Other than enteric fermentation, rice cultivation worldwide is also a major contributor of global emissions. Between 2000 and 2011, emissions from



rice cultivation constituted 16% of the total GHG emissions from the agriculture sector.

Globally, India is the second largest emitter of GHG from agricultural activities with the highest emission being made by China. Between 2000 and 2011, China emitted 718 thousand gigagrams of CO₂ equivalent gases while India 592.3 thousand gigagrams of the same. Brazil and U.S.A are the third and fourth largest contributor with 401.2 and 355.2 thousand gigagrams of emission during the same period.



Amongst the different regions, Europe has been able to decrease its share of emissions significantly. The total emission of CO₂ equivalent gasses from the European region decreased by 9% from 445,658 gigagrams in the year 2000 to 405,423 gigagrams in 2011. Countries like Germany and France decreased the emission from agricultural activities during 2000 and 2011 by about 10% in case of each of the countries (Fig 21).



PROF. R.B. SINGH

GREENING AGRICULTURE FOR GREEN ECONOMY

Policy Options and Actions

A Global Priority

Over the past 50 years, almost coinciding with the beginning of the Green Revolution, the World has been seeking convergence of comprehensive food, nutrition, income, livelihood, and environmental security. Outcomes of several major international conferences, especially those organized and pursued by the United Nations, have been the guiding forces. Building on the eye-opening Rachel Carson's Silent Spring and Club of Rome's Limit to Growth, the first landmark UN Conference on Human Environment held in 1972 in Stockholm had enunciated as many as 26 principles for environmental protection and development. The highlight of the Conference was the most striking address of the then Prime Minister of India, Late Shrimati Indira Gandhi, who said "We cannot for a moment forget the grim poverty of large numbers of people", and asked "Are not poverty and need the greatest polluters". Thus, for the first time, poverty was linked with the environmental insecurity.

Since 1972, every 20 years, the UN has been organizing this most important global conference on saving humanity by saving environment. The

1992 Conference, The Earth Summit, held in Rio de Janeiro, heralded as "historic moment for humanity", adopted the famous Agenda 21, the most widely implemented program of action in all areas of sustainable development ever sanctioned by an international platform. The UN Framework Convention on Climate Change (UNFCCC) and Convention on Biological Diversity (CBD) were also adopted at the Earth Summit.

Twenty years later, held again in Rio de Janeiro, the UN Conference on Sustainable Development, 2012, popularly known as Rio+20, in its Declaration on The Future We Want called for global Green Economy "that protects the health of the environment while supporting the Millennium Development Goals through growth in income, decent work and poverty eradication". The Conference emphasized also on increased resource-use efficiency, vibrant ecology, climate smart agriculture, and inclusiveness towards an economically, socially and environmentally sustainable future. "Green Economy with Agriculture" was the key FAO message for Rio+20. It underpinned that Climate Smart Agriculture (CSA), which encompasses



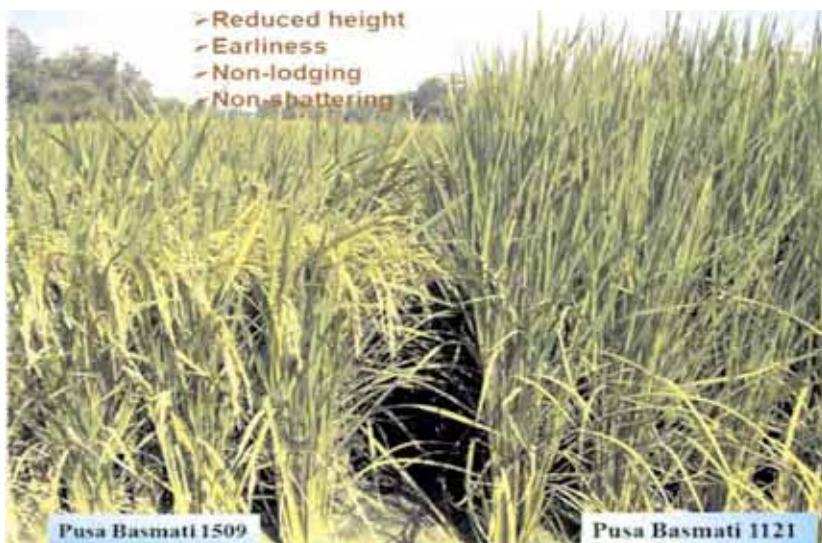
sustainable agriculture, enhanced productivity, adaptation to changing climate and GHG mitigation, with their associated technological, policy and investment implications, is the way to an evergreen future.

Rio+20 had also emphasized that the Planet Earth is under stress and three of the nine planetary boundaries, namely, biodiversity loss, climate change, and nitrogen cycle have already been crossed. This process of marginalization of the humanity at large and pushing people to the edges must be reversed. Nobel Laureate Professor Elinor Ostrom had urged all people in all countries to effect necessary policy changes to avoid irreparable damage to our planet, and had helped Rio+20 in preparing a blueprint to keep the humankind within safe natural boundaries.

One of the planetary boundaries is that the world must feed itself. Although globally the availability of food is no longer a problem, the perpetuating high incidence of poverty has rendered food economically inaccessible to nearly 1 billion people who remain hungry and another billion are malnourished. Given the high rates of population and income growths and accelerating urbanization, food demands for quality, quantity and diversity will intensify. FAO estimates that mostly in developing countries food production has to increase by 60 percent between now and 2050 to meet the demands, whereas the production resources, especially land, water, biodiversity, and fossil fuels are shrinking and becoming more fragile.

The Indian Enigma

India, since independence, between 1951 and 2013, had increased its foodgrain production over five fold, from 51 million tonnes to 263 million



tonnes. During the same period, milk, fruits, vegetables and fish production had swelled 8 to 10 times. The overall economy had also transformed, and during the decade ending 2010-11, the country had registered a high overall GDP growth rate of about 8 percent. Yet, unfortunately, the country is home to about one-fourth of the world's undernourished and poor, let alone the high social inequity. India is thus far from attaining Green Economy.

Notwithstanding the Green Revolution, Indian agriculture during the past three decades has failed to attain the targeted annual growth rate of 4 per cent. In the recent past, however, an agricultural growth rate of about 3.8 percent was recorded. But, as analyzed by Professor Ramesh Chand of the National Centre for Agricultural Economics and Policy Research (NCAP), the growth was fuelled by high commodity prices and not by increased total factor productivity. Net income gains to the farmers in real terms were negligible. Consequently, the gap between incomes of agricultural and nonagricultural workers, the former accounting for more than 50 per

cent of the population, has further widened beyond 1:4, as if we are living in two India.

Main Challenges and Issues

Among other things, India is today faced with three major challenges and development issues: (i) implementation of the National Food Security Bill essentially through home-grown grains seeking accelerated, enhanced and sustained national food and agricultural production, (ii) pushing up the overall GDP growth rate which has slumped to about 5 percent recently, including ensuring at least a 4 percent steady growth rate of Agricultural GDP through productivity gains (the situation got further aggravated due to the fall in Rupee value, increasing current account deficit, and inflating food prices), and (iii) increasingly visible negative impact of climate change not only in depressing agricultural productivity but also in increasing variability and volatility in total production, and the poorest and the hungriest are being hit the hardest by climate change.

The natural resources have degraded and the total factor productivity growth rate has declined. In

particular, groundwater potential has been exploited beyond 100 percent, and water availability, one of the foremost commons, has already reached critical level especially in the Green Revolution areas. Not only water (jal), but also the air (vayu) is getting overly polluted. For instance, in Delhi, the proportions of ozone and particulate matters have increased dangerously and the city ranks one of the poorest in environmental indices. The jal and vayu stresses are manifested in the climate (jalvayu) change-led increased vulnerability of agriculture and livelihood security. These non-green agricultural trends must be reversed and a much more productive, socio-economically rewarding, inclusive and environmentally sustainable agriculture (Green Agriculture) must evolve towards attaining Green Economy.

Since agriculture makes up roughly 14 percent of India's GDP, a 4.5 to 9.0 percent negative impact on production implies a cost of climate change to be roughly at 1.5 percent of GDP per year. Despite a fall in the share of AgGDP, from about 55 percent in 1950-51 to about 14 percent now, the role of agriculture remains crucial on counts of nutritional and employment security. Enhancing agricultural productivity, therefore, is critical for ensuring household level food and nutritional security and for alleviation of extreme poverty. In the absence of mitigation and adaptation strategies, the consequences of long term climate change could be even more severe on the livelihood security of the poor. Moreover, while the men and women both will be adversely impacted by the climate change, the women are projected to suffer more. With the increasing feminization of agriculture, this differential impact should be addressed judiciously.

Sustainable Productivity Growth

Greening of Indian Agriculture seeks doubling of the agricultural production essentially through enhanced productivity by the year 2050. As the natural resource base of agricultural production, encompassing land, water and biodiversity, is shrinking fast and the problem is further exacerbated by the increasing frequency and intensity of climate shocks, climate smart agriculture and highly efficient use of water and other inputs must comprise the main elements of Green Agriculture. The vast rainfed areas and coastal ecologies, which have relatively higher concentration of hungry and poor people, will face greater stresses. In such areas, in particular, the route to the Green Economy will be primarily through the greening of the vast grey agricultural areas. Synergistic integration of gene smart, water smart, soil and nitrogen smart, energy smart, carbon smart, weather smart, and knowledge smart development pathways will be needed to green the economy.

A sustainable productivity enhancement approach must be central to the Green Economy movement. A three pronged approach is called for bridging the serious yield gaps. First-

ly, by saving and consolidating the productivity gains already achieved, secondly, by extending the gains to areas which are yet to benefit from technological transformations and where significant yield gaps exist, and thirdly, by achieving newer and higher productivity levels – piercing the yield ceilings through mustering modern technologies and resource management practices.

The approach must be to create rich and dynamic knowledge domains to rationalize input use, enhance input-use efficiency, thus cutting down on the excessive use of water, fertilizers and other agrochemicals. In other words, produce more from less. This is very much in line with FAO's call "Save and Grow", and one can often substitute knowledge for purchased inputs. In this context, changing land-use practices such as the location of crop and livestock production, crop rotation, especially inclusion of legumes in the rotation, sequence and duration, rotating or shifting production between crops and livestock, and altering the intensity of fertilizer, water and pesticide application can help increase yield and at the same time reduce risks from climate change in farm production.

Serious attempts towards water



conservation and harvesting and improvement of irrigation accessibility and water use efficiency, coupled with fertilizer and overall input-use efficiency will be highly essential for agricultural production management. Farmers have to be trained and motivated for adopting on-farm water conservation techniques, micro-irrigation systems for better water use efficiency, selection of appropriate crops, etc. Principles of increasing water infiltration with improvement of soil aggregation, decreasing runoff with use of contours, ridges, vegetative hedges and reducing soil evaporation with use of crop residues mulch could be employed for better management of soil-water.

As highlighted by the Fifth Assessment Report (AR5) of the IPCC, 2014, science-led crop breeding will provide the much needed tolerance to the abiotic and biotic stresses. Multiple stress tolerant crop varieties combining genes for high yield and tolerance to submergence, drought, high temperature, and salinity are already giving significant yield and stability gains. The recent identification of a “thermostat” like gene, called *OSCA1*, by scientists at Duke University, USA, offers new opportunities for developing drought resistant crop varieties. Such researches deserve high priority.

Pusa Basmati 1509, a rice variety recently developed and released by the Indian Agricultural Research Institute (IARI), is a significant contribution towards “more from less” and “save and grow”. Being a 115 to 120 day high yielding quality rice variety, it’s per day, per litre water, and per kg fertilizer productivity is the highest in the contemporary world for Basmati or scented rices. This is a brilliant example of genetic alchemy for

convergent economic, environmental and social transformation. This genetic improvement will further consolidate India’s position as the world’s leading rice exporter, particularly of high quality aromatic rice, currently valued at nearly US\$ five billion. These developments must also induce creation, implementation and institutionalization of niche and differentiated production.

Pusa Basmati 1509 saves at least five precious irrigations and this saved water could be deployed for producing an excellent wheat crop in the subsequent season for free (in context of water) – “save and grow” in true sense. The Institute has also come up with an equally brilliant wheat variety - HD 2967. It is an exceptionally high yielding and widely adapted variety possessing multiple resistance to rust, especially yellow rust, and, most importantly, is resistant to extreme weather fluctuations, especially heat and cold. Further, fortunately, 60 day mungbean varieties capable of yielding about 1 t/ha on an average are available. Using conservation agriculture techniques, depending on soil moisture and water availability, a catch crop of mungbean between wheat and rice is a distinct possibility, augmenting the nitrogen and carbon economy, income growth and, above all, protein nutrition.

Science-Policy Interface

Developing Greener Agriculture should thus be a priority national goal. It must be recognized that the persisting, even worsening, socio-economic divides and inequalities are main hurdles in reducing hunger and poverty in developing countries. Science must continuously enrich development by providing rigorous scientific evidences which

will sensitize policy makers and help institutionalize science-policy interface at national, regional and global levels. National capacities for multi-disciplinary and participatory research, knowledge generation, building databases, science-informed policy-formulation, strategic planning and program implementation will need to be strengthened. A scientific approach and understanding of what drives adoption or dis-adoption or mal-adoption should help guide the national system in making more informed choices and decisions on guiding policies and investments.

Towards a Greener Agriculture, the following experiences gained in several countries should prove helpful:

- Assessing the current non-Green situation, defining the baseline (business as usual) and alternative development pathways.
- Understanding barriers to adoption of Green Agricultural practices which may include technological, institutional, financial, and market constraints.
- Building and sharing information on existing and expected social, economic and environmental development settings as assessed through deploying effective and realistic indicators.
- Assessing efficacy of various Green Agricultural practices and strengthening both adaptation to abnormal weather fluctuations and to extreme variations by ensuring access to reliable information and appropriate technologies.
- Providing agricultural insurance, based particularly on weather indices, with special attention to smallholder farmers. As recommended by the National Com-

mission on Farmers, a National Agricultural Risk Fund should be established to meet not only the emergency needs but also to institutionalize the risk management process.

- Defining coherent policies (technical, institutional and economic priorities) and policy levers for adoption of cost-effective measures for sustainable food, nutrition and livelihood security.
- Guiding investment based on cost benefit analyses of various proven practices.

Investment in science and research for development and the associated human resources should be linked with an effective monitoring, evaluation and impact mapping system. Innovative approaches to social safety nets will be needed to augment household resilience. The science-policy interface must be institutionalized to ensure that the rigour of science sensitizes policy makers and guides the policy process, options, actions, investment, incentives, and even implementation.

Efficacies of different policies related to greener and climate resilient agriculture and effectiveness of their implementation should be critically assessed. Policies such as those on Agriculture, Disaster Management, Food Security and Nutritional Adequacy, Water, Land etc. should be synergistically converged at different levels, particularly at the grassroots, such as at the level of the climate smart villages. Guided by outcome / impact pathway analyses, institutional adjustments and inter-ministerial convergence are needed to ensure judicious allocation of financial and other resources and program implementation.

Digital India to Green the Agro-Economy

Inter-connected knowledge platforms built through multi- and interdisciplinary research, technology and innovation are a must for developing greener agriculture. Under the recently launched Digital India, each village should become a knowledge centre. The ICT revolution should be capitalized for reaching the unreached large number of farmers. ICT-based agro-advisories promoted by private sector, such as Digital Green and IFFCO Kisan Sanchar Limited (IKSL), be supported both for their push component through which agro-advisory is disseminated to the farming communities (both in voice and text through mobile phones) and the pull component through which farmers are provided advisories on their real time problems in farming. A careful balance of push and pull factors should be promoted particularly for technology transfer and extension activities.

The knowledge platform can also be used for building an effective index-based agricultural insurance system, coupled with baseline information on critical factors and input and output markets, and in taking appropriate decision by farmers and other stakeholders. The system will help also in up-scaling climate smart village programs.

Way Forward

Adopting a human-centric approach emphasizing 'save and grow', 'more from less for more for ever', 'per drop more crop', seeking congruence of increased productivity, profitability, food-nutrition-livelihood-income security, bio-security, environmental sustainability, resilience to climate change, and, most importantly,

inclusiveness is the way forward. The veritable stakeholders – scientists, policy makers, development officers, private sector, NGOs and, of course, farmers should jointly address the multi-functionality of agriculture in a multidisciplinary mode.

The Green Economy movement will be green and evergreen only when agriculture becomes greener to wipe off the dark shadows of poverty and hunger. Development of Greener Agriculture emphasizing creation of water- and carbon-plus systems with minimal environment footprint should thus be mainstreamed in the national policy. In this resolve, we must protect and judiciously use our most precious common heritage and natural resource capital, JanJal, on the same lines as the Prime Minister's Jan Dhan Yojana, and link it with other such initiatives viz. Digital India.

Investment in science and research for development and the associated human resources needs to be doubled, and the research intensity should be reviewed every two to three years. An effective monitoring, evaluation, impact mapping and accountability system must soon be institutionalized under a national coordinating service. Smart science and knowledge domains should underpin our policy options, actions and priorities. Moreover, innovative approaches are needed to create and operate social protection floors. All these are needed today. The time is not on our side. The millions of hungry children cannot wait; they cannot be named "Tomorrow". We must act now.

The writer is Chancellor, Central Agricultural University, Imphal and Former President, National Academy of Agricultural Sciences, New Delhi

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- Reduce malnutrition
- Revitalize the environment

ICRISAT's work is focused on the **drylands**, which covers 55 countries in Asia and sub-Saharan Africa and are inhabited by 2 billion people, 644 million of whom are poor. These regions are most vulnerable to climate change with very little rainfall, degraded soils and poor social infrastructure.

We conduct research on **crops of immense value to the nutrition and economics** of the semi-arid tropics – **dryland cereals** (sorghum and millets) and **grain legumes** (chickpea, pigeonpea and peanut).

The Solution – Holistic Approach

By **analyzing key problems and opportunities**, we work along the whole **agricultural research for development** chain, **integrating social dimension**, in all stages:

Sustainable Intensification

- Managing soil and water
- Crop improvement
- Diversifying farms
- Developing on-farm practices and technologies

Building Agribusinesses

- Introducing processing technologies
- Facilitating market access
- Driving market development

Inclusive Market-Oriented Development

- 'Inclusive' of stakeholders in developing solutions, and ensuring that all benefit from the development, especially the poor and women.
- Market driven – moving the poor farmers from subsistence to a commercially oriented profitable business.

Our Capabilities

- **Multidisciplinary high-class science**
- **On the ground in Africa and Asia**
- **Strong networks**
- **Participatory approach**
- **Recognized as independent**



International Crops Research Institute for the Semi-Arid Tropics

About ICRISAT: www.icrisat.org
ICRISAT's scientific information: <http://EXPLOREit.icrisat.org>



ICRISAT is a member of the CGIAR Consortium

Contact information:

William D. Dar, PhD

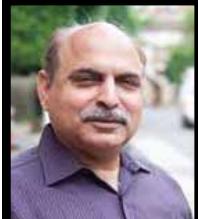
Director General
ICRISAT, Patancheru 502 324
Telangana, India
Tel +91 40 30713071
Fax +91 40 30713074
icrisat@cgiar.org



A. BIRAH



S. BHAGAT



M. SEHGAL



C. CHATTOPADHYAY

ROLE OF IPM FOR SUSTAINABLE AGRICULTURE

Philosophy of integrated pest management (IPM) has evolved over time through integrated crop production to integrated farming system targeted at improved crop health. IPM is knowledge intensive, requires holistic approach, expert advice, timely decision making and actions on fast track. Needs of farmers in pest management revolves around pest diagnostics, surveillance, forecasting and dissemination of expert information in short time.

Insect pests are well recognized as one of the major limiting factors in enhancing and sustaining agricultural production in India. Recent improvements from research brought considerable change in the cropping systems and allowed farmers to grow several crops throughout the year, which were very seasonal in the past. This also brought significant shift in the insect population dynamics and change in the status of several insect pests. Recent interactions with the farming communities revealed that 93 per cent of the farmers in India had adopted chemical control, 51 per cent farmers get their plant protection advice from dealers, while 22 per cent from extension officials and majority of the farmers (73 per cent) initiate the plant protection based on the appearance of the pest, irrespective of their crop stage, damage relationships and their population. The cost of plant protection on various crops ranged from 7 to 40 per cent of the total crop production cost. Though integrated pest management (IPM) has been advocated for the past two decades, only 3.2 per cent of the farmers adopted IPM practices in various crops. IPM research in the past decade brought out changes in the farmers' attitude in pest management, which resulted in reduction in pesticide use in different crops. The recent farmer participatory approach working in a consortium mode proved very effective in the exchange of technology. Though the results are encouraging, there is a need to further strengthen the IPM adoption in Indian

agriculture through increased investments in both basic as well as applied research in plant protection to overcome the prevailing three evil "Rs" (Resistance, Resurgence, and Residues). To be more effective, readdressing the policies for encouraging eco-friendly options and strengthening extension, involving farmers should be considered as high priority.

The declining trend in pesticide use in agriculture during the 1990s can be attributed to central government's fiscal policy and technological developments in pest management. During 1990s, taxes were raised on pesticides and phasing out of subsidies was initiated. Programmes on training of both the extension workers and farmers in the Integrated Pest Management (IPM) were started throughout the country. In fact, the Government of India had adopted IPM as a cardinal principle of plant protection in 1985. Even though, adoption of IPM has not been encouraging as biopesticides capture hardly two percent of the agrochemical market. Despite its techno-economic superiority over conventional chemical control, adoption of IPM remains restricted to hardly 2 percent of the



area treated with plant protection inputs. The structure of agrochemical market also suggests a similar level of adoption; biopesticides share only two percent of the agrochemical market in India. There could be a number of technological, social, economic, institutional and policy factors restricting large scale adoption of IPM.

India has successfully reduced pesticide consumption without adversely affecting the agricultural productivity. This was facilitated by appropriate policies that discouraged pesticide use, and favoured IPM application. Despite it, adoption of IPM is low owing to a number of socio-economic and other constraints. Lack of commercial availability of biopesticides and inappropriate institutional technology transfer mechanisms are the critical impediments to increased application of IPM. The presence of private sector in biopesticide production and marketing is trivial which needs to be improved. On the demand side, farmers though are aware of technological failure of pesticides to control pests, and their negative externalities to environment and human health, pest risk is too high to experiment with newer approaches to pest management. IPM is a complex process and farmers lack understanding of biological processes of pests and their predators and methods of application of new components. There are a number of IPM practices that work best when applied by the entire community and in a synchronized mode. Though many technology programs are based on community approach, they do not have any proper exit policy to sustain the group approach. The IPM policy should also provide incentives to farmers to adopt IPM as a cardinal principle of plant protection.



Biological control is also a very effective component of crop protection. Due to public awareness about the hazards related to use of chemical pesticides, there has been a lot of interest generated for use of eco-friendly strategies targeted at management of crop pests. For this purpose, bio-pesticides could be a cost-effective, eco-friendly and sustainable option, when proven source of host resistance / tolerance against several pests is not available. However, the quality, quantity, application method and timeliness play a significant role in determining the level of success of biological control. There are several success stories of biological control doing a commendable job in the field of crop protection. Successful biological management of papaya mealy bug and sugarcane woolly aphid alone have saved more than Rs.2.5 thousand crore (more than 4100 million US\$) in two years for the nation. Garlic bulb aqueous extract (2% w/v) has also been adopted by farmers and Government of Rajasthan in managing pests of Indian mustard. Use of quality

strains of *Trichoderma*, *Pseudomonas fluorescens*, etc. in recommended quantity even as seed treatment has been found very successful in managing dreaded diseases of different field and horticultural crops, which could protect from high yield losses. When they are combined with soil application and / or foliar spray, they result in even better impact not only in reducing pests, increasing yields, economic benefits but also in safeguarding the environment from dangerous chemical pesticide load. A few states have been more progressive in encouraging biological control of crop pests viz., Gujarat, Tamil Nadu, West Bengal, etc. Safeguarding intellectual property on strains of bioagents is an important issue in the present era. Accordingly, there is need to have DNA bar-code data of all such strains in order to sustain IPR. There is need to undertake a specific policy to encourage biopesticides, streamlining their label claim issues, simplification of process of registration for biopesticides with strict and adequate quality check from government departments

(CIPMCs, SAUs, etc.), increased support to biopesticide industry for scaling up of production as a matter of government policy (viz., subsidies to biopesticides, higher taxes on chemical pesticide industries, etc.), which shall also enable generation of employment for small / micro-industries at village level in line with concepts of model bio-village. This shall bring a paradigm shift in the chemical pesticide industry and transform them towards producing biopesticides.

Potential benefits of short-to-medium range weather forecast from numerical weather prediction (NWP) models or future climate projections have been least harnessed in India for regional crop protection services. Recent momentum to assimilate more updated satellite-based spatio-temporal atmospheric and land surface products from Indian geostationary satellites (Kalpana-1, INSAT 3A) for high resolution (5-15 km) weather forecasts from advanced NWP model such as WRF (Weather Research and Forecasters) is encouraging. Under the circumstances, precision pest management to reduce indiscriminate use of chemical pesticides could plan use of state-of-the-art technology through innovative and strategic research to devise Integrated Decision Support System (IDSS) for Crop Protection Services that suggests operational focus, research priorities and evolution in a phased manner, which could involve (A) periodic production of alarm zones encompassing 127 agro-climatic zones through well-tested models, weather forecast, high-resolution remote sensing data and operational crop map (B) (i) forecasting models for major pests, (ii) evaluation and improvement in qual-

ity of well-validated satellite-based products, improved data assimilation approaches, (iii) field-to-satellite-based remote sensing with high-resolution observations to differentiate among crops, among phenological stages within crop growth period, biotic stresses from abiotic stresses (moisture and nutrients), normal health and (C) Human Resources Development viz., (i) creation of experts on handling of spatial data, who could be intelligent enough to bring a positive change in the present practices of pest management and talented enough to complete the task, (ii) getting used to more of digital products for interpretation and (iii) regular feedback mechanism from farmers through network of KrishiVigyanKendras by using satellite communication; (iv) competence building at grassroots by increasing awareness of farmers.

Surveillance is the foundation of plant protection for early alert. But it is absent in most of the developing countries. In the recent past, the Information Communication Technology (ICT)-based system of real time pest surveillance has played an important role in our country in collection and transfer of data from remote villages to main station through internet. The information is compiled and displayed on the website in tabulated and graphical form and that can be directly accessed by SAUs for issue of advisory through State Agriculture Department by SMS to farmers and extension workers for implementation in farmers' fields. Potential of ICT has been witnessed by its impact on production and productivity under various programmes in different states as well as crops. There is dramatic reduction in outbreak of any

major pest on selected crops since the inception of ICT activity in different states. As the farmers are getting regular SMSs for IPM interventions, therefore, there is much awareness about IPM. Chemical pesticides are applied only when they are needed. The technology has already become an important component of IPM in different programmes implemented by state departments and it will continue to make significant impact on future strategies.

Holistic planning provides farmers with the management tools they need to manage biological complex farming systems in a profitable manner. A successful IPM programme requires time, money, patience, short- and long-term planning, flexibility and commitment. The research managers must spend time on self-education and making contacts with extension and research personnel to discuss farming operations, which vary widely. This would aid in developing integrated plans. The government could create policy environment for promotion of IPM. The central and state governments must take lead in changing the pest control picture through measures that would make chemical control less attractive through legislation, regulatory and fiscal measures. The Indian Council of Agricultural Research (ICAR) and the Department of Agricultural Research and Education of the Ministry of Agriculture, Government of India, are committed to the development and promotion of IPM in our country.

The authors are from ICAR - National Centre for Integrated Pest Management, New Delhi

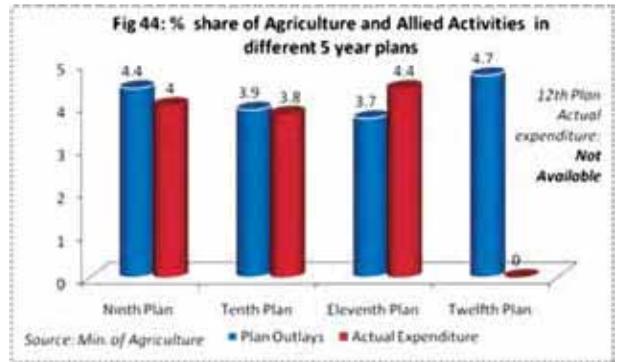
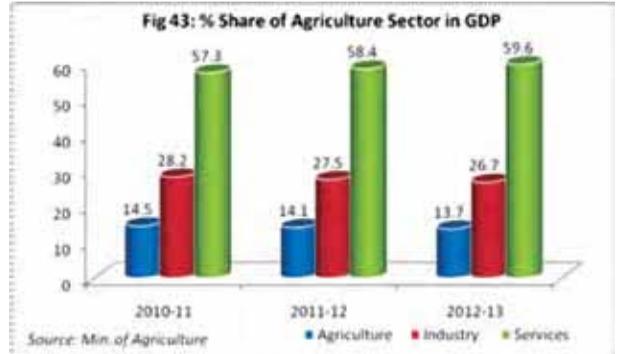
*Agriculture and Indian
Economy*

OVERVIEW

Although agriculture has still got a considerable share in the Gross Domestic Product (GDP) of India, however, it is declining over the years. In 2012-13, share of agriculture in the country's GDP was 13.7%. Industry had 26.7% share whereas the services sector constituted remaining 59.6% of GDP (Fig 43). In 2010-11, the share of agriculture was 14.5% in the GDP which fell down to 14.1% the following year (2011-12). Share of industry and the services sector in 2010-11 was 28.2% and 57.3% respectively while the same in 2011-12 was 27.5% and 58.4% respectively.

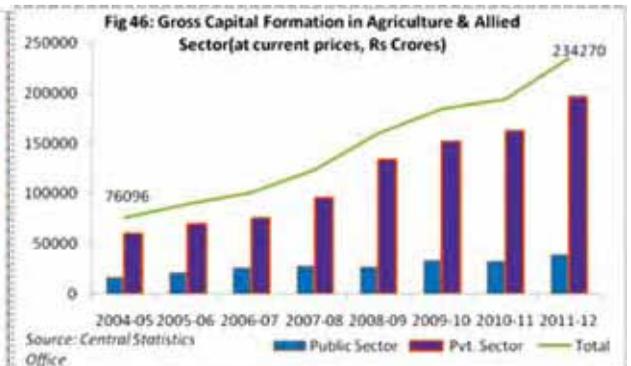
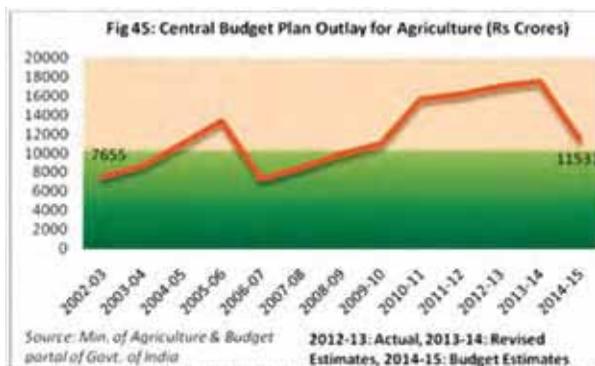
In the 12th Five Year plan of India (Five Year Plan 2012-2017), 4.7% of the total planned expenditure outlay has been allocated to agriculture and allied sector. This is almost an increase of 7% from the plan outlay in the ninth five year plan. In Figure 44, plan outlays vis-a-vis actual expenditure have been shown in different five year plans (except 12th FY plan where only actual expenditure is shown). During the ninth plan, as against the 4.4% of original plan outlay, ultimately 4% was the actual expenditure for agriculture and allied sector.

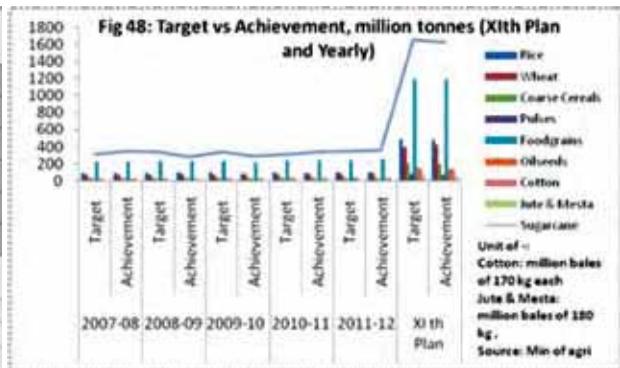
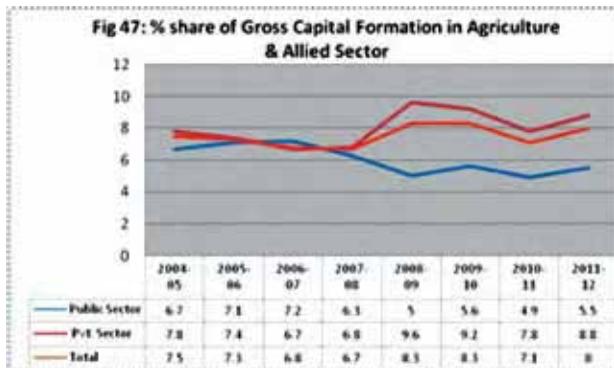
Plan outlay for agriculture in central government budget has witnessed fluctuations in different years. In 2002-03, the actual budget allocation for agriculture sector was Rs 7.6 thousand crores. In 2013-14, the budgetary allocation (revised estimates) was Rs 11.5 thousand crores which is 50.6% increase when compared to 2001-03. In the fiscal year 2006-07, the budgetary allocation for agriculture was reduced significantly to Rs 7.4 thousand crores. As compared to the previous year's (2005-06) budget allocation of Rs 13.4 thousand crores, this was a decrease of about 45%. The budget estimate for the agricultural sector in the current fiscal year of 2014-15 is Rs 11.5 thousand crores which is a significant 34.3% lower



than the budgetary allocation the previous fiscal year of Rs 17.5 thousand crores in 2013-14 (Fig 45).

Gross Capital Formation (GCF) from the agriculture sector has been increasing consistently during the past several years. The GCF contribution from the private sector has been many times more than that of the public sector every year. During a period





between 2004-05 and 2011-12, the total GCF has increased by more than 200% (Fig 46). In 2004-05, the GCF was Rs 76096 crores which in 2011-12 increased to Rs 234270 crores. During the same period, GCF in the public sector increased by about 138% when compared between 2004-05 (Rs 76096 crores) and 2011-12 (Rs 234270 crores). However, GCF growth in the private sector was much higher at 227% when compared between 2004-05 (Rs 59909 crores) and 2011-12 (Rs 195756 crores).

When studied in terms of percentage contribution of the private and the public sector in agriculture in the total GCF of the country as in Fig 47, a lot of fluctuations can be observed in the percentage contribution by the pub-

lic sector which ultimately decreases from 6.7% of the total GCF contribution of the country in 2011-12 to 5.5% in 2011-12. The private sector in ag-



riculture to the contrary increased its share of contribution from 7.8% in 2005-05 to 8.8% in 2011-12. The total contribution of the agriculture sector as whole in the total GCF of the country increased from 7.5% in 2004-05 to 8% in 2011-12.

A look at the status of target vs achievement of production of different agricultural crops during the XIth five year plan reveals that in 2009-10, almost all the crops failed to achieve their yearly targets miserably (Fig 48 and Table 4). That year, monsoon failed and cultivation of almost all the crops was affected. Overall, by the end of XI th five year plan in 2011-12, except wheat and cotton, all other major crops or crop categories failed to achieve the targets.

Table 4: Target vs Achievement, million tonnes (XIth Plan and Yearly)

Crops	2007-08		2008-09		2009-10		2010-11		2011-12		XI th Plan	
	Target	Achievement	Target	Achievement								
Rice	93	96.69	97	99.18	100.5	89.09	102	95.98	102	104.32	494.5	485.26
Wheat	75.5	78.57	78.5	80.68	79	80.8	82	86.87	84	93.9	399	420
Coarse Cereals	37.5	40.76	42	40.03	43.1	33.55	44	43.68	42	42.01	208.6	200.03
Pulses	15.5	14.76	15.5	14.57	16.5	14.66	16.5	18.24	17	17.21	81	79.44
Foodgrains	221.5	230.78	233	234.47	239.1	218.11	244.5	244.78	245	257.44	1183.1	1185.58
Oilseeds	30	29.76	31.75	27.72	31.6	24.88	33.2	32.48	33.6	30.01	160.15	144.85
Sugarcane	310	348.19	340	285.03	340	292.3	315	342.38	350	357.67	1655	1625.57
Cotton	22	25.88	26	22.28	26	24.02	26	33	34	35.2	134	140.38
Jute & Mesta	11	11.21	11	10.37	11.2	11.82	11.5	10.62	12.3	11.57	57	55.59

Min. Of Agriculture, Govt. Of India

SUMANA SARKAR

Changing Face of India's Agriculture Trade

Agriculture has been a source of foreign exchange for India over the years. Indian agriculture has greatly contributed to foreign trade even in its traditional form. The performance of agriculture upon integration with the world markets in a liberalized regime, post globalisation is largely linked to the success of exports. While the growth performance of Indian agriculture sector has been fluctuating across the Plan periods, exports of agricultural products have exhibited reasonable performance during recent years.

Exports of agricultural products from India in terms of value increased at a compounded annual growth rate (CAGR) of 16.6 per cent from the year 2000-01 to 2013-14. The share of agricultural products in total exports, however, decreased marginally from 13.9 per cent in 2000-01 to 12.5 per cent in 2013-14. This may be seen compensating in India's increasing share in global exports of agricultural products during the period. India's share in global agricultural exports has increased at a CAGR of

18.7 per cent during the same period from 1.1 per cent in 2000 to 2.7 per cent in 2013.

Composition of Agriculture Exports

India has been a major supplier of several agricultural commodities, such as tea, coffee, rice, spices, cashew, oil meals, fresh fruits, fresh vegetables, and marine products to the international markets. However, in the recent years composition of Indian agricultural exports has been undergoing considerable change. While in value terms there has been an increase in exports across product category from 2000-01 to 2013-14, an analysis of their shares in total agricultural exports reveals that the shares of traditional items in total agricultural exports, such as marine products, oil and oilseeds and tea and coffee have significantly declined during the period. Cereals, however, continues to remain as

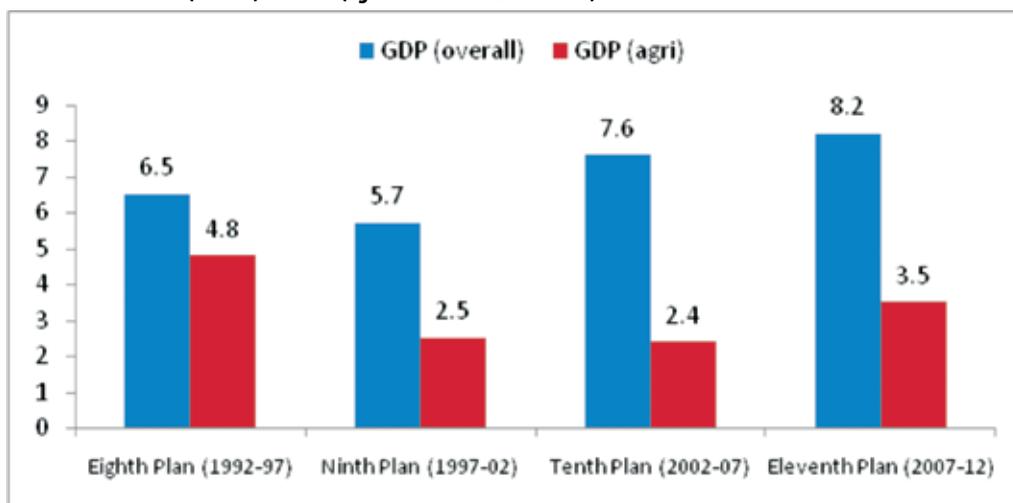
one of the leading export items in India's agricultural exports.

Destination of Agricultural Exports

A study of the export destination of agricultural products from India, in the recent years, reveals



Growth Rates – GDP (overall) and GDP (agriculture and allied sector)



Source: CSO

Agricultural Exports from India

Year	Exports		
	All Products	Agricultural Products*	Share
	US\$ million		(%)
2000-01	44560.3	6184.1	13.9
2005-06	103090.5	9776.9	9.5
2010-11	251136.2	21386.6	8.5
2013-14	314405.3	39325.0	12.5

Source: DGCIS



a distinctive shift from traditional markets of EU, USA and Middle East to newer markets in Asian and African regions. While there has been an addition of new regions, there also has been expansion to new markets in the existing regions of exports. This shift has been observed in both traditional items of export as well as in new items.

The Table above shows, while USA, Japan, China and EU member countries traditionally make up the top export destinations for marine products from India; in the recent years, Southeast Asian countries, such as Vietnam and Thailand have also emerged as key destinations for marine exports from India.

Similarly, meat and meat products, which emerged as a major export item in India's agricultural export basket, in the recent years, have diversified widely in the Southeast

COMPOSITION OF INDIA'S AGRICULTURAL EXPORT

Products	2000-01	2005-06	2010-11	2013-14	Share (2000-01)	Share (2013-14)
	US\$ million				(%)	
Cereals and preparations	783.0	1662.4	3444.1	10861.9	12.7	27.6
Meat products	318.9	616.5	1960.7	4475.5	5.2	11.4
Fruits	599.3	850.0	1137.7	1412.4	9.7	3.6
Vegetables	265.0	567.9	897.6	1356.1	4.3	3.4
Tea, Coffee & spices	857.6	905.1	2181.3	2746.6	13.9	7.0
Floriculture products	29.1	68.1	64.9	75.3	0.5	0.2
Dairy & dairy products	45.6	250.0	248.7	705.1	0.7	1.8
Marine products	1376.4	1421.2	2321.0	4823.0	22.3	12.3
Processed food	235.5	615.6	1162.4	1572.8	3.8	4.0
Sugar & sugar confectionery	119.4	168.5	1335.3	1354.9	1.9	3.4
Cocoa & cocoa preparations	3.0	5.6	27.9	94.0	0.0	0.2
Oil seeds & Oleo, Oilmeals	333.4	421.4	1243.9	1709.4	5.4	4.3
Beverages, spirits & vinegar	37.1	58.3	186.8	409.0	0.6	1.0
Lac, gums, resins & other vegetable saps & extracts	235.3	398.9	853.3	2414.9	3.8	6.1
Residue & waste from food industries	462.0	1122.9	2519.7	3047.7	7.5	7.8
Tobacco & manufactured tobacco substitutes	190.7	300.6	875.3	1011.4	3.1	2.6
Total	6184.1	9776.9	21386.6	39325.0	100.0	100.0

Source: DGCIS, Exim Bank Analysis

Changing export destinations for marine products from India

2000-01		2005-06		2010-11		2013-14	
US\$ million							
Japan	506.1	U S A	338.9	U S A	377.9	U S A	1,225.1
U S A	237.1	Japan	223.7	Japan	301.8	Viet Nam	964.6
China	115.8	China	138.5	China	273.7	Japan	396.7
UAE	71.0	Spain	106.3	Spain	157.1	Belgium	205.6
U K	60.9	Belgium	90.4	Hong Kong	131.4	China	188.9
Spain	44.3	U K	72.0	Viet Nam	128.3	Spain	160.3
Taiwan	34.5	UAE	46.2	Italy	101.8	Thailand	149.7
Italy	29.4	Canada	37.2	Thailand	94.3	U K	138.6
Thailand	28.0	Hong Kong	37.2	Belgium	87.9	UAE	130.3
Belgium	19.5	Italy	36.3	U K	69.8	Italy	123.4
Total	1,376.3	Total	1421.1	Total	2,320.9	Total	4,822.9

Source: DGCIIS

Asian markets, such as Vietnam, Thailand, Malaysia, and Philippines, which were earlier confined to Middle East and African markets.

In Sum

The buoyancy in exports of agricultural products in India's total exports has been evident with its rising share in

the recent years. While there is an increase in the absolute quantum of agricultural exports, there is consistent decline in the percentage share of primary products in total export from 17.9 per cent during the 1990s to 12.5 per cent during 2013-14. Cereals have been the only traditional item contributing to the growth story of

agriculture exports in India. Since the opening up of exports of rice in 2011, there has been a surge in its share in total exports by more than three-fold from US\$ 2,575 million in 2010-11 to US\$ 7,742 million in 2013-14.

Similarly, exports of some of the non-traditional products, such as guar gum also showed an increase of over six-fold from US\$ 194 million during 2009-10 to US\$ 3,270 million in 2012-13 due to increased international demand. However, since India exports it in raw and semi-processed forms, we have not been able to realise its full potential and has lost out on fetching higher prices in the international markets, which is realized by the importing countries post value-addition. India should thus focus on exports of more value added products for better price realization of its agricultural exports.

Although India is a major supplier of several agricultural commodities, the country faces fierce competition from other major players in the field, both the existing and new entrants in the fray mainly within Asia, such as China, Vietnam, Thailand, Malaysia and Philippines. In order to sustain in this competitive environment, stable and long-term trade policy with respect to export of agricultural products is essential. Further, incentivizing the development of the agro-processing sector may enhance overall productivity of the agricultural sector giving fillip to value added agricultural exports. A mix of more value added products along with traditional products may help India to increase its foothold sustainably in global agricultural export markets.

The author is Head – Agriculture Research, Research and Analysis Group, Exim Bank

Changing export destinations of meat and meat products from India

2000-01		2005-06		2010-11		2013-14	
US\$ million							
Malaysia	80.7	Malaysia	112.8	Viet Nam	281.7	Viet Nam	1,797.5
Egypt	63.0	Saudi Arabia	63.4	Malaysia	237.4	Malaysia	388.7
UAE	51.4	Philippines	60.8	Egypt	231.4	Egypt	338.2
Philippines	43.9	UAE	49.8	Saudi Arabia	179.4	Thailand	296.7
Iran	12.8	Jordan	49.7	Philippines	116.1	Saudi Arabia	280.1
Jordan	12.2	Angola	49.6	Jordan	113.4	UAE	188.9
Oman	9.6	Kuwait	49.2	UAE	96.9	Jordan	149.7
Saudi Arabia	7.1	Iran	19.0	Kuwait	72.6	Algeria	139.6
Kuwait	5.8	Viet Nam	18.8	Myanmar	71.5	Philippines	119.1
Angola	5.6	Georgia	16.4	Algeria	63.6	Iran	117.3
Total	318.9	Total	616.5	Total	1,960.71	Total	4,475.5

Source: DGCIIS



DR. J S SANDHU

India's Food Security – Fallout of Pro Agro Policies

It is first and prime most duty of any Government to ensure food security to its citizens. India got independence in 1947 and since that time, the foremost task in front of the Government of India was to provide food security to its citizens. In 1950, total food grains production of the country was 50.82 million tonnes and population was 361.1 million. Thus, per capita per day availability of food grains was just 395 grams which was inadequate to meet the daily requirement. Hence, to meet the domestic demand, additional 4.80 million tonnes food grains were imported. As early awakening of nation, the honorable Prime Minister Pandit Jawaharlal Nehru rightly said “everything else can wait but not agriculture”. With this resolve India started journey of agriculture development in the country.

First historical policy decision was taken by the Government in 1966 to import 18000 tonnes of seeds of high yielding wheat varieties from Mexico, and its distribution in small quantities to a large number of farmers. It is in itself a kind of a record for importing such a huge quantity of seeds in one go. The Indian farmers realized the potential of new seeds. Simultaneously,

segregating wheat materials from CIMMYT were also imported and given to Indian Agricultural Research Institute, New Delhi and State Agricultural Universities. Almost at the same time, high yielding, semi-dwarf rice varieties from International Rice Research Institute (IRRI) were also introduced in the country. The new high yielding varieties of both wheat and paddy were semi-dwarf, lodging resistant, photoinensitive and responsive to fertilizers and other agronomic practices. To exploit full potential of new varieties, the government of India also taken various policy decisions to incentivize the farmers by providing to them chemical fertilizers, seed, irrigation & creation of irrigation facilities, farm machinery, farm power etc., at subsidized rate.

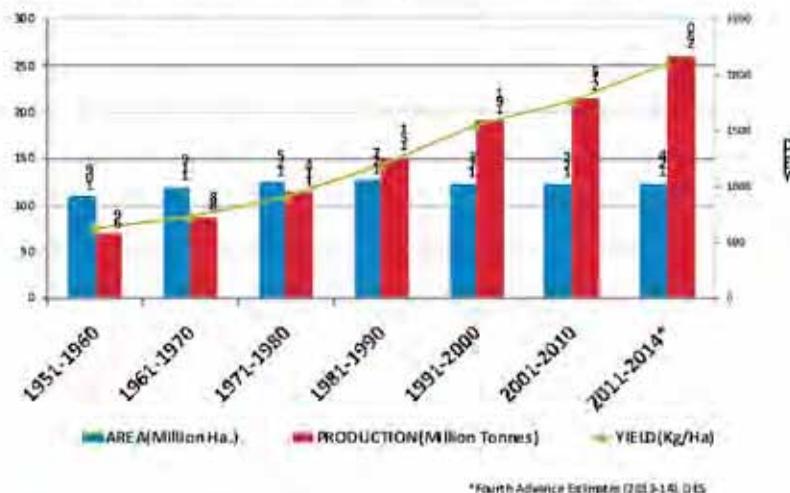
Another important historic policy decision of government was to announce the Minimum Support Price (MSP) Scheme for first time in the wake of Green Revolution taking firm roots in the Indian soils. MSP scheme has now extended to other crops as well, and as of now 25 crops are covered under this scheme. Under this scheme mainly wheat and paddy produce is being procured to ensure the marketing of these commodities.



As a result of various policy decisions of the government, there was an unprecedented increase in food grains production from 50.8 million tons in 1950-51 to 264.17 million tons (4th Advance estimate) in 2013-14. The increase in production was from expansion in area until 1981-1990, and after that no significant change in area was noticed under food grains crops. Enhancement in productivity at a steady pace is other important factor for continuous increase in food grains production. Expansion in irrigation infrastructure has led to increase in area under irrigation of food grains from 18.1 per cent in 1950-51 to 47.8 per cent in 2010-11 which is another critical factor for boosting the food grains production in the country, as both wheat and rice crops respond to irrigation.

In spite of the phenomenal increase in food grains production, in 2006, it was estimated that total food grains requirement by the end of XI plan (2011-12) would be 235 million tonnes as population of country was also growing. In 2006-07, total food grains production was 217.28 million tonnes, and there was a need for additional production of 18-20 million tons by 2011-12. Keeping this in view, the Government of India launched National Mission for Food Security (NFSM) in 2007 to target additional 20 million tonnes (Rice 10, Wheat 8 and Pulses 2 million tons) of food grains by the end of XI plan. The Mission aimed at achieving additional production of 20 million tonnes of food grains through technological interventions in low productivity areas and with following objectives: i) Area expansion and productivity, ii) Restoring soil fertility and productivity and iii) Creating employment opportunities.

Total Food grains Area, Production & Yield (1951-2014)



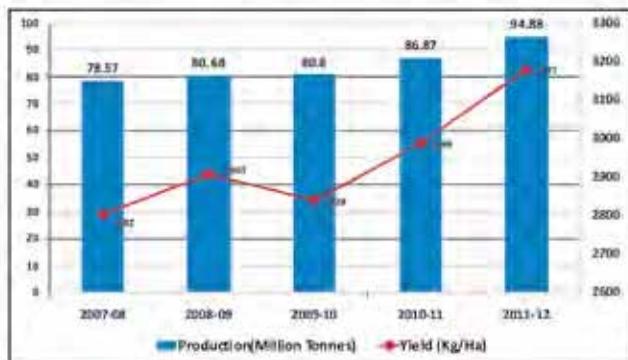
Eastern States generally have low crop productivity and cropping intensity. This is despite the fact that the region has been bestowed with very favorable climatic conditions for year round cropping. With a view to ensure optimal use of available natural resources (land and water) for improving crop productivity and cropping intensity, in 2010-11, an important decision was taken by the Government of India to boost rice production in the Eastern States of India and launched "Bringing Green Revolution in Eastern India" (BGREI) a sub scheme of Rashtriya

Krishi Vikas Yojana (RKVY). The major objective of this scheme was to address the production constraints of rice based cropping system in the eastern states. The latest production technology was demonstrated in cluster mode with each cluster of 100 ha besides distributing seeds of new varieties/hybrids, micro-nutrients, soil amendments, pump sets, water carrying pipes, construction of check dams, farm ponds, promotion of sprinklers, marketing support etc. through these programmes.

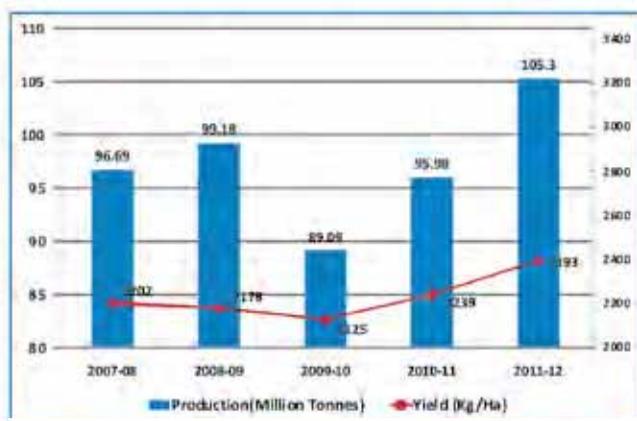
Similarly to boost the production of millets, another sub scheme of RKVY



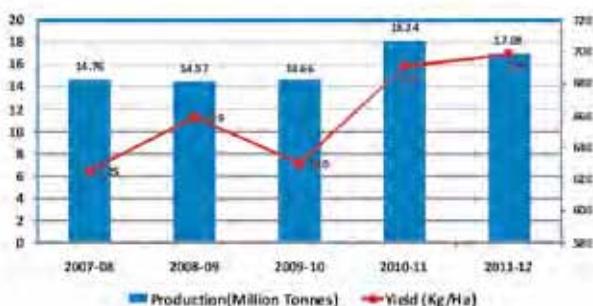
Wheat Production & Yield In XI Plan (2007-08 to 2011-12)



Rice Production & Yield in XI Plan (2007-08 to 2011-12)



Pulses Production & Yield XI Plan (2007-08 to 2011-12)



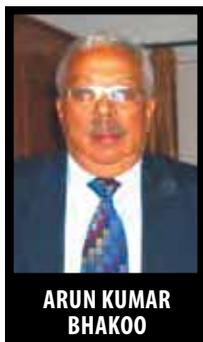
entitled "Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP)" was launched by the Government in 2011-12. The scheme was aimed to demonstrate improved production and post-harvest technologies in an integrated manner with visible impact to catalyze increase in production of millets in the country. Besides increasing production of millets, the Scheme through processing and value addition techniques was expected to generate consumer demand

for millet based food products. Implementation of INSIMP has made a significant contribution in area expansion, adoption of improved package of practices over larger area, improvement of yield, creation of post-harvest infrastructure, value added food products, awareness and demand for millet grains in the country. The scheme remained under implementation in 2012-13 and 2013-14. During XII Plan this scheme has been subsumed with National Food Security Mission (NFSM).

These programmes have led to a substantial increase in production of wheat from 78.57 million tonnes (2007-08) to 94.88 million tonnes (2011-12), rice from 96.69 million tonnes (2007-08) to 105.3 million tonnes (2011-12) and pulses from 14.76 million tonnes to 17.09 million tonnes (2011-12). Total increase in foodgrain production by the end of XI plan was 42.01 million tonnes. Thus, more than targeted additional food grains production of 20 million tonnes was achieved through successful implementation of programmes across the country. Both the programmes NFSM and BGREI are continued in XII plan as these programmes played a significant role in overall development of agriculture in country.

Over the years, different government policies have made visible impact on food grains production. The India which was known for 'ship to mouth existence' up to mid-seventies has turned around due to pro-agricultural policies of Government of India and has become net exporter of wheat and rice. India is now the top exporter of rice and second top exporter of wheat and cotton. Overall agricultural exports stood at Rs. 2,01,000 crore in 2012-13.

The author is Agriculture Commissioner, Ministry of Agriculture, Government of India



**ARUN KUMAR
BHAKOO**

AGENDA FOR RURAL & FARM SECTOR GROWTH – FARMER'S PERSPECTIVE

Agriculture is not just a means of producing food for the Indian population but is a business activity and like any other businesses, profitability is essential and farm income must grow adequately in a sustainable manner. Lack of induction and adoption of latest agro technologies, slow rate of capital formation, low average yields, small and scattered holdings, low intensity of cultivation, declining factor productivity, grossly inadequate rural infrastructure, international competition and inadequate and inefficient market mechanisms and support has ensured that farmers operate at very low income levels, if any. Generally, unfavorable price regime and miniscule on-farm value addition is resulting in abandoning of farming and migration of farmers to urban areas. In fact, there is a decline in real per capita income in rural India in comparison to the rapid economic growth and income in urban India, and this income gap is widening. Benefits of so

called Indian growth are not reaching 65 per cent of the population! Government of India's rural and agricultural policies has disappointed the rural lot, and may result in widespread unrest in rural India.

Therefore, there is an urgent need to bring about a change in the mind set of the policy makers as well as farmers to define and put in place a pro farmer, pro rural development agenda that can address this serious threat and bring about a more equitable agricultural & rural growth. We suggest following agenda for ensuring viability of farming, ensuring rational rural and farm income on par with urban areas, rapid and equitable agricultural and rural growth and to narrow the widening disparity in the economic and social status of rural and urban India.

POLITICAL AGENDA

- Agriculture should be brought on the concurrent list of Indian Constitution. States alone do not have the vision, competence,



expertise & resources to bring about the required rapid transition from subsistence farming to commercial farming which is necessary to bring about compatibility in rural and urban incomes, and to narrow the rural and urban divide.

- Bring all agriculture related subjects like irrigation, rural development, food processing etc. under one ministry for efficient, rapid equitable growth of rural and agriculture sector.
- Based on India's food and nutritional security, global competitiveness and strengths and opportunities for Indian Agriculture, a National Agriculture and Rural Development Policy should be formed for next ten years. Based on this policy, a National Rural and Agricultural Development Plan should be formulated and implemented.
- Based on the above mentioned National Rural and Agricultural Development Plan, agricultural production, growth and rural and agricultural income enhancement targets should be set. Separate budget should be presented for Agricultural and Rural Development. This shall highlight and acknowledge the crucial importance of rural and agricultural development in India and shall give required impetus

POLICY AGENDA

- Agricultural land laws in India have become obsolete and have been hampering growth of the farm sector. Like laws related to industry and business, all agricultural land laws should be reviewed, liberalized and reformed to ensure dynamic agricultural and rural development, and



growth and enhancement of rural incomes in tune with urban India.

- Leasing of agricultural land should be allowed and a vibrant market, like stock market, should be created for leasehold land, ensuring the ownership rights of actual owners.
- Agricultural and rural income enhancement should be the criteria for growth, not production enhancement. Focus should be on improving and enhancing the well being of the farmers feeding the nation than just on production.
- Food and nutritional security, global competitiveness, enhanced water use efficiency, high farm mechanization, adoption of resource conservation technologies and renewable energy, mitigation of climate change impacts, improving the soil health, providing social security and enhancing income of the rural and farm sector - should be the thrust and key

focus areas of the agricultural and rural development policy.

- Mandatory active representation and participation of farmers should be ensured in all agricultural and rural policy decision making at all levels of central and state government and all institutions and bodies concerned with agriculture & rural development.
- National and State level Farmer's Commissions, headed and managed by farmers should be set up to monitor all decision making processes by the government and its various agri agencies, research institutions etc.
- A special affordable life insurance policy and provident fund scheme should be formulated and implemented to provide old age security to the farmers.
- Inland aqua culture and poultry farming should be given the status of agriculture.
- CACP should be an autonomous body and should have decision

making representation from the farmers and should have constitutional authority. CACP should recommend and fix a Remunerative Price (RM) instead of MSP and this should be at least 50 per cent more than the weighted average cost of production. Like salaries and pension of government employees, mechanism to automatically adjust this price to cost of living index should be in-built in the system. Government must ensure that farmers are not paid less than this price even in mandis.

- Differential and Higher RM/MSP should be given to farmers who supply produce to procurement agencies after the main season and stock their produce at the farm during this extended period. This shall reduce work load on government procurement agencies, ensure higher price to farmers and shall create on farm storage capacity.
- RM/MSP should cover all crops of importance for food and nutritional security, including perishable horticultural crops. Marketing federations should purchase the produce of farmers at RM/MSP during glut period.
- Model Contract Farming Act which ensures fair terms to the farmers should be enacted in the country. All agro food processing and allied industries etc. availing subsidies from the govt., must buy at least 50 per cent of their raw material, fruits and vegetable requirements directly from farmers through long term contracts facilitated and guaranteed by the govt.
- Generic agro chemicals should be made available to the farmers.

After implementation of new Drug policy of government of India, availability of generic drugs has reduced the price of drugs substantially for human use. Similar policy of making generic agro chemicals available to the farmers shall substantially reduce the cost of agrochemicals to the farmers.

- Put in place an efficient delivery mechanism with deep penetration down to each farmer in village level to ensure efficient extension and dissemination of latest technology and making available the benefits to the farmers as per government policy.
- Direct cash subsidy to the farmers not through fertilizer companies, agro chemical manufacturers, equipment manufacturers etc.
- Declare next ten years as Farm and Rural Renaissance Period. Abolish electric, irrigation and fertilizer subsidies, and directly reimburse farmers @ Rs. 15,000 per hectare during this period. Abolish all taxation on agro inputs, farm machinery and all farm mechanization and modernizing equipment, and review/withdraw the same after ten years.
- All implements, tools and equipment for mechanization, water use efficiency enhancement, rural godowns, primary agro processing at farms, adoption of resource conservation and renewal energy and farm modernization should be financed at 0 per cent interest, and all crop loans upto Rs. 5 lakhs should carry 1 per cent rate of interest for ten years, and this concession should be reviewed/withdrawn after ten

years of Farm and Rural Renaissance Period.

- Insurance should be made compulsory for all crops, milch animals etc. at reasonable cost shared by the government. Insurance should be on a realistic basis to cover the genuine risk of the farmers, not as a lip service.
- Agricultural Research Agenda should be accountable, should be as per ten year National Farm and Rural Renaissance Plan, should work with farmers, and in addition it must demonstrate the income enhancing capacity of new technologies and seeds developed by them on a commercial scale at their and farmer's fields. A new technology or seed should be released only if it enhances farmer's income.
- A 24 hour national TV channel in all major regional languages, fully devoted to rural and agricultural sector, showcasing the rural and agricultural policies, national and international agro technologies, prices of all agricultural commodities in all major Indian and international markets of relevance, should be put on air immediately and should act as the major extension tool to empower the farm sector and rural areas. This channel should also act as main weather and marketing advisory system for the farm sector.

*The writer is General Secretary,
Farmers' Association- Kashipur,
Uttarakhand*

*Major Crop Cultivation
in India*

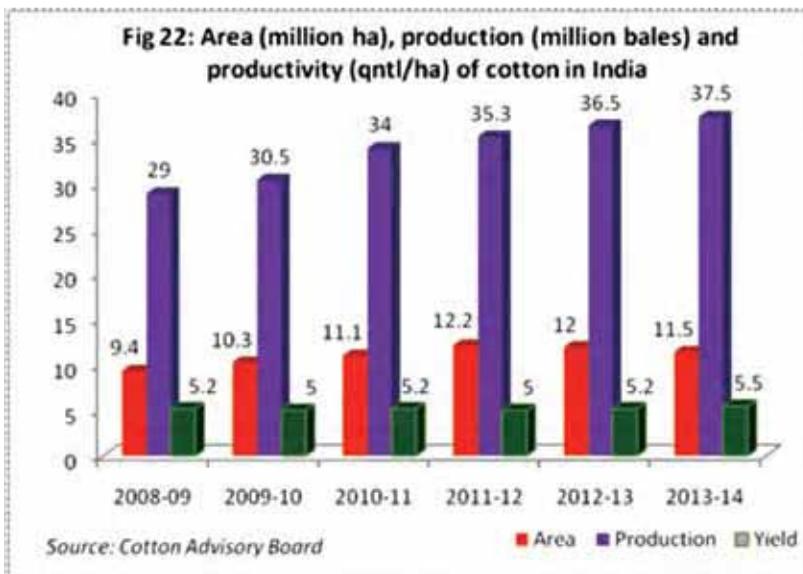
4.1 Cotton

Net acreage under cotton in India increased by 22.3% between 2008-09 and 2013-14 from 9.4 million hectares to 11.5 million hectares in the corresponding years. Production increased by 29.3% during the same period between 2008-09 and 2013-14 from 29 million bales to 37.5 million bales (Fig 22). In the year 2012-13, delay in monsoon resulted late cotton sowings in all the major cotton growing States of India. Apart from this, almost 3 weeks of delay occurred due to late harvesting of wheat in Northern States also due to delayed monsoon rains in Central and

Southern States, especially in Gujarat caused delay in cotton cultivation. Barring heavy rains across the coastal districts of Andhra Pradesh due to Neelam cyclone, overall agro-climatic conditions at the time of sowing were favourable in all the cotton growing States. However, due to delayed monsoon across the cotton belt, the acreage under cotton in 2012-13, except Andhra Pradesh, decreased by around 3.5% to almost 11.8 million hectares as compared to 12.2 million hectares in the previous year.

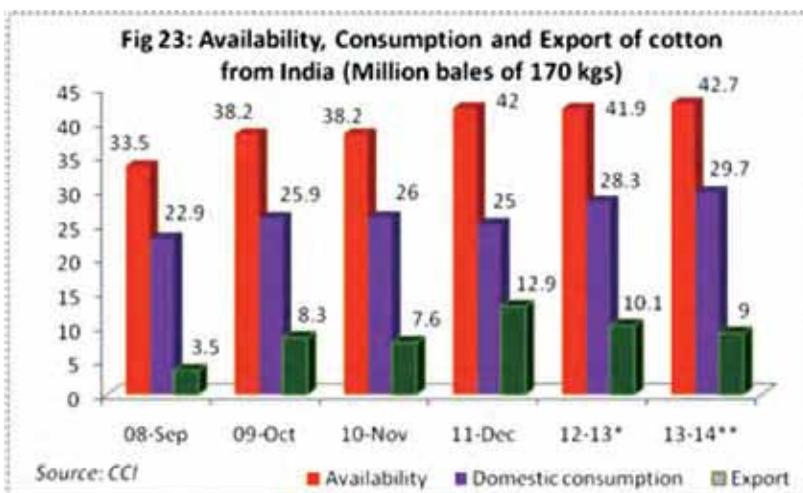
In Andhra Pradesh, farmers increased the acreage under cotton to a record level of around 2.3 million hectares as compared to around 1.9 million hectares in previous year. This was mostly driven by receipt of good prices for cotton as compared to other competing crops along with timely arrival of monsoon rains which encouraged farmers to go for cotton.

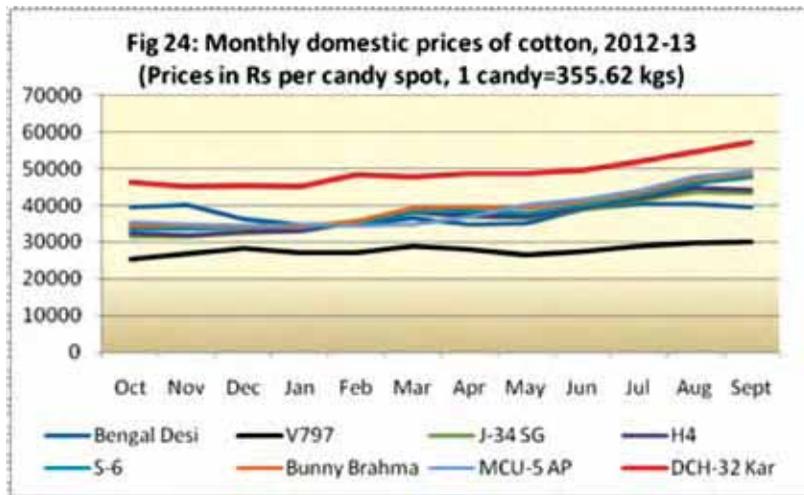
In 2012-'13, farmers in the Northern States switched over to other competing crops like maize, pulses and jawar as a result of which the region



witnessed a decline in the acreage under cotton by about 6% to 1.6 million hectares as against 1.7 million hectares in corresponding previous year. Punjab witnessed the most significant reduction in area grown under cotton by around 10% to 0.5 million hectares as against 0.56 million hectares in previous year.

Central zone witnessed a declined from the level of 7.8 million hectares in 2011-12 to 7.1 million hectares in





2012-13. The most significant reduction in cotton acreage happened in Gujarat by around 19% due to delayed and inadequate rains and consequential switching over to other competing crops like groundnut, castor and jawar. Madhya Pradesh also witnessed a reduction in total cotton acreage by at least 14% to 0.6 million hectares as compared to 0.7 million hectares in previous year. The cotton acreage in Maharashtra was almost at par with previous year of 4.1 million hectares.

Southern States utilised the benefit of timely monsoon rains and the acreage under cotton increased considerably by 12%, from 2.6 million hectares in 2011-12 to 2.9 million hectares in 2012-13. The largest increase in area under cotton cultivation in southern India was witnessed in Andhra Pradesh by around 21%. It increased to 2.3 million hectares in 2012-13 from 1.9 million hectares in previous year. Many of the chilli farmers during that year switched over to cotton. The acreage in Karnataka and Tamil Nadu however declined by around 12% and 5% respectively in 2012-'13.

Area under BT cotton cultivation in India was on a continuous growth path till the cotton season of 2012-13. That year, due to reasons like inadequate rains and farmers shifting over

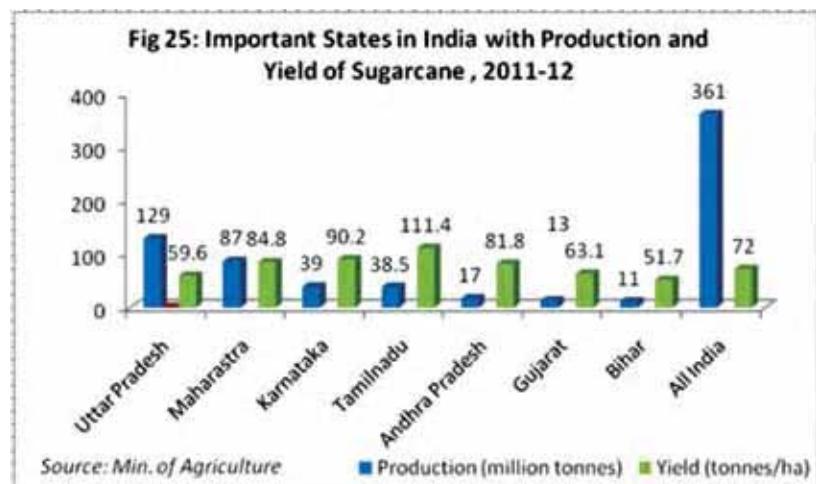
to other competing crops, total area under BT cultivation in 2012-13 was about 12 million hectares. This was 88% of the total area under cotton in India. In 2011-12, BT cotton constituted 91% of the total area.

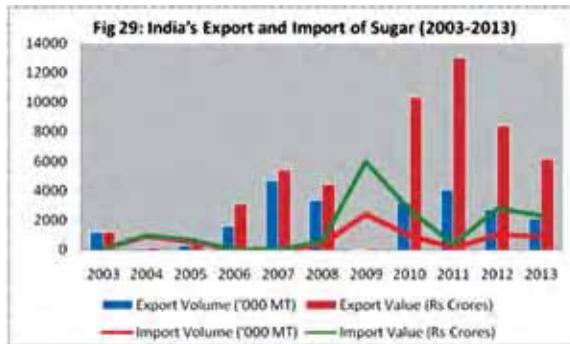
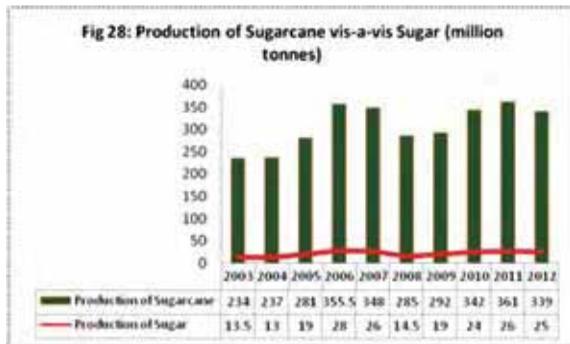
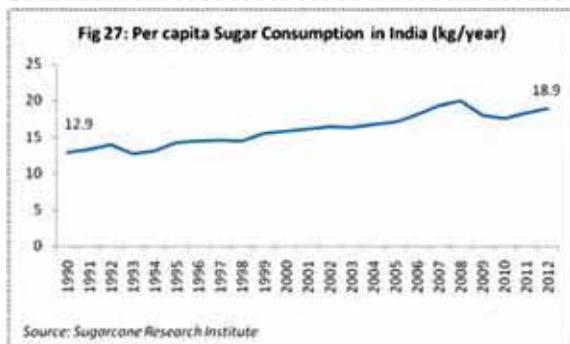
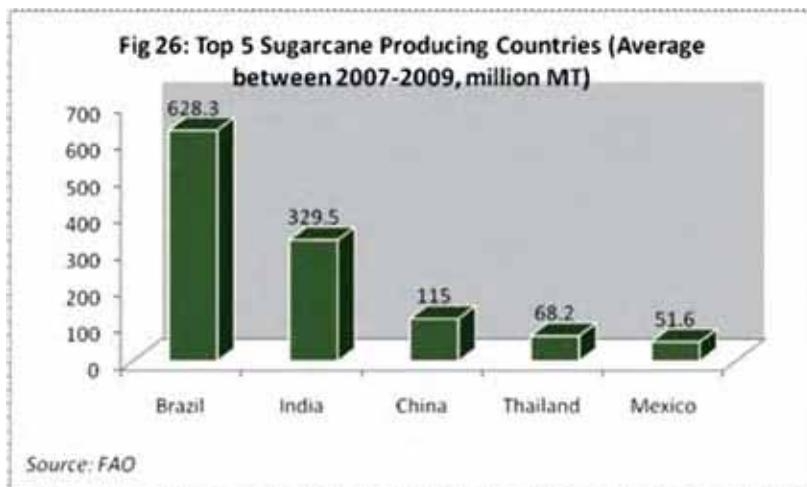
This year in 2014, there has been significant delays in sowings as a result of weak monsoon lowering crop expectations during the 2014-15 cropping season. It is estimated by organisations like USDA that the ultimate cotton production in 2014-15 could be a four year low at around 28 million bales. Till the end of July 2014, there has been a significant delay in planting in the major cotton growing areas of the country. Delayed rains and poor distribution of monsoon rains were the

main reasons. Monsoon in 2014 started on a weak note and till June, it was 43% below the seasonal average. This is also expected to lower the yield and its estimated this year the yield would be about 517 kg per hectare, significantly below the normal average yield of about 550 kg/hectare.

4.2 Sugarcane

India is one of the leading sugarcane producing country in the world. In 2011-'12, India as a country produced a total of 361 million tonnes of sugarcane. The yield was 72 tonnes/ha (Fig 25). Uttar Pradesh like several other previous years was the leader in the total sugarcane production in the country. In 2011-12, Uttar Pradesh produced 129 million tonnes of sugarcane. Maharashtra in the same year was the second largest pro-





ducer with a total production of 87 million tonnes. Other important states with high production were Karnataka

2009 reveals that India was second to Brazil with an average yearly produc-

tion of 329.5 million tonnes. The average yearly production of sugarcane in Brazil in the same three year period was 628.3 million tonnes. China was the third largest producer with an average production of 115 million tonnes followed by Thailand (68.2 million tonnes) and Mexico (51.6 million tonnes). This year in 2014, till the month of August, Sugarcane planting was 47.17 lakh hectares as on August 8, 2014, according to the Agriculture Ministry

Per capita sugar consumption in India has been increasing over the years with minor fluctuations. When one looks at the per capita sugar consumption in the country in 1990 and 2012, there has been a substantial increase of 46.5% from 12.9 kg/person/year to 18.9 kg/person/year in 2012 (Fig 27). The per capita consumption witnessed a consistent increase from the year 1990 till 2012 except for two years, once in 1993 and then again in 2009. Per capita consumption dropped from 13.9 kg/person/year in 1992 to 12.7 kg/person/year in 1993. It again witnessed a decrease from 19.9 kg/person/year in 2009 to 17.9 kg/person/year in 2010.

India's total production of sugar when compared to the total production of sugarcane is very low. However, when one compares the rate of production of sugarcane to that of sugar during a period of 10 years from 2003 to 2012, it's seen that the production of sugarcane has increased at a slower pace than the production of sugar. During the 10 year period between 2003 and 2012, sugarcane production in the country increased by about 45% from 234 million tonnes in 2003 to 339 million tonnes in 2012. On the other hand, during the same period, production of sugar increased at a faster rate by 85% from 13.5 million tonnes in 2003 to 25 million tonnes in 2012 (Fig 28).

Comparing the export and import

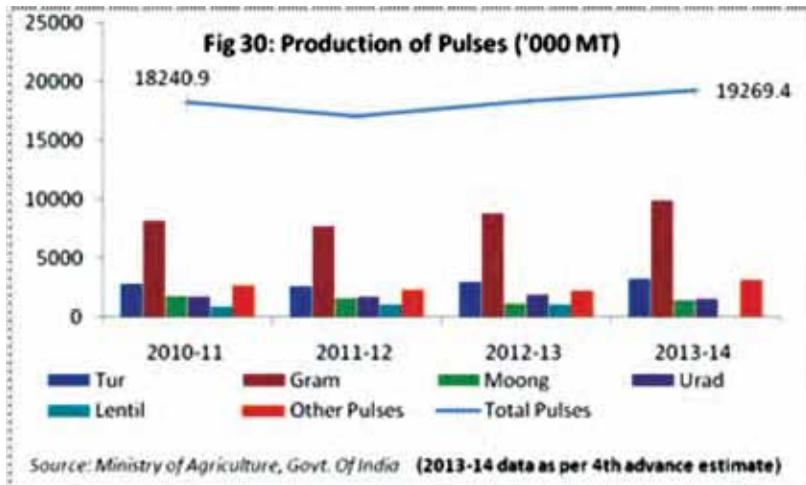


Table 1: Production of different pulses in India ('000 tonnes)

	2010-11	2011-12	2012-13	2013-14	% of total pulses ('13-14)
Tur	2861.1	2654.1	3022.7	3292.8	17.09
Gram	8221.1	7702.3	8832.5	9880.9	51.28
Moong	1800.2	1634.4	1186.2	1495.3	7.76
Urad	1759.7	1766	1946.7	1513.4	7.85
Lentil	943.8	1058.7	1134	NA	NA
Other Pulses	2655.1	2273.4	2220.4	3087	16.02
Total Pulses	18240.9	17088.9	18342.5	19269.4	

data for sugarcane by India, it can be seen that India is a net exporter of sugarcane. However, as can be seen in Fig 29, both export and import volumes experienced significant fluctuations over the last decade.

4.3 Pulses

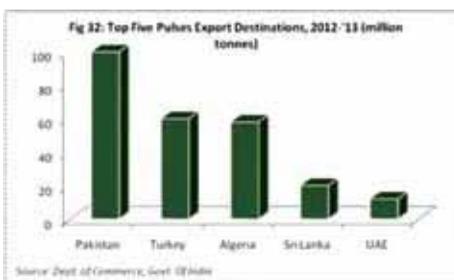
Pulses cultivation scenario and the trade around it is quite interesting for a country like India. It is the largest importer, producer and consumer of pulses. India is also the largest proces-

sor of pulses. Various types of pulses or peas and beans are cultivated in India like chickpea, lentil, dry peas, pigeon pea, urd bean, mung bean, cowpea etc. during kharif and rabi season depending on their growing season. Over the years, among various pulse crops, chickpea with more than 40% constitutes the largest share among all pulses grown in the country. Others like pigeon pea constitutes about 18-20%, mung bean with a share of more than 10%, urd bean constituting

a share of 10-12%, lentil with 8-9% are the different types of pulses grown in the country.

Shown in Table 1 is the data related to the production of different pulses in India from 2010-11 to 2013-14. It can be seen that in 2013-14, gram or chick peas constituted more than 51% of the total pulses production in the country. Tur, moong and urad constituted 17%, 7.7% and 7.8% respectively of the total production. As seen in Fig 30, there was an increase in the total production of pulses in 2013-14 as compared to 2010-11. In 2010-11, the total pulse production in the country was 18.2 million tonnes which in 2013-14 increased by 5.6% to 19.2 million tonnes. Individually, pulses like tur (15% increase) and gram (20% increase) posted significant increase in production in 2013-14 as compared to 2010-11. However, urad and moong witnessed decrease in production. Production of moong decreased by almost 17% from 1.8 million tonnes in 2010-11 to 1.5 million tonnes in 2013-14.

The recent increase in total production of pulses as is also accompanied by an increase in the total area under pulses cultivation in recent years. The total net sown area under pulses in India in January 2014 was 15.6 million hectares which is an increase by 4.6% as compared to 14.9 million hectares in January 2013 (Fig 31). Individually, except moong and urad, all other important peas and beans like gram, lentil, peas witnessed increase in net





sown area.

Though India is one of the major exporters of peas and beans, its export witnessed considerable fluctuations in the recent years, sometimes due to international trade uncertainties and sometimes due to government regulations. As seen in Table 2, total pulses export in 2010-11 was 208 thousand tonnes. This decreased significantly in the next year in 2011-12 by 16% to touch low export level of 174 thousand tonnes. Export figure however recovered the following year in 2012-13 increasing to 202 thousand tonnes. However, in 2013-14, India's export of pulses touched new height of 343.5 thousand tonnes recording an increase by 70% over the previous year.

India exports peas and beans to a number of foreign countries. India exported about 100 million tonnes of

pulses in 2012-2013 to Pakistan. It also exported about 60 million tonnes and 58 million tonnes in 2012-2013 to Turkey and Algeria respectively. Other than these countries, India exports significant quantity to Srilanka (about 20 million tonnes) and UAE (about 12 million tonnes).

India's import of different peas and beans saw steady increase from 2010-2011 till 2012-2013 (Fig 33). India imported 3.3 million tonnes of total pulses in 2011-12 which was about 25% more than what it had imported in the previous year (about 2.7 million tonnes). The import further increased by 14% in 2012-13 as compared to the corresponding previous year. The total import of pulses in 2012-13 was 3.8 million tonnes. However, in 2013-14, import of pulses dropped by 20.5% to 3 million tonnes.

4.4 Oilseeds

Monsoon in 2014 arrived late and till the end of July, the rain deficit was almost 25% which was initially almost 40% during the start of the monsoon this year. As a result of this, sowing pattern of major crops in the Kharif season has been affected and there are reports that farmers from some areas in states like Gujarat are switching

over to alternate crops like cotton.

Though sowing of oilseeds has picked up in 2014 after the monsoon situation improved during the end, it is still lower than last year. The area under oilseeds in the country by the end of July, 2014 was 13.73 million hectares. In the previous year, it was 16.97 million hectares during the same period.

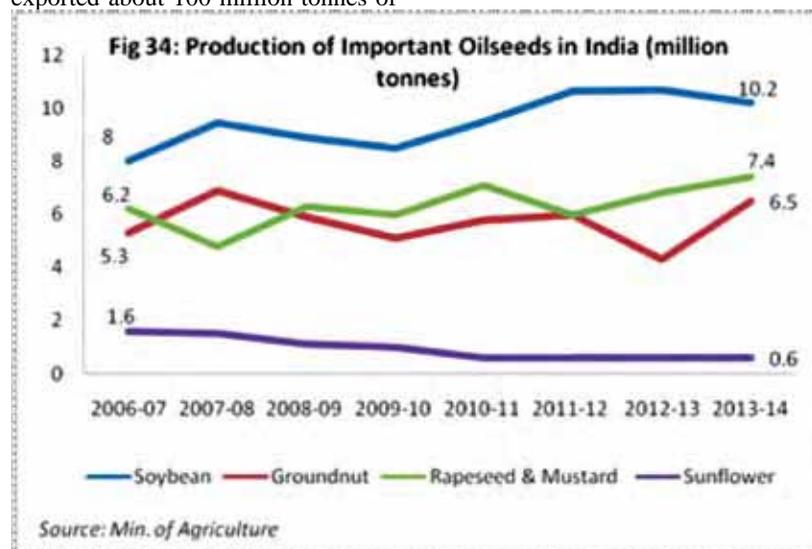
According to estimates as on July 2014, area under groundnut cultivation has decreased by almost 3%, from 3.68 million hectares in the kharif of 2013-14 to 2.84 million hectares during the same corresponding period this year.

However, less rainfall critical oilseed crops like sesame seed was less affected due to late arrival of monsoon in 2014 and the area under sesame seed is expected to remain almost the same in 2014. Last year, the net sown area under sesame was at 1.02 million hectares.

As on June 2014, exports of different oilseeds from India have increased by 10.22 per cent to USD 26.48 billion in comparison to USD 24.02 billion in June 2013. In the April-June period of fiscal year 2014-15, exports have increased by 9.31% and reached a level of USD 80.11 billion.

Groundnut exports so far during this fiscal year have witnessed substantial growth. Export of groundnuts from India during April-May, 2014 increased by almost by 80% to 103.7 thousand tons. Export during the same period last year was 57.6 tons during same period in the previous year. In value terms the exports have increased to Rs. 610.93 crores in comparison to 404.52 crores.

Sesame seeds exports from India also increased from 38.7 million tons valued at Rs. 494.08 crores during April-May, 2013 to 42.3 million tons valued at Rs. 625.80 crores during April-May, 2014.



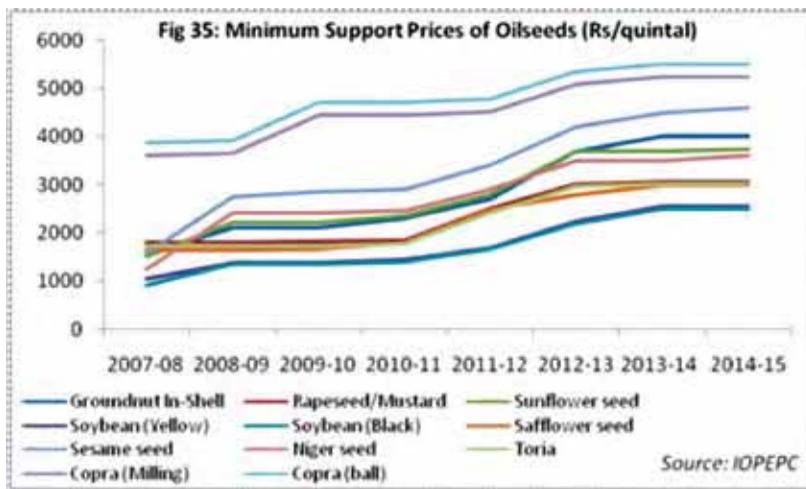


Table 3: India's Export of Oilseeds (quantity: '000 tonnes, Value: Rs Crores)

Crops	2011-12		2012-13		2013-14	
	Quantity	Value	Quantity	Value	Quantity	Value
Sesame	389	2641	299	2881	257	3583
Groundnuts	833	5246	536	4065	512	3212
Mustard / Rape-seeds	37	125	31	134	39	145
Niger	28	117	18	90	21	114
Safflower	15	55.5	12	56	10	35
Sunflower	5	27	5	44	4	34

Source: Ministry of Agriculture, Govt. Of India

Production of all the major oilseeds like soybean, groundnut, rapeseed and mustard has grown over the past several years, albeit witnessing inter year fluctuations. However, production of sunflower witnessed a decline. In 2006-07, total production of soybean in India was 8 million tonnes which increased to 9.46 million tonnes the succeeding year. However, over the next two consecutive years (2008-09 and 2009-10), the production dropped continuously to 8.9 million tonnes and 8.5 million tonnes respectively. However, the production again picked up during the next two years but dropping again in 2013-14. In this year, the total production of groundnut was 10.2 million tonnes. Similarly, from 2006-07 and 2013-14, production of ground and rapeseed and mustard in-

creased on an overall basis but going through fluctuations.

Sunflower production witnessed a consistent decline in production over the past years starting from 2006-07 to 2010-11. In 2006-7, the production of sunflower was 1.6 million tonnes. It then started declining steadily and fell down by 62.5% to 0.6 million tonnes in 2010-11 and thereafter, till 2013-14, production of sunflower remained stagnant at 0.6 million tonnes.

Talking about export of different oilseeds, all major oilseeds produced in India except Niger and rapeseed and mustard witnessed decline in quantity and value during a three year period between 2011-12 and 2013-14 (Table 3). Export quantity of sesame in 2011-12 was 389000 tonnes with a value of Rs 2641 crores. The same values in

2013-14 were 257000 tonnes and 3583 crores. Similarly, groundnut witnessed a steady decline from 833000 tonnes valued at Rs 5246 crores in 2011-12 to 512000 tonnes and Rs 3212 crores in 2013-14. However, export of mustard and rapeseed from India witnessed fluctuations. In 2011-12, the export quantity and value was respectively 37000 tonnes and Rs 125 crores. Next year, although the quantity dropped to 31000 tonnes, the value increased to Rs 134 crores. In 2013-14, the export quantity of mustard and rapeseed increased to 39000 tonnes and the corresponding value increased to Rs 145 crores.

Government has been supporting oilseed farmers with minimum support price (MSP) every year. Some of the oilseeds have witnessed many fold increase in MSP over the years. For example, MSP of groundnuts (in shell) has increased significantly when compared to 2007-08 and 2014-15 (Fig 35). This year during 2014-15, according to latest reports, the MSP declared by the government is Rs 4000/quintals. This is 158% more than the MSP of 2009-08 of Rs 1550/quintal. Similarly, the 2014-15 MSP of sunflower seeds announced is Rs 3750/quintal which is 148% more than the MSP of 1510/quintal in 2007-08. Sesame seeds witnessed the highest increase in MSP during the period between 2007-08 and 2014-15. In 2007-08, the MSP of sesame was Rs 1580/quintal which increased by 191% to Rs 4600/quintal in 2014-15. Niger seed too saw a significant increase of 190% from Rs 1240/quintal to Rs 3600 in 2014-15. However, the MSP of many oilseeds this fiscal year (2014-15) has been kept same as the MSP of 2013-14, like that for groundnut (in shell), rapeseed/mustard, soybean (yellow and black), safflower seeds, Toria and Copra (both milling and ball).

ALOK SINHA

AGRICULTURE PRODUCTION & PROCUREMENT

THE GREEN REVOLUTION of the sixties which helped multiply foodgrains' output to more than five times to its present annual level of just about 250 million tonnes, was based on the Minimum Support Prices (MSP) offered to farmers with a marketable surplus, so that agricultural prices do not crash. Coupled with this was the Public Distribution System (PDS), meant to assure food grains supply to the needy, at a reasonable rate.

It would be fair to assume that an extension of the MSP to marketable surplus of food grains output will not be easily done away with in the foreseeable future. No democratically elected government in India would risk a consequent crash of agri-market prices, and thereby alienate the farmers with a marketable surplus, who today control the rural political economy, the rural electoral vote-banks, and rural political opinion. It would be equally fair to assume that no one would similarly be willing to do away with the PDS, howsoever imperfect it might be, for no political party in a democratic set-up would be willing to alienate the poor.

Since food security would require an annual supply of around 60-65 million tonnes, many

argue that such a huge figure would be a logistical nightmare for the FCI to handle. But this is an erroneous viewpoint because if the Food Corporation of India (FCI) can handle 55 million tonnes of annual procurement (average for the last three years), with its vast network of more than 1500 godowns spread across the length and breadth of the country, surely an addition of 5-10 million tonnes should be possible to manage.

Moreover, forcing the FCI to release its biodegradable stocks will ease the liquidity crunch in the market. In fact, since the FCI is forced to squeeze up most of the marketable surplus of wheat and common rice, it only makes sense to make it available for human consumption, before such locking up further raises market prices.

In the above background, the issues are how to increase agricultural production, and how linked is procurement with production.

Historically, India went through a series of decadal famines in the 19th century, when however the lack of communications, organized public awareness and a colonial mindset combined to ensure that there was no hullaboo about it, except in what is disparagingly known



as vernacular literature. However, the Bengal Famine of the 1940's (which is said to have accounted for two million cheap human lives, and surely many times more cattle lives) did remain etched in public awareness fired by the national movement. In fact, it was the colonial administration that introduced marginal PDS in some parts of Urban India, the commodities so distributed were so well "rationed out" that thereafter "ration" in desi lingo has become co-terminus with essential foodgrains.

But with a population that is presently more than 130 crores, that is ever-growing, and at least one-third of whom live below poverty line (according to Dr C Rangarajan), and another one-third of which live well below Western standards of poverty, there is no doubt that we have to leap well over the present annual foodgrains output of about 250 million tonnes.

On a philosophical scale, the Right to Food is indisputably a human right. Hunger, as defined by the Hunger Task Force in 2003, is 'a condition in which people lack the basic food intake to provide them with the energy and nutrients for fully productive lives.' The Food and Agricultural Organization (FAO) in 2000 defined the absence of hunger as 'access by all people at all times to enough nutritionally adequate and safe food for an active and healthy life.' And as the NGO, Save the Children, has put it so succinctly; it is lack of affordability and not lack of availability that causes hunger.

If we accept these internationally recognized definitions as applicable to India as well, then we cannot escape posting them with our country picture. Astonishing though it may sound, since we claim to be riding a great growth story post-liberalization, the India HDR 2011 (quoting the National



Family and Health Survey 2009) points out that in terms of undernourished children under five years, India's figure at 48 per cent was almost double of 26 sub-Saharan African countries which was only 25 per cent. On a relative scale, Kerala, Himachal Pradesh, Punjab, Sikkim, Manipur and Mizoram were shining beacons since the rest of India was at best either at par or well below the average of sub-Sahara!

It would help if the opponents of food security mull over the specific findings of the above nutrition report:

- India is the worst performer in terms of low birth weight, underweight, and wasting among children in BRIC and SAARC countries.
- Nearly half of India's children under three are malnourished.
- There are wide gaps between states and rural and urban areas with respect to cereal consumption.
- A very high percentage (21.5%) of babies in India, are born with low birth weight.
- Child malnutrition is higher in rural than in urban areas.
- The prevalence of anaemia among adolescent girls is, disturbingly, higher than even among pre-

school children.

- Anaemia among children has increased over the years with rising rural-urban disparity.

It these findings do not impress our columnists, let us see what the international award-winning (and one-time detenu) good doctor Binayak Sen has to say in establishing that 'our country is in a state of stable famine.' He quotes the National Nutrition Monitoring Bureau's conclusion that 37 per cent of our adult population has a Bio Mass Index below 18.5. The World Health Organization (WHO) maintains that if more than 40 per cent of a community has a BMI below 18.5 per cent, then it is in a state of famine – and half our Scheduled Tribes and 60 per cent of our Scheduled Castes' BMI is, unfortunately, less than 18.5 per cent.

What is worse is that food in general is becoming both unavailable as well as unaffordable for the large majority of our fellow citizens. Noted economist Utsa Patnaik talks of a steady decline in grain consumption in the last decade, with a five-member family's annual intake going down from 880 kg to 770 kg. And the 'Alternative Economic Survey India

2011'says that 'one rupee's purchasing power in March 2011 was equal to 26 paise in 1990-91... the rupee almost lost three-fourths of its worth during this period' of post-liberalization great growth in two decades.

This deadly combination of rising prices and the declining purchasing power of the rupee has reduced the daily per capita net availability of food grains from 465 grams during 1981-90 to 444 grams during 2001-2009. And so we have the dubious achievement of maintaining the status of a net exporter of food grain even though we do not have an exportable surplus. It is basically because millions of fellow Indians are not able to purchase food in adequate quantity due to poverty.

If the objective of food security cannot be denied on grounds of mass poverty, rising malnourishment and ever-rising prices, then the only way out is to see how it can be made operational, and not merely list out the roadblocks without suggesting how they can be cleared, as if the roadblocks are insurmountable!

With such a miserable situation, the question is not whether we need a National Food Security Act, but how to implement it well --- not merely in terms of adequate foodgrains in the PDS kitty, but also how to ensure that foodgrains going through the PDS net reach the entitled, that is, that the PDS net plugs all leakages.

Since agricultural production and procurement are closely linked up, the first question is how to leap over the present stagnant annual foodgrains output of 250 million tonnes. The first Green Revolution was achieved by maximizing output through a combination of assured irrigation, improved seed technology, and chemical fertilizers. The momentum of increased

output was then kept up by the regimen of Minimum Support Prices (MSP) which kept going up steadily. Even though this has primarily helped the kulak class (post

1956 land reforms) mopping up their marketable surplus through assured procurement.

But the first Green Revolution, being largely limited to areas with assured irrigation, covered only one-third of our cultivable areas. Further, official patronage extended to this area means that 80 per cent of wheat/ rice procurement takes place in this golden land of assured irrigation.

Of the total cultivable area, two-thirds are left to the vagaries of the skies, otherwise known as "rain-fed agriculture". It is noteworthy that this rain-fed agriculture area is also coterminous with the tribal belt, affected by what the previous Prime Minister termed as our "biggest security threat", that is, Maoist insurgents! And it is equally noteworthy that "rain-fed agriculture" remains pathetically neglected. In 2006, The Government created a National Rainfed Areas Authority, which remains as badly neglected as it has been a complete non-performer. Infact, no one talks any more of the NRAA, which was created within the Ministry of Agriculture, then got transferred to the Ministry of Rural Development, then found itself parked in the Planning Commission !

Helping out this till-now neglected rain-fed area would definitely help us cross the present hump of annual foodgrains output of 250 million tonnes, to cope with providing enough to implement the National Food Security Act in a situation where the present population figure of 125 crores would touch 150 crores in another ten years.

But having enough in the kitty of the Central Pool of FCI will never be enough to provide adequate food security to the entitled. All surveys show that more than 25 per cent of the foodgrains that go out of the PDS never reach the people, because one-quarter of the ration cards are bogus and fake. So reforms and improvement of the PDS system is a must. One sure way would be to link up elected local bodies with PDS delivery systems. Such transparency would ensure lesser leakages, as the better Panchayati Raj systems of Kerala, Gujarat, West Bengal and Tripura show.

AFTERTHOUGHT --- If we really want to hype up our foodgrains output well beyond the present annual plateau of 250 million tonnes through a Second Green Revolution, we have to have a professionally sound and scientific Action Plan. The way Mexican wheat and IR-8 paddy were, in the sixties, introduced into India through improved seed technology, similarly we have to have another round of improved and tested New Seed Technology for the rain-fed agricultural areas. For that to happen successfully, agricultural scientists have to be given both freedom and patronage to evolve better seeds through latest scientific know-how as well as field experiments. We must not allow the kind of pompously medieval practice of 2010-12 when the then Environment Minister banned BT field trials, much like Galileo's tormentors, without any sober dialogue with the scientific or the farming community --- such autocratic methods would not take us towards any progress whatsoever.

The writer is former Chairman, Food Corporation of India

*Horticulture- Ever
Increasing Economic and
Nutritional Importance*

Horticulture crops

Both area and production of different horticultural crops in the country has increased over the past years. Fig 36 shows the gradual increase in area and production of horticultural crops in India from 2002-03 to 2012-13. However, it can be seen that production has increased at a greater pace than the increase in area under horticulture crops in India. In 2002-03, the net area under horticulture crops in the country was 15.3 million hectares. The same increased by about 55% in 2012-13 to 23.7 million hectares. On the other hand, total production of horticulture crops in the country in 2002-03 was 144.4 million tonnes. This increased to 268.8 million tonnes in 2012-13 registering an increase of 86%.

Although growth in production of total horticulture crops outpaced the growth in area under all the horticulture crops when compared between 2002-03 and 2012-13, however in case of fruit crops which is a major constituent of all horticulture crops in the country showed opposite trend. In case of fruit crops, area increased by

89% when compared between 2002-03 figures of 3.7 million hectare and 2012-13 figures of 7 million hectares. At the same time, the production of fruits increased from 45.2 million tonnes in 2002-03 to 81.3 million tonnes in 2012-13, registering an increase of about 80% (Fig 37).

Comparison of the rate of increase between area and production of vegetables reveals a trend that is very different from that of the fruits. In case of vegetable crops in the country, production almost doubled when

compared between 2002-03 and 2012-13. As seen in Fig 38, net production of all the vegetable crops in India in 2002-03 was 84.8 million tonnes and it increased by more than 91% to 162.1 million tonnes in 2012-13. However, the area under vegetable cultivation in the country increased by about 51% which is much less than the increase in production.

In India, banana constitutes the largest share of the total fruit production in the country. Banana shared one third of the country's total fruit pro-

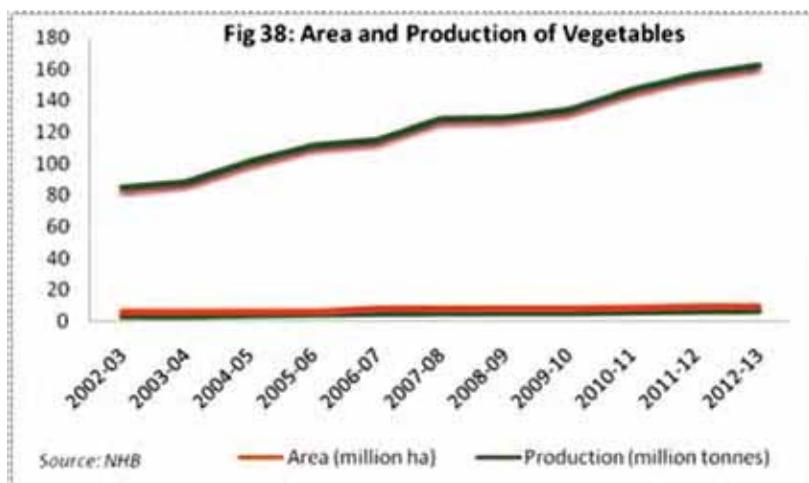
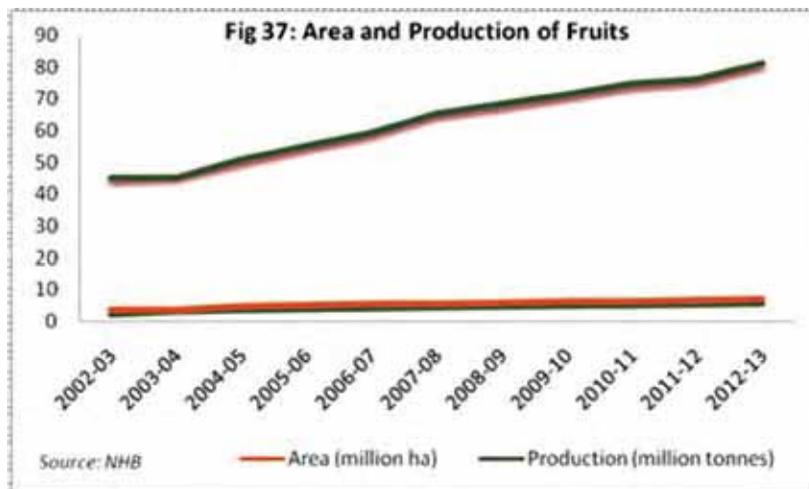


Fig 39: Production Share of Major Fruit Crops (2012-13)

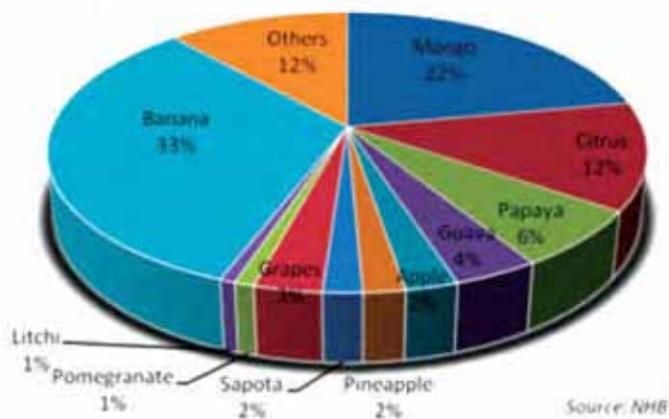


Fig 42: Production Share of Major Spices (2012-13)

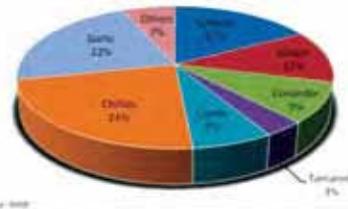


Fig 40: Production Share of Major Vegetables (2012-13)

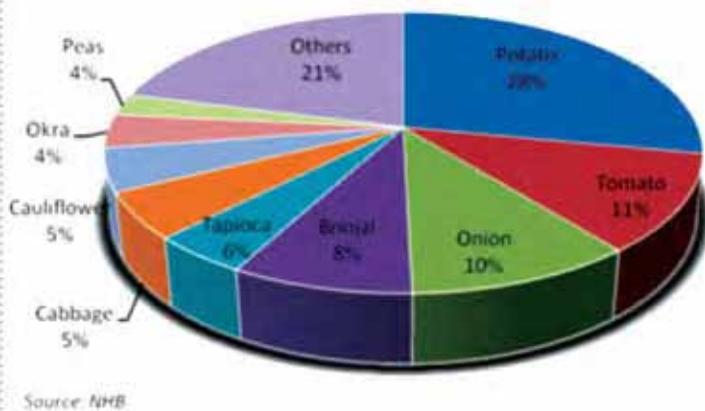
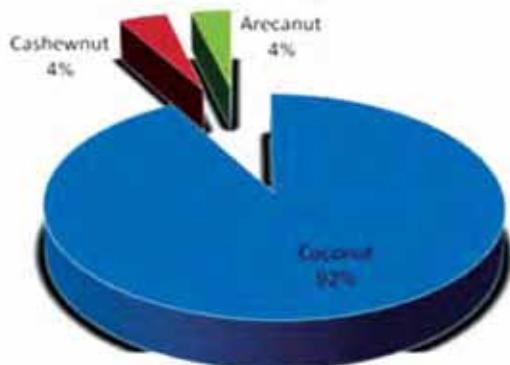


Fig 41: Production of Major Plantation Crops (2012-13)



duction in 2012-13. Amongst other fruits, share of mango was 22%, citrus was 12%, papaya 6% and guava 3% in 2012-13 (Fig 39). In vegetables, in 2012-13, potato had the highest share with 28% of the total production with crops like tomato, onion and brinjal taking a share of 11%, 10% and 8% respectively of the total production (Fig 40). Amongst the plantation crops, coconut had the maximum share of 92% in 2012-13. Arecanut and cashewnut each had a share of about 4% in the same year as seen in Fig 41.

Other than fruits, vegetables and plantation crops, India also produces a considerable quantity of different spices. Cultivation of spices has been on the radar of policy makers in agriculture sector of the country for quite some time now due to the export potential of various spices and their potential contribution in foreign exchange earning of the country. Chillies have the maximum share in India's total spices production. In 2012-13, the total share of chillies was 23% closely followed by garlic with 22% share. In 2012-13, turmeric had a share of 17% in the total spices, ginger had 12% share. Other spices like cumin (7% of the share) and coriander (9% of the production) were also important.



DR VIJAY SINGH
THAKUR

Horticulture in Himachal Pradesh

The agro climatic conditions of Himachal Pradesh vary from subtropical to temperate making the region a suitable niche for growing temperate to sub tropical fruits such as apple, pear, peach, plum, apricot, cherry, grape, almond, walnut, pecan nut, citrus, mango, litchi, guava, aonla, kiwifruit, strawberry and vegetables like cabbage, cauliflower, peas, capsicum, tomato, beans and exotic vegetables like celery, asparagus, globe artichoke etc. The importance of vegetables in providing balanced diet and nutritional security has been realized today and they have been anointed as 'health food'. Flowers like carnation, chrysanthemum, gladiolus, rose, gerbera, alstromeria, liliun etc. hold a special place in the minds and hearts of traditional and modern inhabitants of Himachal Pradesh. Horticulture in the state has shown its promises as one of the most remunerative diversification of land use in the hilly state, providing greater income and employment opportunities. Successful market interventions have led to economic empowerment of farmers.

The horticulture industry of Himachal Pradesh has emerged as an important sector of the state economy with an annual turnover of more than Rs. 4832 crore which accounts for about 15.25 per cent of the Gross State Domestic Product. The total area under fruits, which was only 792 hectares in 1950 has increased to 2.14 lakh hectares in 2011-12. Similarly, the fruit production has also increased from 1200 MT in 1950 to 5.40 lakh tonnes in 2012-13. Apple is the most important fruit crop of Himachal Pradesh which constitutes about 47 per cent of the total area under fruit crops and about 83 per cent of the total fruit production. Area under apple has increased from 400 hectares in 1950-51 to 1,01,500 hectares in 2011-12 with annual production of 8,92,000 MT. The area under temperate fruits other than apple has increased from 900 hectares in 1960-61 to 1,01,930 hectares in 2011-12. In the recent years, mango has emerged as an important fruit crop in foot and mid hill regions of the state. It occupies an area of 38,444 ha with a production of 38751 MT. Litchi is also gaining importance in mid and low hills with an area of 4060 ha



and production of 3383 MT. Peach is another important fruit crop and the total area under peach cultivation is 5170 ha with a production of 9935 MT during 2008-2009. In apricot, area covered is 3556 ha and annual production at 2438 MT. Guava is also becoming an important crop in some pockets of the state with an area of 2236 ha and production of 2426 MT. Wild fruits like kaphal-Box Myrtle (*Myrica nagi*) is gaining importance due to its Vitamin C content and anti-oxidant properties.

Similarly, the total area under vegetable crops is 80,400 ha with total production of 1.46 million tonnes. The total productivity is 18.06 tonnes per hectare in this hilly state. Pea and seed potato cultivation has brought revolution in Lahaul Valley, while tomato cultivation in Solan and Kullu districts has reached new dimensions. In Himachal Pradesh, tomato commands a total area of 10,000 ha with a production of 384.5 MT. Capsicum covers an area of 2136 ha with a production of 32,092 tonnes. During 1993-94, area under floriculture was only 25 ha but now it has increased to 813 ha and the farmers of the state are earning about Rs.30 crore annually from flower business. Crop diversification in the state has taken place in favor of crops like pomegranate, kiwi and area under these crops is 1085 ha and 128 ha respectively with productions of 475 MT and 118 MT, respectively. Besides, cultivation of crops like strawberry, cherry and nectarine is coming up in a very big way in the state.

The rich diversity of agro-climatic conditions favors cultivation of temperate and sub-tropical fruits in Himachal Pradesh. However, climate change has resulted in huge losses to the apple and mango crops thereby resulting in a loss of Rs. 89

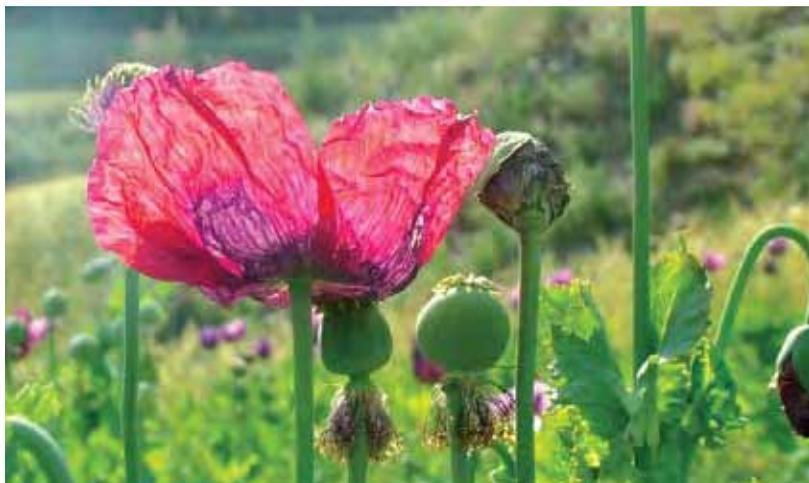


crore. Farmers in Shimla district alone suffered a maximum damage worth Rs. 67 crore to the apple crop. The effect of climate change has resulted in shifting of apple cultivation from lower elevation to higher altitudes. Hailstorms at flowering and fruit development stages affect quality and productivity of different fruit crops. Besides, bee activity was found to be affected by low temperature. Erratic rains at flowering time in apple affected the fruit set as well. In nectarines, low temperature has also been found to affect the fruit quality by developing russetting symptoms. Besides, abrupt rise in temperature was found to influence the color development of fruits. It was found that a high temperature leads to early color development in apple fruits and others thereby resulting in market gluts. During the last decade, it was revealed that chilling requirements of the plants were not fulfilled which affected the overall productivity of fruit crops.

In the recent past, there have been unusual rains at harvesting time which resulted in occurrence

of new diseases like Marssonina and Alternaria defoliation and core rot of fruits in apple. But due to late winter, apple scab disease was under check. As a result of erratic climate changes, the management strategy to combat the diseases is becoming ineffective. In Cherry, fruit fly infestation was recorded and resulted in huge losses to the farmers. So a refinement of our management strategy in different fruit crops is warranted keeping in view the changing climate conditions. Besides, establishment of orchards should be on account of climate changes, climate based disease forecasting, weather aberrations and contingency crop planning etc.

Adaptation and mitigation strategies were worked out to address the impact of climate change on fruit crops through new research findings under different agro-climatic settings. Studies were also carried out to enrich organic matter in the soil and efficiently conserve and utilize rain water. Effect of climate change has been mitigated by growing scientifically improved varieties of apple like Super Chief, Red Chief, Scarlet Spur, Oregon Spur-II, Silver Spur, Well Spur, Red Spur and Bright-N-Early etc. besides improved color strains viz., Vance Delicious, Top Red, Starking Delicious, Fuji strains, Gale Gala, Granny Smith etc. on semi-vigorous and semi dwarf clonal rootstocks like MM111, MM106, M7 and M793 etc. This has resulted in an area expansion in the state especially in lower as well as very high elevations. In addition to this, pomegranate and kiwi have been found to be an excellent diversification option in mid hills of the state which has benefitted the farmers for their food and economic security. For mitigating the problem of climate change in future



with respect to winter chilling, short term strategies may be adopted for modifying the chilling requirements through cultural amendments such as evaporative cooling and bud break chemicals. Under long term strategies, the replacement of existing plantations with low chill cultivars will be a step forward for sustainable production.

A critical SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of horticulture in the state suggests that strategic reorientation and restructuring of horticulture production systems is required for ensuring sustainability of horticulture in the hills. Policy interventions are needed for converting weaknesses into strengths and threats into opportunities. The strengths and opportunities must also be effectively harnessed.

Horticulture in the state of Himachal Pradesh is benefitted from the following identified strengths giving it an opportunity to excel in comparison to other parts of the country.

- Horticulture is most important sector of the state economy contributing nearly 15 per cent to Gross State Domestic Product and accordingly gets most judicious

attention and protection from the state government.

- Dr YS Parmar University of Horticulture and Forestry and other developmental institutions dealing with horticulture have established credentials in the minds of farmers, policy planners and other stakeholders. A number of novel initiatives of the institutions have led to the spectacular success stories of producing apple, other temperate and sub tropical fruits, vegetables, spices like ginger, flowers and their seed production. The harnessing of the potential of cold deserts through fruits, vegetables and seed production are another initiatives. Supportive institutional framework provides continuous opportunities on capacity building of the farmers and orchardists.
- There is presence of receptive clientele in the form of well qualified farmers and orchardists.
- Horticulture generates a large number of employment opportunities as the production and marketing of fruits, vegetables, spices, root and tuber crops, flowers, ornamental plants, medicinal and aromatic

plants and mushroom and honey industry etc are labour intensive.

- A large number of fruits, vegetables, spices, flowers and medicinal and aromatic plants are cultivated in different agro climatic conditions varying from sub tropical to wet and dry temperate conditions.
- Horticulture ensures nutritional security as fruits and vegetables are rich source of vitamins, minerals, proteins, carbohydrates, etc. and many of these have anti-oxidant properties.

Weaknesses have also been identified for the horticulture sector in the state. These weaknesses need to be converted into strengths through strategic policy interventions.

- The input supply system is inadequate and could not succeed in the deliberation of desirable outputs. It needs complete reorientation for timely supply of the adequate amounts of vital production and marketing inputs.
- The genetic background of planting material is a major challenge for the state and effective R&D interventions are needed along with the creation of awareness amongst the orchardists and farmers. The productivity levels of the fruit crops of our state are not comparable with the competing countries in our domestic markets. Besides, apple plantations made before the year 1965 are old and senile for the purpose of replantation.
- Lack of processing facilities and limited opportunities for value addition lead to heavy post harvest losses up to Rs. 1000

crore annually. Efforts are needed in this direction. Educated youth can be encouraged for the establishment of these agro vocations through their skill up gradation and capacity building.

- There are serious problems in the handling of horticulture produce particularly during the periods of peak production. There is sharp fall in the value of the produce along with problems of their timely disposal. This issue needs a serious deliberation in the light of current attention aimed at increase of existing productivity levels.
- The existing Transfer of Technology modules do not bridge the gaps between the recommended and the adopted technology levels on the farmers' fields. There is a need of credibility and usefulness of the generated technologies along with their supply chain.

Opportunities are also available in the horticulture production system in the state which need to be properly addressed for effective harnessing its potential.

- The state has an advantage of diverse climate conditions comprising of several agro-ecological regions which provide ample opportunities to grow a wide range of fruits, vegetables, flowers, spices and medicinal and aromatic plants. There is a good potential for the production of off season vegetables, rare exotic vegetables like broccoli, celery, asparagus etc. besides seed production of temperate vegetables.
- Multinational companies are well ahead in seed production of



different vegetables in hills and this venture is taking the shape of most profitable enterprise. Farming communities can now opt for diversification of their produce for seed production.

- Many pockets in the state have minimum use of inorganic fertilizers and by default, largely qualify for organic production system. These specified pockets can be exploited for organic horticulture production and possibilities can be explored for export market of the produce.
- Industrial groups are showing interest in value addition of fruits, vegetables, mushrooms, flowers and other commercially potential horticultural products. Appropriate industrial linkages in this regard can be explored for income and employment generation.

The horticulture in the state is also facing certain threats which need to be properly addressed for minimizing the losses and wherever possible to convert these threats into opportunities for subsequent benefits.

- The climate change over the years along with erratic and delayed rain and snow patterns is posing a threat to overall sustenance of the traditionally practised horticulture system.

Technological interventions are needed to mitigate the adversity of climate change.

- International treaties have led to free trade from different competing countries. China, Australia, USA etc have posed serious challenges to fruit industry of Himachal Pradesh particularly apple. There is thus a need for quality production and competitive marketing of the horticulture produce.

A variety of fruits having domestic marketing and export potential should be cultivated in diverse and rich agro-ecological farming situations. Structural changes in horticultural production systems through diversification, value-addition, and harmonious integration of modern and indigenous know-how, organized marketing strategies, infrastructural development and socio-economic policy research on technology assessment are needed to ensure sustainability. The existing R&D strategies need to be redefined and reshaped in the light of new research and development priorities and modern technologies. The institutional set up needs to be restructured. The future vision of horticulture must include key challenges and opportunities for developing an appropriate strategy and a roadmap for growth, development and equity that ensures food, nutritional and livelihood security to farming community of Himachal Pradesh.

The writer is Vice Chancellor, Dr YS Parmar University of Horticulture and Forestry, Nauni- Solan (HP)



JAI GOPAL

Challenges and way-forward for Onion Cultivation

India is the second largest onion producer after China at world level but is far behind in productivity compared to many countries. The average productivity of onion in India now stands at only 14.21 t/h, which is lower than world average of 19.47 t/ha. The highest productivity of onion has been reported to be 67.33 t/ha in Ireland (FAO stat 2010). Maharashtra, Karnataka, Gujarat, Bihar, Madhya Pradesh, Rajasthan, Andhra Pradesh and Tamil Nadu are the main onion growing states in India. In general, barring North Eastern states and Kerala, all other states grow onion. Country's 26 per cent area and 29 per cent production come alone from Maharashtra (Agricultural Statistics, 2013).

Research and development has helped in enhancing production and export of onion, but when it comes to productivity, the increase has been only marginal. Statistics indicate that production of onion has increased from 40.4 lakh tons in 1994-95 to 166.4 lakh tons in 2012-13 (Agricultural Statistics, 2013). This increase, however, has come mainly from increase in area under onion which in 2012-13 stood at 10.6 million hectares.



The main reasons for low productivity of onion in India are:

- Inherent low yield potential of short day onion varieties grown in India
- Non-availability of suitable F1 hybrids
- Susceptibility of all cultivars to diseases, pests and abiotic stresses
- Tropical climate is more congenial for diseases and pests
- Non – availability of genuine seeds of released varieties
- Sub – optimal standards of cultivation adopted by farmers
- Shortage of irrigation at critical stages
- Poor storage capacity of present day varieties and poor storage facilities
- Kharif crop always pull down country's average productivity
- Fluctuation of prices disturbs the attitude of farmers towards use of inputs and modern technology

By 2050, India's population is projected at 1.7 billion, and there is no possibility of increase in cultivable land. To cater to the requirement of this ever increasing population, keeping per capita consumption, export, processing and losses at existing rate (consumption i.e., 7.83 kg/person/year, export 9% , processing 6.75% and losses 30%; base year 2010-2011), we will require 24.62 million tonnes of onion in 2050 against 19.29 million tonnes in 2013-14. This demands an increase in average productivity from 15.85 to 22.7 t/ha, which is 42.9 per cent higher than that of in 2013-14. Efforts can be made to reduce losses up to 20 per cent, increase export up to 25 per cent and processing up to 15 per cent by 2050. With these targets, we have to increase production from 19.29 million tonnes to 33.39 million tons with productivity of 30.72 t/ha.

Thus there is need to explore innovative measures to improve productivity and stabilize production in India. The challenges and way forward for R&D of onion cultivation are

analysed below.

Narrow genetic base

Meager biodiversity and narrow genetic base is a major challenge in varietal improvement programmes of onion. Most of the onion varieties are selections from a few land races like Poona Fursungi, Nasik Red, Talaja Local etc. This limits the genetic potential as well as diversity in the varieties under cultivation. The big threat of reduction in biodiversity is increased epidemics of pests and diseases. Thus, there is an urgent need to broaden the genetic base of the varieties. Evaluation of germplasm for various biotic and abiotic stresses including adaptability should be addressed on priority. Wild *Allium* species also need to be collected, characterized and pre-bred to be utilized in the breeding programmes.

Hybrids of onion

Development of hybrid onion varieties for production of uniform high yielding bulb crop is the critical. At present, only open-pollinated varieties are in cultivation. Few hybrid varieties are being promoted by private sector, but those are not much in demand due to their trivial advantage over the commercial open-pollinated varieties and high seed cost. Non-availability of inbred lines due to inbreeding depression hampers hybrid production. Development of male sterile inbred lines with appropriate maintainer is a long term programme, but recently some progress in this direction has been made.

Varieties for processing and export

The existing commercial varieties are also not suited for export and processing purposes due to lower



TSS. High TSS (> 13%) varieties are desperately needed by processing industry owing to emerging market. Development of export oriented red, white and yellow onion bulb varieties is required as onion is exported to Gulf and South East Asian countries and has potential of export to European market. Keeping in view the medicinal importance of onion, varieties rich in certain nutraceuticals and having high pharmaceutical values need to be developed.

Quality seed material

Poor productivity of onion in India has been attributed to the use of farmer produced poor quality seeds of inferior local cultivars. This is mainly due to few seed production programmes of the released varieties in the country and the requirement of large isolation distance. Further, dearth of appropriate protocol and facilities for seed storage reduces the longevity of seeds. Seed produced by the universities as well as research organization and other government institutions is not being channelized to the farmers through an established system of seed distribution. The

seed from the research organization should be procured by the state and national seed certification agencies for multiplication and distribution to the farmers at reasonable rates. A complete system of seed production, multiplication and distribution as existing in other major crops, is still absent in onion. Such a system needs to be initiated for onion at the earliest. There is also a need to popularize seed village concept, particularly for quality seed production in onion.

Integrated nutrient management

The optimum nutrition during critical growth stages is a key for bumper harvest. However, its deficit or excess usage reduces the productivity heavily. Storage potential has also been found altered due to improper nutrient applications. Therefore, optimization of dosage vis-à-vis growth stage has tremendous importance. Apart from macronutrients, micronutrients play a vital role in the quality of the produce. Sulphur, calcium, magnesium, iron, selenium etc. have been found to impact the productivity and hence its standard package of application,

its source and quantity is a grey area that needs to be strengthened. Thus, a suitable Soil Test Crop Response (STCR) equation needs to be standardized for onion.

Pest and disease resistance

All onion varieties presently in cultivation in India are susceptible to various diseases and pests. Resistance breeding for various diseases and pests need to be given priority. Sources of durable resistance to various diseases and pests are not well known. There is need to screen all available germplasm including the wild *Allium* species for various diseases and pests, systematically. Resistant or the tolerant types so identified need to be adopted and used in breeding for developing disease and pest resistant varieties of onion. Molecular breeding involving marker assisted selection can also be made use of for accelerating the development of disease and pest resistant varieties. Integrated approach of using resistant varieties with wide spectrum pesticides along with mechanical and biological control is a viable alternative. Emphasis should be given to more important diseases like purple blotch, anthracnose and Stemphyllium blight, and pest like thrips, which besides causing direct damage to the standing onion crop, are also the vectors of a number of viruses.

Mechanization

Emerging labour problem is becoming a big hindrance for small and medium scale farmers. Electricity shortage is another challenge for successful cultivation. There is demand for development of machines and tool for small and medium level farmers besides the large one to minimize

labour use with increase in efficiency. Development of eco-friendly low cost storage structures for small, medium and large scale is another need to reduce the postharvest losses which will also help in price regulation in the market. Short duration uniform maturing varieties suitable for mechanical harvesting will be required in near future.

Kharif production technology

Kharif onion production contributes only about 20 per cent of total yearly production. It is an important season for onion cultivation for its continuous supply in the market. The arrival of kharif produce during October to December is very crucial for price stabilization. However, production of successful onion crop during kharif is still a challenge as productivity is quite low (10-12 t/ha). Among the multidimensional reasons, unpredictable rainy season and severity of attacks by many diseases and pests are major issues. Albeit, some exclusive varieties of onion for kharif have been released,

which are doing well in the field. The kharif production technology needs to be refined for the use of efficient agro-cultivation practices, nutrient management, pest management and postharvest management.

Storage

Postharvest losses in rabi onion are to the tune of 40 to 50 per cent for storage up to six months. Kharif onion is not suitable for storage. Storage of onion is the function of genotypes, season, cultural practices adopted and storage environment. Prevention in losses can add to net availability. India needs storage facilities of onion from May to November. For domestic supply, export as well as for seed bulbs, about 40 lakh tonnes of onion needs to be stored at present. There is an urgent need for popularization of storage structures and providing financial assistance to onion growers in different states. Cold-storage technology is now picking up particularly with private sector. These cold storages are ventilated type with controlled atmosphere wherein gases particularly carbon dioxide, are



monitored and controlled regularly. There is need to popularise storing onion in controlled atmosphere cold storages. An economic technology package for pre-cooling, cold storing and cool chain trans-shipment is required. The innovations in the designs of the containers will also be crucial to reduce the transit losses. Development of these facilities in strategic production areas would help reduction in post-harvest losses remarkably. It needs to be made economical and perfected so that it is available on large scale for routine use by the farmers.

Processing and value addition

Processing industries are emerging at a faster rate and would demand more raw materials in future. Onion flakes, granules, powder, rings, onion in brine, powder, paste and oils are the products prepared from onion. The present processing units in Maharashtra and Gujarat are processing onion to the tune of 1 lakh tonnes. However, by 2050 the estimated world market for processed onion is to the tune of 2.5 lakh tonnes. Thus, there is tremendous scope for processing in future. Further, the onion blended food products, which are otherwise unexploited areas, have enormous commercial potential in domestic and export markets. The processing units are facing problems of year round supply of high TSS white onion (>18%) varieties. Research support by development of high TSS white onion varieties and contract farming for continuous and assured supply will strengthen the processing units. The culled market waste could be used for energy generations. However, the dearth of



an appropriate technology demands exclusive R&D to make such project commercially viable. Development of value added nutritionally rich onion varieties and products or exploitation of functional food value of these crops are challenges that require urgent attention.

Marketing

Sharp fluctuations in prices of onion in market disturb the attitude of farmers towards adoption of improved production techniques and good management practices, which add to the cost of production, besides it results in fluctuation in production and export. There is a need of firm production and export policy to sustain in a competitive world trade. Synergy between R&D, policy makers, State Government Departments, Agricultural Universities, NGOs, private sector, farmer cooperative groups and marketing agencies will help in stable supply of onions at price beneficial to producers, traders and consumers.

Export

India has very old and strong tradition

of export of onion, and exports 14-18 lakh tonnes of onion mostly to Gulf and South East Asian countries. Red and light red onion varieties are exported to these destinations. Rose and multiplier onion from Andhra Pradesh, Karnataka and Tamil Nadu have got overseas market. If channelized systematically, the present level of onion export can be increased to the tune of about 70 lakh tonnes by 2050. Besides red onion, yellow onion for export to European market has remained grey area for long time. Presently European Union requires 18 to 20 lakh tonnes onion mostly coming from New Zealand, Tasmania, South Africa, which are far off. India is in advantageous position since it is half way nearer to Europe. Further, it has been amply proved by Directorate of Onion and Garlic Research that we can grow good quality yellow onion from October to February. There is critical gap in supply in Europe from February to June whereas India has ample production during these months. European market being stringent, lot of market-oriented research would be needed in production, grading, packing and shipment.

Focus should also be to evolve a robust supply chain based on domestic demand, export and a quantum for processing to avoid price fluctuations by harnessing available resources, modern infrastructures, improved technologies and innovative endeavors. Policy makers will have to work hard to provide amicable solutions to pricing which should lead to higher profits to farmers but not at the cost of consumers.

The author is Director, Directorate of Onion and Garlic Research, Rajgurunagar, Pune



DR.SK CHAKRABARTI



G. PADMAJA

Production and Utilization of Tropical Tuber crops in India: Current Scenario, Issues and Future prospects

There are more than 50,000 edible plant species in the world; out of which only fifteen provide 90 per cent of the world's food energy intake. Besides, grains, roots and tubers like cassava, sweet potato, taro, yams, etc. are important staples for over 1 billion people in the developing world. Population of India is projected to grow to 1.62 billion by 2050 and the demand for food grains which is projected to increase to 345 million tonnes in 2030, can even go up to 450 million tonnes by 2050. In this context, tropical tuber crops like cassava, sweet potato, elephant foot yam, yams, taro etc. become important for ensuring food and nutritional security of the country. India produced ~10.24 million metric tonnes of tropical tuber crops in the year 2010-11 with a farm harvest price of approximately Rs. 5,258 crores (Rs. 52.58 billion) that constituted around

0.75 per cent of agricultural GDP.

Tuber crops have a higher biological efficiency as food producers with high dry matter production per unit area per unit time and have gained importance not only as food crops but also for their scope in feed and agro-based industries. Tuber crops have proved to be life sustaining crops in times of natural calamities and famine. Most of the tuber crops are bestowed with resilience to global warming and climate change, potential for better return under adverse soil and weather condition, diverse industrial applications and nutritional attributes, and most of all exceptionally high CO₂ fixation potential. The exceptional soil carbon sequestration property of cassava makes it a potential crop for ameliorating green revolution fatigue. Besides, there is immense potential of cassava as raw material for bio-ethanol production. In fact, China has taken a policy



CMD resistant cassava –Sree Padmanabha



Sree Kanaka-carotene rich sweet potato



ST 14- carotene rich sweet potato



Leaf blight tolerant taro- Muktakeshi



Sree Athira- first hybrid Elephant Foot Yam



Sree Dhanya- first Dwarf Yam

of substituting corn with cassava for bio-ethanol production. Considering the fact that access to modern affordable energy is essential for the achievement of the internationally agreed development goals, the United Nations General Assembly declared 2012 the "International Year of Sustainable Energy for All". Cassava may contribute in a big way towards fulfilling targets for production of green energy without disturbing food security situation.

R&D Achievements

The Central Tuber Crops Research Institute (CTCRI) under the aegis of ICAR, solely involved in R&D activities of tropical root and tuber crops, started functioning at Thiruvananthapuram, Kerala in 1963. In order to address the issues of tuber crops and promote their development in the northern and eastern States of India, a Regional Centre of the Institute is also functioning in Bhubaneswar, Odisha. Besides, the All India Coordinated Research Project (Tuber Crops) is making concerted effort in creating awareness on the vast diversity and potential of tuber crops as a food and industrial crop in the traditional as well as non-traditional areas of the country and specially in the North-East India.

Over the years, the Institute has addressed many important aspects of root and tuber crop research viz., breeding, biodiversity conservation - both ex situ and in vitro, resource management, production, protection, utilization, and popularization. Sustainability of cassava production both for edible purpose as well as for starch extraction is largely dependent on availability of high yielding varieties. Other tuber crops like sweet potato, yams and elephant foot yam are still being used primarily as food



crops and varieties having good cooking and nutritional qualities are key desirable attributes in addition to higher yield. Keeping those priorities in view, CTCRI developed and released 49 improved varieties of tuber crops for cultivation in different agro-climatic regions of the country. Demand of the starch industries have been met with the development and popularization of high starch varieties of cassava like H165, H226, CMR-1 and new triploid varieties 4-2 and 5-3. Cassava mosaic disease (CMD) being a major threat to cassava cultivation, was given highest priority that resulted in the development of CMD resistant variety Sree Padmanabha and several highly resistant lines ready for release. Similarly, sweet potato (Sree Kanaka, Gouri, ST-14) and greater yam (Da 331) varieties with higher content of carotene and anthocyanin, respectively, have been developed. Elephant foot yam (EFY) and greater yam are gaining importance as vegetables throughout India and high yielding EFY varieties like Sree Padma and Sree Athira as well as dwarf yam variety have been developed.

Viable multiple cropping systems were evolved for tuber crops which could provide additional income

to the cultivators. Organic farming technology for aroids and yams as well as Site Specific Nutrient Management practices for cassava, integrated nutrient management technology for tuber crops, miniset technology for large scale multiplication of planting material were standardized and transferred to farmers. Potassium efficient lines were identified in cassava which could improve the K use efficiency and result in higher yield. Similarly, eco-friendly management packages have been developed for important fungal diseases like cassava tuber rot, elephant foot yam collar rot, taro blight, and insect pests of sweet potato, cassava and stored products. The sweet potato variety, Sree Bhadra, was identified as trap crop for nematode management. Efficient bio-pesticides have been developed from cassava leaves and rinds that could manage several noxious pests of important crops as well as storage pests. Diagnostic techniques were standardized for important viral diseases viz., cassava mosaic diseases, sweet potato feathery mottle, sweet potato leaf curl, elephant foot yam mosaic virus, yam mild mottle virus and yam Badna virus which forms a part of management. Strategies were developed for the production of disease free planting materials to cater to the requirement of farmers.

A major problem in the postharvest utilization of cassava is the poor shelf life of tubers, necessitating immediate processing to storable forms like chips, starch, flour etc. Besides, the very low protein content in cassava is a major drawback in its use as food. Keeping these major issues in view, CTCRI has developed a number of value added products, which include nutritionally fortified snack foods and fried chips. The technologies of snack food preparation from cassava

have been transferred to a number of small and medium entrepreneurs while fried chip technology has been commercialized by M/S Tierra Food India Pvt. Ltd. (<http://www.tierra.in>) as "Kappo". Besides, many starch based products like super absorbent polymers, graft co-polymerized starch, superporous hydrogels, biofilms etc. were developed that are ready for commercialization. Health foods like low glycemic pasta/spaghetti were developed from cassava and sweet potato, which had high nutritional quality as well, substantiating the emerging role of tuber crops for food and nutrition security of India. A number of post harvest processing machinery viz., chipping machines, starch extraction machinery, granulators, adhesive plants etc. were developed in the past which are having good domestic and international demand.

Current scenario

Presently, there is a loosely knit linkage between the research, extension and clientele system in case of tuber crops. There is no well defined Government policy for root and tuber crops development, both at Central or State Government levels except for 2 to 3 States. On the contrary, in countries like Thailand and Indonesia, the major root crop viz., cassava receives adequate development support from Government, both policy and finance wise. In order to synchronize production of tuber crops with marketing, it is necessary to open new avenues for its better utilization, under the present context where traditional uses have almost stabilized. Cassava is mainly used in industrial (60%), human consumption (28%) and animal feed sectors (12%). In the textile industry, starch is required for sizing of cotton yarn before weaving

Value Added Products from Tuber Crops



and presently maize starch is the major competitor for cassava starch. The cotton yarn sizing industry is currently consuming nearly 85,000 tonnes of cassava starch.

By virtue of its good adhesive properties, cassava starch has become an important raw material in the adhesive sector. Cassava starch based adhesive finds important place of application in corrugation box industry, paper conversion industry and liquid gum industry for domestic use. Maize starch is one of the competing raw materials in adhesive sector for cassava starch. Kraft paper and starch (either cassava or maize) are the important raw materials in making corrugation boxes. These corrugation boxes are being used in all the industries like textiles, consumer durables, processed foods etc. Currently two million tonnes of kraft paper is being used in making 15,137 million sq. mt length corrugation boxes and most of the units use cassava starch in making corrugation gums due to good adhesive properties and its low

price over maize starch. As a result, this industry presently consumes 1,15,000 tonnes of cassava starch.

Issues and Future Prospects

Since agriculture in India is by and large linked to food security, it is necessary to integrate the production systems of various tuber crops with food grain production. Simultaneously, there is also the necessity to fully tap the potential of tuber crops especially cassava and sweet potato as industrial raw materials. The area, production and productivity of cassava in India has been showing an increasing trend since 1991 and growing at 0.1, 2.5 and 2.5 per cent respectively in area, production and productivity and still higher growth rates were recorded during 2001-10 (0.7% in area; 3.7% in production and 3.0% in yield). However, the area and production of sweet potato have been declining at an annual rate of 0.8 per cent and 0.4 per cent respectively, although its yield showed increasing trend at 0.2 per cent per annum during 1991-

2010. Greater thrust is necessary in tuber crops research, by spreading their cultivation to non-traditional areas, projecting the nutritional and food security role of tuber crops, augmenting the utilization prospects by developing value added food, feed and industrial products, developing demand assessment strategies and exploring new market options, exploring hitherto under-explored areas like developing herbal products with medicinal effects, bio-insecticides, natural food colourants, etc. Tuber crops in general and cassava in particular are well adapted to conditions of drought. They can also be cultivated under wide range of soil conditions and their ability to grow under a wide range of agro-climatic situations enhances the scope of extending the cultivation to the non-traditional regions. The phenomenal growth of cassava in harsh semi-arid environments in Tamil Nadu and Andhra Pradesh

establishes the strength of cassava crop to sustain dry environment. Nevertheless, tuber crops in general are labour intensive and require large number of labour for cultivation. Reducing the cost of production through less dependence on labour and inputs is necessary to tide over this situation. Mechanization of agricultural operations like land preparation, planting, weeding and harvesting is one of the alternatives to make tuber crop cultivation remunerative.

Reduced availability of irrigation water will be a major constraint for agricultural production in India and especially so for tuber crops production due to climate change and more demand from other high value crops. Further, there is a need for the development of precision farming technology and micro-dosing and methods for improving fertilizer use efficiency. Being vegetatively propagated, quality seeds are

limiting factors for rapid spread of new varieties and the crop. Miniset technology for rapid multiplication of planting material for tuber crops is yet to take off in many RTC growing states, stressing the need to create awareness and dissemination about the technology through Government machinery and NGOs.

Some of the biotic stresses include Cassava mosaic disease, sweet potato weevil, taro leaf blight, anthracnose disease and nematodes in yams, collar rot and viral diseases in elephant foot yam and the abiotic stresses include water and salinity stress, water logging, inconsistency in tuberization in sweet potato etc. Emerging pests and diseases due to climate change and introduction of invasive pests and pathogens are also main challenges. Appropriate technologies to contain such biotic and abiotic stresses are necessary which are being addressed on a large scale at CTCRI.

Functional foods from tuber crops



Demand for cassava in the human consumption sector has been declining drastically especially in the traditional cassava consuming state of Kerala in India. The drastic reduction in consumption is because of increased availability of cereal food grains, increased per capita income and thereby increased standard of living. This creates a situation where future of tuber crops especially cassava lies in the industrial and livestock sectors. Lack of adequate proteins in cassava tubers is one of the major drawbacks in its use for composite feed manufacture for cattle, poultry, pig and fish. Although, cassava and sweet potato leaves have high protein content, their potential as animal feed has not been properly exploited.

With the rapidly changing food habits and increased migration to urban areas coupled with the projected rise in per capita income, there is also a projected increase in lifestyle diseases. Demand for processed and ready-to eat convenience foods may also simultaneously increase in the next 30-40 years. One of the major challenges for the country will be to provide nutritious, safe and healthy food to people. There exists potential to develop prophylactic and therapeutic functional foods from tuber crops, as unlike fruits, the starch and flour open large avenues for processing, fortification etc. Sweet potato, despite being a health food is seldom consumed by urban and elite and factory level processing does not exist presently in India, unlike in China, Japan, Korea and parts of America. The immense nutraceutical value of tuber crops due to its anthocyanin and carotenoids content has so far not been fully exploited.

The projected per capita cotton cloth availability and the positive growth trend in the production of cotton yarn during the last two decades indicate a favourable demand for cassava starch in the textile sector. Projection of cassava starch demand in the sizing industry, based on population projections (Census Commissionerate, Govt. of India) and projections of per capita availability of cotton cloth shows that by 2016, sizing industry would require 90,383 tonnes of cassava starch, by 2021, the requirement would be 101,368 tonnes and by 2026, the sizing industry would require 115,793 tonnes of cassava starch.

Cassava starch demand in corrugation box industry is a derived demand from total industrial growth in the country. Cassava starch demand in the corrugation box industry sector shows a very favourable trend and nearly 1.61, 2.26 and 2.96 lakh tonnes will be the starch demand by 2016, 2021 and 2025 respectively at a projected growth rate of 7 per cent, while the demand by 2016, 2021 and 2025 would be 1.85, 2.98 and 4.36 lakh tonnes respectively at a growth rate of 10 per cent. The starch demand by 2016, 2021 and 2025 would be 2.31, 4.65 and 8.14 lakh tonnes respectively at an anticipated growth rate of 15 per cent. Therefore, it is very evident that large gap between demand and supply of starch is likely to be created by 2025 itself and it may be very hypothetical to project for 2050 due to rapid changes occurring in the economy. This calls for concerted efforts to increase the production of cassava tubers and thereby starch, both in traditional and non-traditional areas of cassava.

A major challenge faced by the cassava growers and industrialists alike (in the context of WTO agreement) is the increasing import of starch from countries like Thailand, where the cost of production is less due to cheap labour. India started facing stiff competition from Thailand in the international trade for cassava starch after liberalization and opening of our markets. Cheaper Thailand cassava starch started entering Indian starch markets thereby affecting domestic cassava starch industries. This is likely to lead to an alarming situation, where many of the traditional starch factories will have to be closed down, which indirectly can lead to further decrease in the cultivated area under cassava and unemployment for many who depend on the industry. Cost effective production of starch as well as its diversification to new products having domestic and international demand are thus essential for the sustainability of processing industries. There is an increasing awareness about the pollution caused by plastic materials as well as the inefficient and unhealthy ways of its disposal. This points to the need to develop 100 per cent biodegradable packages/allied materials like films, containers etc. Tuber crops as such provide a vast scope for diversification and value addition and there lies a great opportunity for non-traditional uses of tuber crops in the form of convenience foods, functional foods, biofuels, starch based innovative products like biofilms, thermofoams etc.

The authors are respectively Director and Head, Division of Crop Utilization, Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala

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DR. H.P SINGH

DYNAMICS OF INDIAN HORTICULTURE

Indian horticulture- Past, Present and Future

Indian horticulture is the core sector of agriculture, representing a broad spectrum of crops and production of a wide range of horticultural commodities. Horticulture includes fruits, vegetables, nuts, ornamental, plantation, tuber, spices, medicinal and aromatic crops and mushrooms. Collectively, these horticultural crops make a significant contribution to the Indian economy, in terms of rural employment generation and farmers' income. Increase in demand for horticultural produce due to greater health awareness, rising income, export demands and increasing population poses the challenge for further increasing the production and productivity of horticultural crops.

The issue of climate change and climate variability has thrown up greater uncertainties and risks, further imposing constraints on production systems. The challenges ahead are to have sustainability and competitiveness, to achieve the targeted production to meet the growing demands in the environment of declining land, water and threat of climate change, which needs innovations and its adoption for improving production in challenged environment.

Scenario of Horticulture in India

The role of horticulture in enhancing productivity of land, generating employment, value addition, improving economic conditions of the farmers and entrepreneurs, increasing exports and above all providing nutritional balance to the people has been well acknowledged.

The horticulture sector has emerged as a promising area for diversification in agriculture on account of

high-income generation per unit of area, water and other farm inputs and environmental friendly production systems. Government of India accorded high priority for the development of this sector, particularly since the VIII Plan and beyond. The impact has been visible in terms of increase in production and productivity of hor-



tical crops.

India has emerged as world leader in the production of a variety of fruits like mango and banana and is the second largest producer of fruits and vegetables. Besides, India has maintained its dominance in the production of coconut, cashewnut and a number of spices. Development trend of horticulture during the decade has proved, beyond doubt, that horticulture is the best option for diversification of agriculture to address the issues of profitability and environmental concerns. Considering the need for 660 MT produce, there is much scope for agribusiness. Agribusiness opportunity could be for inputs like seeds, poultry material, equipment, green house designs and construction, irrigation, equipment and above all marketing information and marketing of produce and high value addition. This changed scenario is expected to



Trend of production and estimated demand during horticultural produce

Commodity	Production (million ton)			
	1991-92	2007-08	2010-11	2016-2017
Fruits	28.63	63.50	74.87	98.00
Vegetables	58.53	125.89	146.55	220.20
Spices	1.90	4.10	5.35	5.50
Flowers	-	0.87	1.08	1.50
Plantation	7.49	11.30	12.38	15.60
Crops				
Total	96.95	207.01	240.5	333.8

improve the economy and profitability to become competitive. The economic importance of horticultural produce has been increasing over the years due to increasing domestic and international demand. Area, production, productivity, availability and export have increased manifold. This has provided ample opportunities for utilisation of waste lands, employment generation and effective land use planning. Diversification, recognised as one of the options for improving land use planning, has had dramatic impact. If data from the production of various crops are compared with the base period of 1990-91 horticultural crops have grown much faster.

Contribution of horticulture to GDP of agriculture, which was only 0.58 percent during 1952-53, with total production of 25 million tonnes increased to 18 per cent from 6 per cent area in 1991-92 and subsequently to 34.45 percent of agricultural GDP from 11.5 percent area in 2012-13 with production of 268.9 million tonnes from 23.69 million hectare. Crop diversification to horticulture has also improved the employment opportunity, which increased sharply between 2000 and 2010. Among the horticulture crops, fruit crops recorded a two fold increase in area and three fold increase in production. India emerged as second largest producer of fruits (81.28 million tonne) obtained

from 6.89 million ha area; contributing 14.2 per cent share in global fruit production. India occupies first place in the production of mango, banana, papaya, pomegranate, sapota and aonla. The productivity of grape is the highest in the world. Production and productivity of banana and sapota is the highest in the world. However, productivity in citrus, mango, apple, guava and pineapple continue to be lower than the world averages.

Production of vegetables has increased manifold to the tune of 162.18 million tonnes from 9.21m ha area, contributing 11.50 percent to global vegetable production.

Commercial floriculture have recorded faster pace of growth during the last decade. Medicinal and aromatic plants, which have immense potential got due recognition in the decade. India continues to be the largest producer, consumer and exporter of spices and spice products in the world, producing more than 50 spices. India is also a leading producer of plantation crops in the world and with contribution of 22.34 per cent in coconut, 25 per cent in cashewnut and 55 per cent in arecanut. The diversification through horticulture has proved as the best option for the farmers to meet their need of food, nutrition, health care besides providing better returns on farm land and employment. The contribution of horticultural produce towards the value expressed in terms of per cent have increased from 18 per cent in 1991-92 to 34.45 in 2012-13, while this contribution for cereals and pulses decreased. This sector has contributed significantly in generating employment opportunities, which has increased seven fold from 100 man days in the year 1990-91 to more than 700 man days in the year 2007-

Phases of horticulture development in India

Phase	Time Period	Specific Characteristics
First Phase	Pre-independence	Horticulture as a whole was not considered, but efforts were made to grow fruits, vegetables, flowers, spices in isolated manner
Second Phase	1948-1980	No planned efforts, but specific problems were addressed. Technical support and development efforts were made for specific commodity like-spices, coconut, potato, citrus, onion etc.
Third Phase	1980-1992	Consolidation of institutional support and starting of plan process for the development of horticulture.
Fourth Phase	1993—2000	Focused attention to horticulture with an enhancement of plan allocation, knowledge based technology driven efforts for the development, heralding the “Golden Revolution”
Fifth Phase	2001-2010	Horticulture is seen as means of food and nutritional security, livelihood and health care. This phase is characterised by innovations, use of innovative technologies and improved investment for research and development.

08. Resultantly, horticulture has been identified for inclusive growth of agriculture sector in the country. Past trends in research and development have been satisfying in terms of technological generation, adoptions, production, availability and export of horticultural produce, and this trend has been marked as “Golden Revolution”.

The period between 1991-2003, has been a period of development for horticulture, leading to sustainable development and planned investment, which made horticulture highly productive. The period witnessed the movement of horticulture from a rural confine to commercial production resulting in adoption of improved seeds, and technologies like micro-irrigation, protected cultivation, precision farming, integrated management of the insect pest and diseases. The success of development in 8th and 9th plan prompted for mission approach of development; addressing all the links in the chain of production and consumption. The farmers who adopted horticulture benefited immensely but fluctuating prices in few commodities led to the creation of infrastructure for storage and transport. Economic conditions of many farmers improved, and horticulture became a means for improving livelihood for many unprivileged classes. But regional disparity continued to be wide. Notably, the period succeeded in creating awareness to capitalize on the strength and convert weaknesses into opportunity. This is the time when Golden Revolution took place across the country through technological changes. The emphasis of technology has been on obtaining higher output of horticultural produce. The package included use of quality seeds and plants, efficient management of

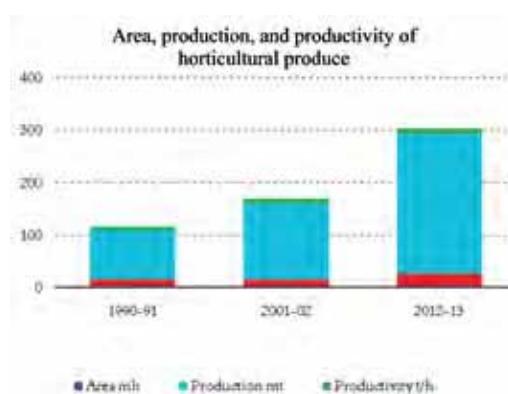
nutrients and water, and management of pest and diseases with focus on integrated management. Horticulture with a focus on farmers and landless labour became focus of development. The policy interventions supported all the activities of development and pressured farmers for active participants. Amazingly decadal growth in horticulture became impressive both for production and improving conditions of the farmers.

Policy changes for the development of horticulture

National Agriculture Policy 2000 has categorically emphasized on integrated development of horticulture, which should be knowledge based, technology driven and farmer-centric. The policy also emphasized on rural institutions, reforms and development of infrastructure. There is no policy document for horticulture, but focus has been given on post harvest management in the policy paper of food processing industries; most notably, policy change is related to storage, processing and marketing of horticultural produce. Backward and forward linked marketing with reform in agriculture produce marketing act and encouragement of contract farming are some of the important policy changes which are likely to enhance production, quality and competitiveness of horticultural produce.

Emerging Challenges to Horticulture Research and Development in India

In the present global scenario, world is concerned to meet food needs of growing population. FAO predicts that the agricultural productivity in the world will sustain the growing

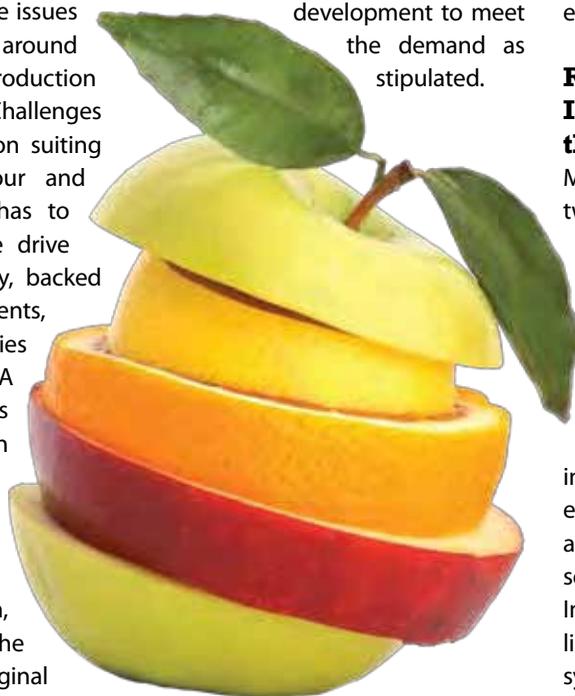


population in 2030, but millions of people in developing countries will starve out of food and remain hungry due to food shortage. By 2025, 83 per cent of the expected global population of 8.5 billion people will be in the developing world. The question before us is - can we meet food needs and provide nutrition, health care, fuel and fiber to the growing population? The answer is - it is difficult, but not impossible. Past experiences build the confidence that country has achieved. It was difficult to feed 320 million population and now we are able to feed 1180 million people and have surplus too. Crops which were not grown at particular location are made to grow. Indian Agriculture, even with high pressure on land (17% population from 2.3% land and 4.5% water) has fed the Indian population. In the post-independence period, India made a steady progress in agriculture. Agriculture was simple; extra land and water was available, few genes did wonder that ushered in ‘Green Revolution’. But the challenges, now, are much greater than before. In the prevailing circumstances of shrinking farm land, depleting water resources and changing climate, the situation has become complex. Optimistically, through the inputs of science and technology, challenges ahead could be converted into opportunities for sustainable production. Horticulture

has proved to provide the best means of diversification, and high land productivity has been achieved with context to gross return per hectare. But there is need to make the sustainable development in production of fruits, vegetables, tubers, plantations and tuber crops for meeting the growing demand of rising population for nutritionally rich horticulture produce.

Achieving the high production levels keeping in view the present and future needs are some of the issues, which needs to be addressed in a systematic manner. The issues are dynamic but they move around the sustainability of production and competitiveness. Challenges to feed growing population suiting to their dietary behaviour and nutritional requirements has to be addressed though the drive of science and technology, backed by enabling environments, resource utilisation strategies and reducing the losses. A large number of varieties developed have been adopted by the farmers and there is phenomenal development in horticulture with respect to production and growth, which has provided the benefits to small and marginal farmers and also consumers. But, gap between the demand and availability continue to widen. How to harness the potential and face the challenges are the issues, which need to be addressed. In this context, it is pertinent to analyze the critical gaps which can be addressed in systematic manner. Critical gap needing attention are low productivity and poor quality of the product, inadequacy of infra-structural facilities for post-harvest management and marketing, inadequate efforts for product

diversification and consumption, inadequacy of quality seed and planting material, inadequacy of human resource in horticulture, lack of appropriate database for effective planning, inadequacy of trained manpower and infrastructure in the states, poor delivery system, credit support/and price support and slow pace in adoption of improved technology. Horticultural development has to be seen as integrated approach, addressing important gaps, in harnessing the potential for horticultural development to meet the demand as stipulated.



Diagnostic of study into the aspect of projected growth rate in XII Plan, by the working group in horticulture for XII plan brought out the fact that opportunities in horticulture has not been harnessed to its potential, and has suggested approaches to address the gaps with emphasis on value chain management and addressing the problem of urban area through urban and peri-urban horticulture. Fact of under exploitation of horticulture potential

was also highlighted in the studies of World Bank 2007. A case study of Indian Horticulture highlighted that with the production of 11 percent vegetables and 15 percent fruits of the world, its penetration in global market was only 17 percent and 0.5 percent, respectively. Although we may have satisfaction of achieving above 6 percent growth rate and production level of 269 million tonnes, we may have to travel a long distance to harness the potential and achieve leadership, which cannot be achieved without knowledge empowered human resources.

Research and Development Initiatives needed to address the Changes in Horticulture

Most significant changes in the last two decades have been in the use of technologies and private sector investment for production system management. Investment made in horticulture during plans have been highly productive in transforming an agrarian economy in many states, which has provided insight for reversing the trend of ever declining farmers' income and, above all addressing the nutritional security and environmental concerns. Impact of change in technologies like new cultivars and production system management is visible in terms of increased production and productivity, which has recorded ten-fold increase (268 million tonnes during 2012-13) from the level of 25 million tonnes in 1950-51. Undoubtedly, horticulture sector has moved dynamically despite numerous challenges and shortcomings, and is in the crucial phase of development needing initiatives for sustainable development. To achieve the targeted production, stipulated in previous paragraphs, vertical growth, through the use of new

Production of horticulture produce- fruits, vegetable, spices, plantation crops, nuts in time scale

Commodity	Production (million tonne)								
	Area			Production			Productivity		
	1991-92	2002-03	2012-13	1991-92	2002-03	2012-13	1991-92	2002-03	2012-13
Fruits	2.87	3.79	6.89	28.63	45.20	81.28	9.97	11.93	11.79
Vegetables	5.59	6.09	9.21	58.53	84.81	162.18	10.47	13.92	17.60
Flowers	NA	0.07	0.23	NA	0.74	1.77 Loose 76.73 Cut	NA	10.57	7.69
Nuts	NA	0.12		NA	0.12	-	NA	1.00	-
Aroma. &Medi. Crop	NA	NA	0.56	NA	NA	0.92	NA	NA	1.64
Plantation	2.30	2.98	3.64	7.50	9.70	16.98	3.26	3.25	4.66
Spices	2.01	3.22	3.07	1.90	3.77	5.74	0.94	1.17	1.86
Mushroom	NA	NA		NA	0.04	-	NA	NA	NA
Honey	NA	NA		NA	0.01	-	NA	NA	NA
Grand Total	12.77	16.27	23.69	96.60	144.38	268.84	7.56	8.87	11.34

A=AREA(in million ha), P=PRODUCTION(in million metric tonnes),

Source NHB, 2012-13: Indian Horticulture data base

cultivars, efficient water and nutrient management, effective plant health management coupled with strategies for reduced post-harvest losses with empowered human resources could be the approach, which would need appropriate innovations and investment. Protected cultivation has shown yield enhancement up to 4 times, but would need investment. Plant architectural engineering and management can mitigate the problem associated with seasonality in many crops and the enhanced efficiency in water management, utilising modern techniques, shall reduce water stress. Since, horticulture provides variability and has potential to adjust in different agro-climatic situations, technology-led development is inevitable, where in horticulture education to empower the youth with new knowledge becomes essential.

Research Infrastructure: The Indian Council of Agricultural Research (ICAR), as an apex organization in National Research System, has built research infrastructure for horticultural

research and education. Currently, the country has 10 Central Institutes, 27 Regional Centres, 6 Directorates of Research and National Research Centres, nine Multidisciplinary Institutes and 14 All India Coordinated Research Projects with 251 centres. There are four full-fledged State Horticultural Universities. Besides these, work on horticultural crops, as per the project needs, is also done in CSIR laboratories, centres aided by Department of Biotechnology (DBT), Bhabha Atomic Research Centre (BARC) and Indian Space Research Organisation (ISRO).

Development infrastructure: Undoubtedly, development of nation or sector is guided by technology, enabling policy environment and investment. In the country ICAR, is apex organisation for research purpose and education in horticulture, while Department of Agriculture and Cooperation (DAC) is charged with the responsibilities of development through dissemination of technology, investment and enabling policy environment. Besides,

the Ministry of Agriculture, Ministry of Commerce with its Board, Agricultural Processed Food Products Export Development Authority (APEDA), New Delhi and Spices Board Kochi and Ministry of Food Processing and Industries are also supporting the development of horticulture. DAC is the apex body for implementing programmes in horticulture through Horticulture Dependent in the states, National Horticulture Board (NHB), National Committee on Plasticulture Application in Horticulture, Coconut Development Board and various Directorates on horticultural commodities. With changed focus on horticulture, there have been an enhanced allocation for the development, which have attracted private investment with change in policy of storage, processing and marketing. Considering the needs for value chain management, mission programmes in horticulture have been implemented which aims to

- Enhance horticulture production by providing holistic growth of the horticulture sector through

an area based regionally differentiated strategies.

- Establish convergence and synergy among multiple ongoing and planned programmes for horticulture development.
- Promotion, development and dissemination of technologies through a seamless blend of traditional wisdom and modern scientific knowledge opportunities for employment generation for skilled and unskilled persons, especially unemployment youth.

After implementation of mission programme for horticulture development, plan investment have increased many fold, which have impacted the Indian horticulture and production has increased from 25 million tonnes in 1959-1951 to 268 million tonnes in 2012-13. The trend of plan allocations in horticulture-both for research and development, clearly indicates that it has been rewarding. However, it is pertinent to note that, changes in farmers happen through changes in technology, institution, trade and market, and policy environment. Expectedly next phase has to be predominated by skills of trade and value-addition, and therefore all the efforts would be needed to have the development strategies which are knowledge-based, technology-driven and farmer-centric.

In the past decade, development of horticulture had enhanced planned investment, which witnessed the movement of horticulture from a rural confine to commercial stature, resulting in adoption of improved seeds, and technologies like micro-irrigation, protected cultivation, precision farming, integrated management of insect pests and diseases. Productivity of horticultural crops increased manifold and the sector sustained the growth rate of 6.5 per cent. Technological support has played a

key role in transforming Indian horticulture. However, many issues have emerged in the process of development and are being addressed.

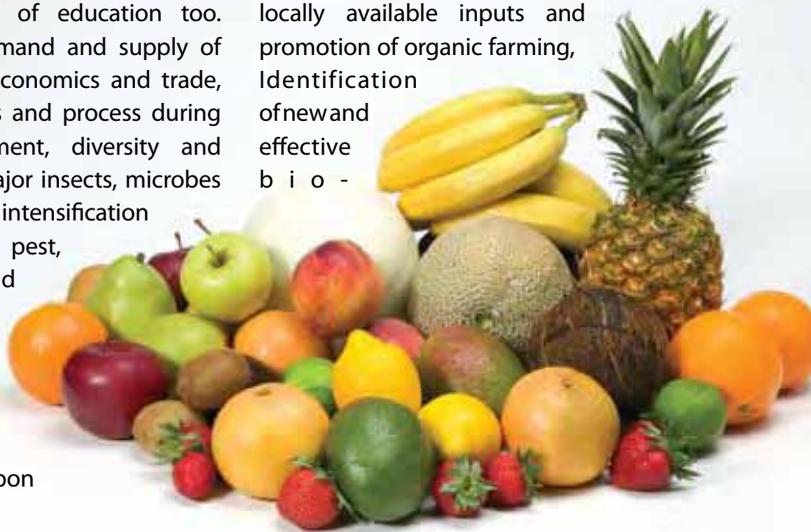
Dynamics of Research, Education and Development in New Paradigm

Production of fruits, vegetables, flowers, spices and plantation crops has been success stories of the last decades, and to continue to build on this success, sector has to face challenges. Therefore, there is a need to prioritise the action outlining the research, education, development and extension, to make this sector a key driver in rural and regional economic development. Demand for high value produce is growing both in domestic and overseas market, at the same time, competition is also increasing. New changes in retailing participation of corporate sector means that retailing will depend upon strategic alliance and supply chain management. Strengthened research on impact assessment to climate change on horticultural crops using controlled environmental facilities and simulation models, analysis of past weather data and integration with productivity changes (including extreme events) will be a guiding principle of new paradigm for orientation of education too. Production, demand and supply of commodities, economics and trade, sensitive stages and process during crop development, diversity and dynamics of major insects, microbes and pathogens, intensification of studies on pest, disease and weather relationships would be essential. Sustainability will depend upon

improving competitiveness, reducing impact on environment, quality assurance and food safety and capability of communities engaged in this sector to manage changes.

The new initiatives to strengthen the research activities should include development of varieties with durable resistance to multiple diseases and pests; heat, drought and salt tolerant varieties, and varieties with efficient nutrient and water use efficiency. Biotechnological tools in conjunction with conventional breeding to tag genes of interest and in marker assisted selection is needed.

Generation of eco-region specific technologies based on maximum productivity of available natural resources like climatic condition, soil fertility and water is another area that can be focused on. Developing system for productive use of water to get enhanced water productivity by increasing the water and nutrient use efficiency, technology packages for various fruit crops as an integral component of multifunctional agriculture of specific zone, IT based enabling mechanism for technology transfer such as decision support system needed, Holistic approach for water, nutrient, pest and disease management with adoption of latest agro-techniques, use of locally available inputs and promotion of organic farming, Identification of new and effective b i o -



molecules for management of biotic stresses for ecofriendly and sustainable management of diseases and pests, new innovative diagnostic techniques for rapid, accurate and cost effective detection of high impact pests and diseases are also important. Integrated management system for emerging diseases and pests would minimize the health risks.

Post-harvest technologies to improve product quality and minimize environmental impacts, increasing the value of production by reducing variability in yield, quality, reducing crop losses and increasing marketability would be crucial to minimize the losses. Production systems that minimize wastes and maximize recycling will enhance resource efficiency. Plenty of wind and solar energy is available in various agro-climatic zones, which can be utilized in mechanization, such as running of small equipment and dehydration of fruit and fruit based products. There is tremendous potential of processing of horticultural produce. Therefore, establishment of processing units, standardization of recipes for various products, certification and marketing network etc. should be given priority.

Adoption of sustainable path for development to meet challenges in fruit production through proper technological innovations and interventions, specifically in areas like value chain management, is needed to improve global competitiveness. Inter institutional mechanisms to network and review the ongoing program of biotechnology, cost effective production technologies, post harvest technology, farm mechanization, transfer of technology and organic farming is essential to provide strategic direction. Improving the understanding of interactions

List of technologies that transformed horticulture

Technologies

- Utilization of genetic resources and development of cultivars for high yield, quality and resistance / tolerance to biotic and abiotic stresses.
- Macro & Micro propagation techniques for mass multiplication of vegetatively propagated plants
- Use of root stock to mitigate problems related with soil- biotic & abiotic stresses
- Plant architecture engineering and its management
- Reduction of production losses through efficient management of pests and diseases.
- Post harvest management to reduce post harvest losses.
- On farm processing, value addition and waste utilization

between native ecosystems and production systems and developing best practices to conserve biodiversity is essential. Understanding of social needs of communities and to build the capabilities for practice change, and for effective utilization of resources and adoption of technology would facilitate accelerated adoption of improved technologies and best practices and, respond to needs including bio-security threats.

CLIMATE SMART HORTICULTURE DEVELOPMENT

The vulnerability of horticultural crops to climate change depends on both the expected regional climate change and the sector's ability to adapt. The projected increases in temperature, variability in precipitation patterns, increase in

frequency of extreme weather events such as heat, cold waves, frost days, droughts, floods would severely affect the production of horticultural commodities. These stresses at different crop developmental phases in varying intensities would ultimately determine productivity and quality. The emission of carbon dioxide due to anthropogenic activities has enriched the atmosphere. The carbon dioxide enrichment influences the carbon fixation and productivity of crops. The studies suggest a positive effect of increase in atmospheric carbon dioxide in C3 photosynthetic pathway crops, promoting their growth and productivity. The studies also indicate the increase in water use efficiency (WUE) of crops due to reduction in transpiration rates. However, the adverse effects of associated excessive heat and drought stress might offset the positive effects of elevated CO₂. The interplay of all these factors associated with climate change would subsequently determine the extent of impact on different crops in different agro-ecological regions. It could bring about both adverse and beneficial impacts on crop production depending on the prevailing climatic conditions of the agro-ecological regions, crop species and season. It could affect the growth, development and quality of horticultural crops and alter the zones of crop adaptation.

We need quick and clear understanding of impact of climate change on horticultural crops for making sound action plan because horticulture based farming systems have high potential for sequestering carbon for mitigation of climate change. The perennial trees act as carbon sinks by sequestering the atmospheric carbon. The carbon credits could be earned under the clean development mechanism

(CDM). The horticultural waste could be composted locally instead of dumping in the landfills, which can reduce the release of global warming methane that is involved in global warming. The organic waste could also be used for generating biogas as an alternate energy source. There are considerable uncertainties about agronomic implications of horticultural crops. Predicting impact of climate change on horticultural crops accurately on regional scale is a big problem. It can be accomplished only by a modeling approach through well-validated robust crop

Managing Climate Change, for Climate Smart Horticulture

The issues of climate change and solution to the problems arising out of it requires local analysis, planning and management which could be managed through innovation, technology evaluation and refinement to provide effective solutions to the problems. Potential impacts of climate change depend not only on climate per se, but also on the system's ability to adapt to change. The potential depends on how well the crops adapt to the concomitant environmental stresses due to climate change. Depending on the vulnerability of individual crop in an agro-ecological region and the growing season, the crop based adaptation strategies need to be developed, integrating all available options to sustain the productivity. The scientists have already developed several technologies to cope with extreme events like high temperature, frost and limited and excess moisture stress conditions. These available technologies could be integrated and made use to reduce the adverse impacts of climate change and climate variability. Further em-



phasis need to be put on developing the crop, agro-ecological region and season-based technologies to reduce the impacts and increase the resilience of horticultural production systems to climate change. To address the adverse impacts of climate change on productivity and quality of horticultural crops we need to develop sound adaptation strategies.

Climate Smart Horticulture is a production system for improved water-use efficiency and to adapt to the hot and dry conditions. Strategies like changing sowing or planting dates in order to combat the likely increase in temperature and water stress periods during the crop-growing season; Modifying fertilizer application to enhance nutrient availability and use of soil amendments to improve soil fertility and enhance nutrient uptake and Providing irrigation during critical stages of the crop growth and conservation of soil moisture reserves are the most important interventions. Crop management practices like mulching with crop residues and plastic mulches help in conserving soil moisture. In some instances, excessive soil moisture due to heavy rain becomes major problem and it could be overcome by growing crops on raised beds. Production of vegetables could be taken up using clear plastic rain

shelters, which can reduce the direct impact on developing fruits and also reduce the field water logging during rainy season. Planting of vegetables on raised beds during rainy season will increase the yield due to improved drainage and reduced anoxic stress to the root system. Use of tolerant rootstock, would provide the scion cultivars with tolerance to soil related environmental stresses such as drought, salinity, low soil temperature and flooding.

In addition to employing modified crop management practices, the challenges posed by climate change could be tackled by developing tolerant varieties. Several institutions have evolved hybrids and varieties, which are tolerant to heat and drought stress conditions. They can be used very effectively to combat the effect of climate change depending upon their performance in a given agro-ecological region. Efforts should be intensified to develop new varieties suitable for different agro-ecological regions under changing climatic conditions. In comparison to annual crops, where the adaptation strategies can be realized relatively fast using a wide range of cultivars and species, changing planting dates or season, the planting and rearrangement of orchards requires a consideration of the more long-term aspects of

Plan	ICAR Budget for horticulture Research (Rs. In crore)	DAC Budget of horticulture (Rs. In crore)
VII	3.5	25
VIII	31.9	789
IX	208.0	1453
X	321.7	4040
XI	629.8	8086
XII	1050.0	15946

climate change. Therefore, before resorting to any adaptation option, a detailed investigation on the impact of climate change on perennial crops is necessary.

The longevity of perennial crops creates situations like - favourable areas becoming unfavourable during the life of a single orchard. The choice of a variety is complicated by the risk that the best variety for the current climate may be poorly suited for future climates. Thus, while adaptations such as planting new varieties and shifting to new areas may reduce impacts in the long-term, short-term losses may largely be unavoidable. In wine grape, each grape variety grows in a range of temperatures and for each variety it is possible to define climates for premium wine production. The physiological and morphological differences between varieties (genotypes) enable production over a relatively large range of climates and depending upon the suitability to different growing areas the cultivars may be adopted. In situations, where there is a strong consumer preference for a select cultivar and also the suitable varieties are not available to adapt to the changing climate of a particular growing region, the option of using rootstocks for better performance of the scion cultivars could be explored.

An integrated approach with all available options of smart

horticulture will be most effective in sustaining the productivity under climate change conditions. To achieve this end, efforts must be initiated at national and agro-ecological region level to assess the impact of climate change on different horticultural crops to develop a number of combinations of adaptation options for horticulture sector, as a whole, in an integrated manner to tackle the impacts of climate change.

Technological changes needed for climate smart horticulture

Grapes are temperate fruits, which have been largely grown under cool climate, be it for table purposes or for wine-making. But the technological change in plant architecture and production system management has helped to produce grapes in tropical situation, with highest productivity in the world. Likewise, the chilling will not be enough to induce flowering in apple and high temperature in the mid hill agro-climatic conditions, may cause desiccation in pollen, shriveling of fruits resulting in reduced yield and more failure of the crops. These are the likely impacts which cause concerns. But, there are innumerable examples to cite that, climate has been changing and the technologies have helped in mitigating the problem. Salinity and alkalinity were a great problem for successful growing of grape but identification of suitable rootstocks has made it highly productive. If we look at potato, tomato, cauliflower and cabbage, these are thermo-sensitive crops and were productive only under long day conditions in temperate climate. But development of heat

tolerant cultivars and adjustment in production system management has made it possible with very high productivity, even in subtropical and mild subtropical and warmer climates. These are the past experiences, which clearly brings home the point that through innovative research threat of climate change could be converted into opportunity, but will need visualization of likely change, its impact and planning to mitigate its bad impact. Now, available tools of biotechnology could add for speedier delivery of research results.

Keeping in view the nature of crop, its sensitivity level and the agro-ecological region, crop-based adaptation strategies need to be developed, integrating all available options to sustain the productivity. Developing strategies and tools to comprehensively understand the impact of climate change and evolve possible adaptation measures in horticultural crops is less understood. To enhance our preparedness for climate change and to formulate a sound action plan, we need to identify gaps in vital information, prioritize research issues from point of view of farmers, policy-planners, scientists, trade and industry. It is imperative to visualize likely changes which can happen in next 50-100 years, how these changes could affect growth, development and quality of horticultural crops, what are the technologies which shall help to mitigate the problem and what kind of innovative research should be done to overcome the challenges of climate change. Thus, policy issues, adaptation strategies and mitigation technologies could be worked out and challenges could be converted into opportunities.

Changing dynamics of horticulture

Horticulture is now recognized for health care through the use of horticultural produce for the treatment of many diseases, therapy, and environment services and above all to the improved quality of life of people living in rural as well as in urban area. Texas university in USA, has integrated approach for horticulture to address the health of people. Similarly, environmental horticulture is emerging as new area to provide environmental services to mitigate and adapt to climate change. Urban and Peri-urban Horticulture is also seen to play a significant role in rapid urbanisation, taking place across the globe, to mitigate many of problems arising due to urbanisation, to meet the needs, utilise the waste and service the environment.

Horticulture for Health Care

Health care of people, at large, has been through modern medicine but still in Asia more than 80 percent people depend on herbs. Many of doctors now feel that modern medicine brings illness rather than wellness, and subscribe for balanced diet which protect against many disease by enhancing self protective mechanism through many immunological advantages. The fruits (aonla, bael, jamun, papaya), vegetables (carrot, cauliflower, onion, garlic, leafy vegetables), spices (ginger, turmeric, black pepper, fenugreek, ajowan) and ornamental plants (Ashoka, Ficus, catharanthus) protect against various diseases. The spices like turmeric, chillies and cumin in the diet have been recognized to protect against cancer. Noni (Morinda citrifolia) with unique characteristics is recognized as best for health care, as it provides protection against various diseases including HIV. Virgin coconut oil protects from HIV and coconut water provides all nutrients to child

apparently. Horticultural crops thus provide ample opportunities for health care. According to the Food and Nutrition Board of the National Research Council, man and women between 23 and 50 years should eat about 2800 and 2,200 calories a day, respectively to maintain weight. The nutrient needs are liable to vary with gender, age, height, weight, physical condition, activity level and the climatic conditions where they live. Pregnant women and lactating mothers will need additional 300-500 calories per day than



t h e i r
usual needs.

Thus, fruits and vegetable provide wider option for meeting the energy requirement for the human system.

Cereals are the main staple food which lacks various minerals and vitamins. To sustain and lead a healthy life, the food we eat should contain a wide range of nutrients in proper proportion i.e. it should be a well-balanced diet. The nutrients include proteins, fat, carbohydrates, vitamins, fibre and minerals. Each nutrient has a definite function. No single fruit or vegetable can nourish the body with all the vital ingredients it requires. Hence it is important to consume a variety of fruits, vegetables, spices and condiments to derive required nutrition. Horticultural crops are

meeting essential requirement for which these crops are rich source of energy, proteins, vitamins, minerals and antioxidants etc. for nourishment of our body.

Urban and Peri-Urban Horticulture/Environmental Horticulture

Trees, potted plants and flowers are not only valued for its aesthetic appeal, but research data have evidently proven that many kind of diseases including depression could be prevented if we are surrounded with plants and flowers. This is also proven that work efficiency is enhanced by 25-30 percent if workers have exposure to flowers. In the current context of climate change, landscape gardening, both interior and exterior, has become inevitable to service the environment. Recognizing the importance of plants and flowers to the mankind, ancient culture has advocated the use of flowers, and the living styles have been interwoven with garden, plant and flower. Evidently, Love or sorrow is expressed with the colour of flowers. However, the quest for food during the development deviated us from the need of flowers for health. With the realization, that plants and flowers are important, there is now a growing interest in urban and peri-urban horticulture, since, and plants offer environmental and ecological services along with aesthetic values.

Trees and other ornamental plants are crucial for the sequestration of carbon from atmosphere and play an important role in reducing carbon foot print. Flowering /foliage plants in the garden not only add beauty but also help to improve the ecosystem. In the cities, environmental benefits and synergies can be achieved when horticulture is planned as a part of the urban landscape including

safe recycling of solid waste and wastewater. The country has responded to the needs for effective urban and peri-urban horticulture with emphasis on green space, green building, development of parks and gardens, and promotion of peri-urban vegetables production, but there continue to be a gap in integration. Therefore, design of UPH must include an element of urban and peri-urban horticulture aimed at improving access to food and advancing the livelihoods of people living in and around cities besides servicing the environment.

Urban and peri-urban horticulture is a necessity rather than a demand. This has become a key component of the survival strategies. UPH could be a source of employment and has the potential to improve the nutritional security of urban residents. Horticultural products @400g/ person/day can prevent non-communicable diseases and improve the health. In urban and peri-urban area horticulture becomes vital to address the challenges emerging owing to rapid urbanisation of cities and small towns. Initiatives of peri-urban vegetables production alone cannot be enough for the dimension of challenges, which is complex and high in proportion. This necessitates holistic approaches having vertical and horizontal integration of the

efforts of all the stakeholders, which should address all the links in chain of UPH development concurrently.

Terrace gardening usually refers to the area in the immediate vicinity of a building. This is a raised ground space constructed around a dwelling house or on the sides of a hill. The terrace forms a link between the house and the rest of the outdoor living space and must, therefore, be designed in harmony with the plan of the house. Roof garden is one of popular alternatives in urban and peri-urban areas, because of the limited available space on the grounds of a house, particularly, in the big cities and towns. The only space left for garden enthusiasts is the roof of the house and the balcony. To ensure the success of roof garden, technical and developmental support is inevitable. Currently, a green space of 20m² as minimum standard has been suggested. There are city-specific specifications which are used to set standards. No dwelling should be more than 500 metres from a green area of at least 6,000 m². Green spaces in urban systems should essentially be developed as networks. There is no definite standard for green space in city based on scientific data. Green cities have become an option to mitigate the impact and adapt to climate change, as plants sequester the carbon dioxide and

other gases. Well planned UPH could be an important strategy to mitigate and adopt to the climate change. Therefore, all the initiatives must be taken for the development of UPH.

A way forward

The decade has witnessed the emergence of horticulture as commercial enterprise moving from rural confine, owing to technological advancement, policy environment and investment in research, education and development. The production, productivity and export of horticultural produce have increased many fold. Despite achievements in horticulture sector, the challenges confronting are still many. With increase in per capita income and accelerated growth of health conscious population, coupled with rapid urbanisation, demand for horticultural produce is on the increase, which is expected to further accelerate. But, the increased production has to be achieved with declining land and water in changing climate. At the same time, growing competition in open economy, demand competitive price of standard quality produce. This opens up opportunity and challenges. Hence, the potential, which exists for horticulture has to be harnessed utilizing power of knowledge with the aim of sustaining the gains.

Development of improved cultivars with high quality characteristics, productivity, resistance to pest and disease and tolerance to abiotic stresses and technologies for improving the efficiency of water and nutrients by reducing variability in yield, quality and reducing pre and post harvest crop losses are the priorities to address the challenges. The crop monitoring mechanism ensuring timely availability of inputs, efficient delivery system and technical



backstopping would be needed as integrated approach. Emerging challenges, thus, require sustained research and human capital to improve competitiveness, enhance efficiency of production system, assuring quality and safety and improved capability of community to manage the change. Consequently, technology driven horticulture will contribute significantly for economic development. In the context of threat of climate change, climate smart horticulture (CHS), has provided options for sustainability, but has many technological challenges and issues of human resource development. Climate change, which has been perceived as threat, will have likely impact on horticultural crops, due to erratic rainfall, more demand for water, and enhanced biotic and abiotic stresses. The changes will not only be harmful, as enhanced CO₂ concentration may enhance faster photosynthesis and increased temperature may hasten the process of maturity.

However, measures to adapt to these climate change-induced changes are critical for sustainable production. Increased temperature will have more effect on reproductive biology and reduced water may affect the productivity but adaptive mechanism like time adjustment and productive use of water shall reduce the negative impact. The strategies must therefore, have to identify the gene tolerant to high temperature, flooding and drought, nutrient efficient cultivars and production system for efficient use of nutrient and water. Development of climate smart horticultural will need tolerant crops to high temperature, moisture stress and salinity. Genomics and biotechnology coupled with nanotechnology would be essentially

required to develop genotype for climate smart horticulture. This would need highly prioritised research and education to address the impact of climate change. Enhancing the adaptation of tropical production system to changing climatic condition is a great challenge necessitating integrated efforts having an efficient and effective strategy to be able to deliver technologies that can mitigate the effects of climate change on diverse crops and production systems. This cannot be done with current level of human resource. Horticulture education therefore,



must have to address all the strategies which can convert the challenges into the opportunities.

In order to achieve, vibrant, responsive and climate smart horticulture, which is eco-friendly, equitable, sustainable and economically productive, new frontiers of science and knowledge and human resource would be inevitable. Essentially, the technologies must have potential to increase the value of production by reducing variability and increasing the marketability. The paradigm necessitates for knowledge empowered human resource that can provide leadership in technology development and policy formulation to attract investment, and keep up the pace of development. Horticulture education, relevant to

needs therefore, have to play a crucial role.

In India, an emerging economy, a key challenge is to harness and sustain the strength and achievements in technologies developed in horticulture. While packing the way through capacity building and new modalities of training for traditional farmers as well as IT-Savy younger generation, it is essential that knowledge significant for the economy is imparted. Since, the path, ahead of Indian horticulture, is driving to Hi-tech horticulture, institutions and learning centres would be essentially required to serve as knowledge banks and evolve as an interactive learning centre backed by comprehensive research and hands on training. Such learning centres should provide superior learning opportunities along with perfect blend of practical training. Manpower and technology development through education and research has to be in accordance with the present day need; both qualitatively and quantitatively. Present day demand is influenced by the development in the recent past, such as nutritional security, food safety, environment safety, commercialization and globalization of horticulture and avoiding huge post-harvest losses have to be met through manpower and technological development. Accordingly, the course curriculums for graduate and post-graduate courses have to be redesigned. The course programmes and the course contents have to be reformulated with modifications, in the changing scenario, to achieve science and technology-led horticulture development.

*The author is the Founder and
Chairman, Confederation of
Horticulture Association of India
(CHAI), New Delhi*



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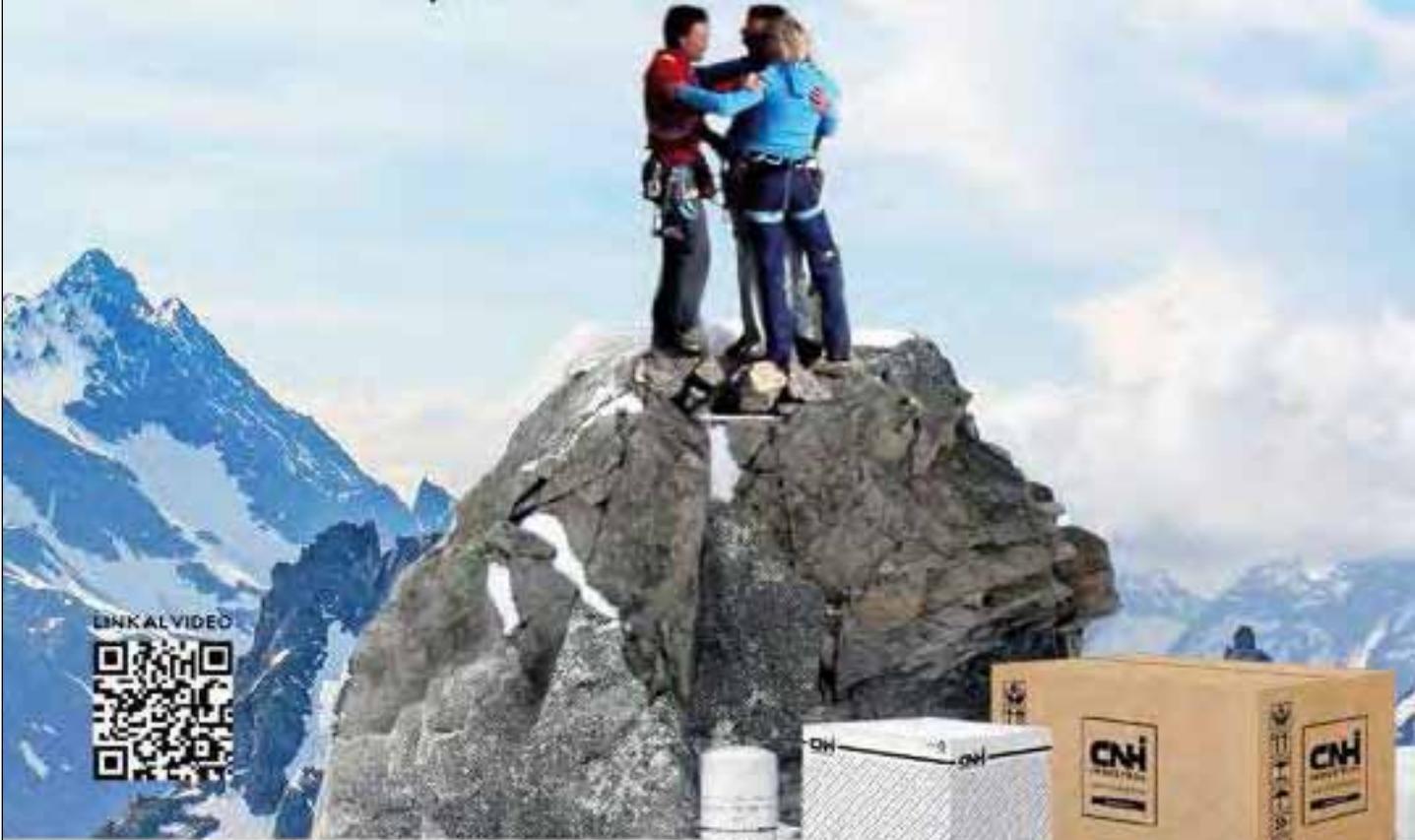


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Raising potato's profile in India

To feed its 1.2 billion people, India must apply to its agriculture sector the same innovative thinking and entrepreneurial spirit that have defined its emergence as one of Asia's economic powerhouses. The country's vast rural farming networks have evolved to take advantage of impressive gains in predominantly rice production systems that have ensured the food security of millions. However, growing environmental vulnerability and rapid urbanisation are challenging these centuries-old practices and dependencies. Many of India's farming states, such as Odisha, are some of the lowest lying and most at risk to the extremes of climate change. Over-intensification from monocropping, including poor irrigation practices, has compromised the quality of arable land and dramatically lowered the national water table. Frequent droughts and flooding have increased salinity, degrading soil quality further. Population growth over the next few decades will continue to be concentrated in cities, and precious farmland will increasingly be lost to roads and buildings.

The state of India's current agriculture sector with all its attendant challenges, policies, and practices was the focus of my meeting with Mr Naveen Patnaik, Chief Minister of Odisha, and several dignitaries from the Agriculture ministry in Bhubaneswar on August 20. Along with Julian Parr, CIP's Regional Director for Asia,

and colleagues we gathered to discuss how CIP's India-wide programme is helping the country to boost its production of potato and sweet potato, especially by encouraging farmers to adopt the use of cleaner planting material of both these crops.

A current initiative highlighted at the meeting was the "Sustainable Intensification of Potato in Rice based System in Odisha for Increasing Productivity and Profitability", a project funded by the State of Odisha's Department for Horticulture is now underway in Odisha. CIP is providing technical support for farmers willing to adopt heat- and drought- tolerant, short-cycle (70–90 days) potato varieties. Participating farmers receive "clean" (disease-free) potato seed at a subsidized rate, helping to increase yields and production in Odisha State, where at 2.5 lakh MT is only 25 per cent of current demand. CIP works with project partners to also provide technical training, better access to organised marketing linkages, and assistance with improved postharvest handling and storage to extend potato's shelf-life and marketability. At the end of the day's discussions, I re-emphasised CIP's commitment to supply Odisha State with all needed assistance to encourage its farmers to adopt potato under the new project.

Comprehensive programmes to scale up potato and sweet potato in India

In 2014, CIP launched six formal programmes that sharply focus and marshal the Centre's agricultural R&D expertise in potato and sweet potato for the world's smallholder farmers and their communities in different agro-ecologies. With India in particular, this includes the need to promote greater cultivation and integration of root and tuber crops in order to diversify cereals-based agricultural farming systems. (Cereal grains, chiefly rice, are particularly vulnerable to climate change effects and costly price fluctuations caused by international trading and speculation.)

The two CIP programmes that hold the most immediate promise for India's agriculture sector



are the “Agile” Potato programme and the one centred on orange-fleshed sweetpotato (OFSP), first pioneered in Africa and now scaling out to India and much of Asia.

Vulnerable populations also continue to experience nutrition challenges due to low levels of diet diversification with limited micronutrient content and the relatively low economic value of cereals. India has one of the highest concentrations of poverty worldwide, and high malnutrition rates among women and children under five are responsible for high levels of infant and maternal morbidity and mortality. Economic and social exclusion, largely due to gender, caste, and ethnic discrimination, intensifies the problems of poverty and malnutrition. Strategies to address food and nutrition insecurity here are urgently needed.

The Agile Potato

Early-maturing agile potato varieties, particularly a 70- to 90-day potato, resistant to heat and viruses and with good processing quality, are a profitable and nutritious complement to low-income cereals in much of India. It can be adapted to a wide range of cropping systems in subtropical, temperate, and highland environments to help low-income consumers cushion the impact of food price inflation and achieve higher incomes from on-farm and added-value options. These potato varieties provide flexible planting and harvesting times without putting undue pressure on dwindling land and water resources.

CIP’s program to promote early-maturing potato aims to improve systems productivity and farm incomes of thousands of Indian households. As we pointed out at the August meeting

in Bhubaneswar, good quality seed or resilient varieties are in short supply and greatly limit the country’s potato production. To overcome this serious bottleneck, CIP’s Agile Potato strategy for India will forge local and national partnerships to develop elite, tropically adapted bred populations and candidate potato varieties with short growing seasons of 70–80 days in subtropical climates and 90–100 days in temperate ones. CIP and its partners in government, agricultural research institutes, and universities will make available necessary early-maturing varieties with traits for resistance to biotic and abiotic stress, including those required by the market and processing



industry, as well as those preferred for home consumption. We will help our partners build capacity and scale up the use of research products for accelerated breeding, improved seed delivery, diversification of value chains, and ecological management practices—especially more efficient use of precious water resources. Collaborative research with the India Central Potato Research Institute (CPRI) on the early-maturing potato will explore sustainable cultivation practices and the environmental impact of introducing the potato into cereal-based cropping systems.

CIP will establish strategic

alliances for going to scale and assess their efficacy and return on investment. Trade-off analysis in terms of labour, nutrients, water, and other input use will be measured to assess the beneficial impact of potato-related interventions on the four key elements of food security: food availability, accessibility, utilization, and vulnerability. Broad-based partnerships and alliances are essential to the development and adaptation of technologies and practices to the needs of smallholder farmers, especially poor and female agricultural workers in India. Under the Agile Potato strategy we will cultivate private-public partnership chains for contract farming and buy-back mechanisms to enhance processing of potatoes and ensure income of farmers and buffer years of overproduction.

There are opportunities to develop and deliver intensive training to farmers who need greater awareness and skills of processing requirements through improved technology options that support agricultural diversification and strengthen rural institutions engaged in market value chains.

Tolerant to high temperatures and resistant to major virus diseases, the resilient, competitive potato varieties, together with appropriate crop and system management practices, can be incorporated into diverse cropping systems of subtropical lowland, highland, and temperate regions. Their specific postharvest qualities will address current producers’ and market needs as well as food security for vulnerable households. They can bring new areas under potato cultivation in cereal-based systems and increase overall food productivity. Agile Potato’s integrative solutions will be a priority for India as it braces itself for the anticipated rise in global

population, the growing prospect of major shocks from climate change, and the impacts on society and natural resources from ongoing urbanization and rural dislocation.

Resilient Nutritious Sweetpotato

The advantages of sweetpotato, OFSP in particular, to improve health, nutrition, and income are thoroughly and solidly documented by our decades of work in West and sub-Saharan Africa. Long stigmatised as a “poor woman’s crop”, biofortified OFSP is now seen as a proven technology for reducing vitamin A deficiency among women and small children, as well as malnutrition and stunting. And in some parts of India, agriculture has largely failed to keep up with the changing needs for more nutritious food, as policies have until recently overlooked nutrition and research systems have fallen behind global scientific advances.

Technology and information delivery systems are not well connected to high-impact partners. This has weakened innovation systems. As I noted above, new challenges from climatic changes are threatening agricultural productivity, and global food price fluctuations are jeopardizing food and nutrition security among vulnerable populations. Smallholder farmers largely do not realize the potential benefits of increased market demand for food stemming from urbanization and improved trade. What is urgently required are agricultural technologies that can produce nutritious and marketable food in agro-ecologies and socioeconomic contexts that are important to the poor.

CIP has demonstrated the efficacy

of OFSP in several African countries, and is now responding to increasing global demand through a phased scaling-up program in India. OFSP’s scaling-up efforts will focus on locations where sweetpotato has an inherent agronomic advantage as a short-cycle crop that requires few inputs and can produce comparatively high yields even under marginal conditions. In the next ten years, we hope to reach more than 375,000 households in Odisha, where we estimate that sweetpotato production will grow to some 422,000 tonnes a year on almost 9 tonnes per hectare. (Odisha already leads the country in sweetpotato production, with intensive sweetpotato cultivation areas planned for expansion into Ganjam, Sundergarh, Koraput, and Dhenkanal districts.)

All of CIP’s scaling-up projects will include specific capacity-building and technology exchange components that will fully use our global reach to link up national and regional expertise for accelerated learning. We have developed methodologies and tools for accelerating varietal development, seed system development, intensification of production systems, and improved postharvest management, to support scaling-up of OFSP interventions in the region. Expanding and extending this network approach will help facilitate transfer of experience, skills, and germplasm to new sites where development impacts can be achieved. Research will continue on scaling-up of breeding, seed systems, cropping system intensification, nutrition interventions, value chains, and partnership models.

Power of partnerships

To expand the role of root and tuber

crops in India’s agricultural sector many key players are required. Central to CIP as a global R&D organisation and a local catalyst for project implementation is working with partners at national, regional, and local levels. Without the direct involvement of governments, research institutions, and non-governmental organisations, our science “products”—whether germplasm from our genebank, or experiential knowledge to improve agronomic practices, or intellectual property to guide future breeding programmes—would have little practical impact. Tapping into India’s entrepreneurial spirit and muscle will pack a more potent punch to delivering these products further. Technical training for organisations and farmers, evidence-based knowledge for policy- and decision- makers, and value chain strengthening to expand markets for potato and sweetpotato call for ever-widening alliances and actors.

CIP’s potato and sweetpotato programmes and initiatives have shown great promise in helping smallholder farmers improve their food security, incomes, and health and nutrition the world over. For India, especially its low-lying fertile farming states, also offer added strategic advantages for agro-diversity, resilience, and sustainability, the country will need to buffer against climate change impacts. We are convinced that root and tuber crops have a greater role to play in India’s agricultural sector, as vital components of the country’s response to feed its billions of people. A healthy mix of root and tuber crops within India’s traditional cereals-based cropping system deserves a higher profile and commitment. CIP is here to help see that vision grow stronger.

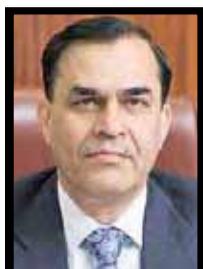


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DR. H.K. BHANWALA

Protected Cultivation in India: Issues and Challenges

India is the second largest producer of fruits and vegetables in the world. The increasing importance of horticulture sector can be gauged from the fact that at an estimated 265 million tonnes, the production of horticultural crops exceeded that of foodgrains and oilseeds in 2012-13. Significantly, while the area under horticulture grew by about 3.8 percent per annum, production rose by 7.6 per cent per annum over the last decade. It is important to note that a significant improvement in productivity of horticulture crops – to the extent of about 28 per cent during the period 2001-02 and 2011-12, led to a substantial improvement in output. It is worth mentioning that special thrust on this sector, with the introduction of the National Horticulture Mission (NHM) and the Horticulture Mission for North East & Himalayan States (HMNEH), has led to positive results.

The growth trend of horticulture crops during the period 2001-02 to 2011-12 is depicted in Chart – 1, which indicates a steady increase from 145.8 million MT in 2001-02 to 257.2 million MT in 2011-12.

India has a huge potential for export of horticulture produce. Export earnings in horticulture have recorded a significant

improvement over the last decade. The value of exports has increased significantly from Rs. 5677.50 crore in 2001-02 to Rs. 13792.20 crore in 2010-11. Hence, it is pertinent to significantly increase production and productivity of horticultural crops, to be more competitive in the international market.

The domestic market has also experienced a surge in demand for horticulture produce due to increase in per capita income and consequently, the desire to consume nutritious food. This indicates a growing scope for the development of the horticulture sector, by improving crop productivity and efficiency in the value chains. However, it is a matter of concern that the recent inflation in India has been driven mainly by increase in prices of horticultural crops, notably vegetables, tomatoes, potatoes and onions. This calls for a substantial rise in productivity of horticulture crops, leading to increase in supply to match the growing demand.

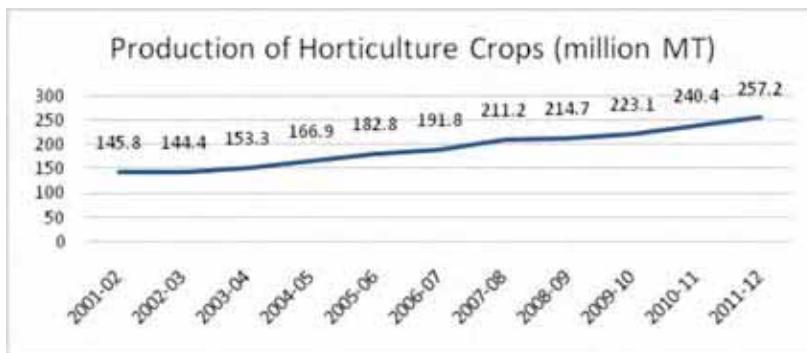
Considering the increasing pressure on land, the policy focus has been on increasing productivity through protected cultivation, high density plantations, micro irrigation, quality planting materials, etc. Further, there has been a greater awareness about the importance of post-harvest management to significantly reduce wastage and increase the value of produce.

Thus, in order to promote sustainable agriculture and horticulture there is a need to encourage protected cultivation, which involves growing these crops in the controlled environment of greenhouses, thereby minimising the use of water and fertilisers.

Protected Cultivation – The Concept

Protected cultivation is a hi-tech method which involves interventions that create favourable conditions around the cultivated plants offsetting the detrimental effects of prevailing biotic and abiotic factors. It is common knowledge that plants in open field conditions experience short cropping season, unfavourable climatic





Source: State of Indian Agriculture 2012-13

conditions, vulnerability to predators, pests and weeds, and depleted soil moisture and plant nutrients. However, in protected agriculture some of these factors are controlled or altered, to the advantage of plants. Also, due to economic reasons, protection or control is provided against the most significant stresses.

Protected cultivation involves the principles of greenhouse effect for heated cultivated space using sunrays and ventilation for cooling and air carbon-dioxide regulation. The cultivated area is covered with transparent plastic film/ cover which allows incoming short wave radiation from sun but is partially opaque to emergent long wave infrared radiation from soil, plant and structural surfaces, thereby trapping the heat. This results in the maintenance of higher temperature in enclosed space than the ambient. The trapped heat is gradually dissipated through conduction, convection and radiation.

Various methods of protected cultivation are: (a) mulching, (b) floating covers, (c) low tunnels/ row covers, (d) cloches, and (e) polyhouses/ greenhouses. The advantages of protected cultivation are (a) significantly higher levels of productivity; (b) superior quality of produce because of isolation and controls; (c) higher input

use efficiencies in cultivation; (d) significant increase in income per area of cultivation; and (e) year-round production of crops which are usually seasonal in nature.

However, a major problem observed in conventional designs of greenhouses is the concentration of heat within the covered structures, which needs to be either expelled or neutralised through energy-intensive cooling facilities. This problem can be overcome by designing naturally ventilated greenhouses where the temperature can be maintained at the desirable level without consuming any energy.

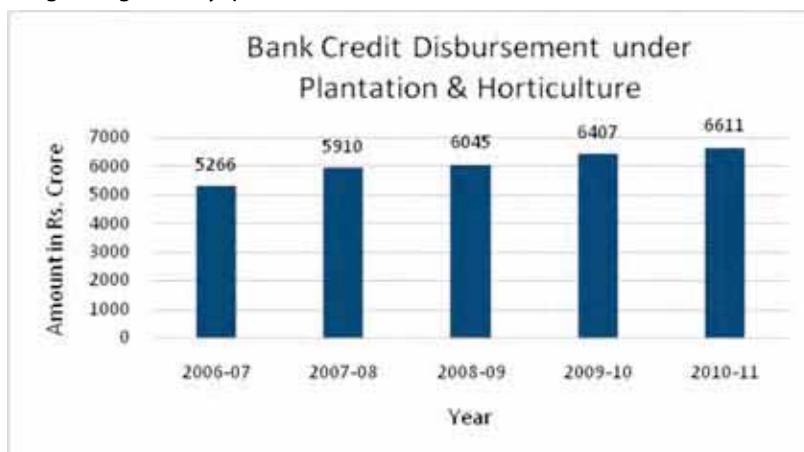
There are other important protected cultivation technologies which have been developed by the Indian Agricultural Research Institute (IARI), viz. an insect-proof net-house for growing healthy plant nurseries;

and a walk-in tunnel technology for safe vegetable production during the off-season. These technologies have been useful for growing crops like cucumber, capsicum, tomato, bottle gourd, summer squash, french beans, etc.

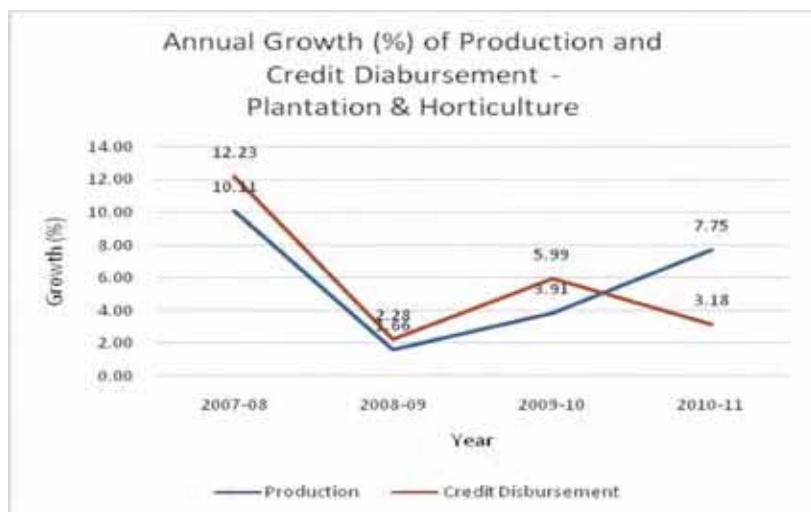
NABARD has initiated a pilot project to fund protected agriculture in Maharashtra, West Bengal and Haryana for onion, potatoes and tomatoes, respectively.

Protected Cultivation—Critical Issues

Globally there are about 20 million hectares under protected cultivation. The Netherlands has a long tradition of protected cultivation under glass shielded greenhouses growing flowers/ ornamentals and vegetables in equal proportion. Israel has extensively adopted protected cultivation technology for producing quality vegetables, flowers, fruits, etc. in water deficit desert areas for meeting its small domestic demand as well as the huge export demand. The Indo-Israel project on greenhouse cultivation, initiated at IARI in 1998, was the first effort in the promotion of hi-tech protected cultivation in India. The Centre for Protected cultivation Technology (CPCT) at IARI has been able to refine and upscale



Source: NABARD Annual Report (2012-13 and 2013-14)



Source: Calculated from data accessed from State of Indian Agriculture 2012-13 and NABARD Annual Report 2013-14

the system to reduce costs, besides designing greenhouse structures to suit local conditions. Experiments by IARI have demonstrated that multi-layered cultivation of vegetables under a controlled environment could maximise production and profits per unit area. Integration of rainwater harvesting with greenhouse cultivation can make water available for such farming at lower cost. The rainwater collection tanks can supply water to the greenhouse crops efficiently through low-pressure drip irrigation system. The requirement of water and energy in such cultivation has been cut down through micro irrigation-cum-fertilization (fertigation) and rainwater harvesting.

Protected cultivation involves high initial expenditure for creating greenhouse structures, but farmers generally do not seem to mind the high cost as it offers increased returns. The farmers can use the greenhouses for a long time, and can grow and sell vegetables and other high-value commodities during the off-season, when prices are generally high. Further, greenhouses also help farmers to reduce the expenditure

on pesticides by warding off insect pests. Significantly, consumers can gain access to a continuous supply of seasonal vegetables. Hence, there is considerable merit in the expansion of the area under protected cultivation, as it benefits both producers and consumers.

In order to promote protected cultivation, IARI has been extending technical and other support to various state government departments, and other organisations. This technology has spread to Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Himachal Pradesh, Uttarakhand, Punjab and Haryana. Rajasthan, Odisha and some north-eastern states have also taken steps to adopt protected cultivation. Accordingly, the total area under protected cultivation in India has increased to an estimated 25,000 hectares.

Protected cultivation has been able to alleviate major constraints in horticultural crop production, viz., inadequate sunlight, inappropriate temperatures, moisture deficiencies or excesses, weed growth, deficiencies in soil nutrients, excessive wind velocity, and atmospheric carbon dioxide. Further, it is economically

more rewarding in production of high value, low volume crops, seeds and planting materials, off-season fruits and vegetables.

Experiments on protected cultivation carried out by the National Academy of Agricultural Sciences, have demonstrated that not only has crop productivity per unit area in respect of vegetable crops increased several times but also productivity per unit volume of water has increased substantially inside greenhouses. Results of experiments have also shown that fruit picking inside polyhouses started about 45 days earlier than outdoors and that productivity was more than double. It has also been observed that vegetable nursery raising under protected condition is a paying proposition and is becoming popular especially in the hilly regions. Further, micro-propagated plant hardening, vegetative propagation and grafting / budding, and rooting of cuttings have been observed to have much higher success rate in polyhouse condition.

Population pressure, fragmentation of land holdings, depletion of groundwater and erosion of natural resources have led to stagnation in agricultural productivity. In this context, it is noteworthy that protected cultivation offers several advantages to grow high-value crops with improved quality even under unfavourable and marginal environments. Indeed, protected cultivation has the potential of meeting the requirements of small and marginal farmers as it can increase their yield significantly per unit area.

While government initiatives for promoting protected cultivation have been significant, there are gaps in human resource development and technical support to the farmers. It is, therefore, critically important to promote credible interface of cultivators,

academicians, administrators/ policy makers, agriculture/ horticulture department officials, entrepreneurs and industry to share ideas, challenges and opportunities.

Financing Horticulture and Protected Cultivation

Horticulture sector has experienced a sharp increase in growth during the last few years. Hence, it is expected that there should be an equally sharp increase in bank credit disbursement to this sector, in order to encourage investment in protected cultivation. Credit disbursement by banks under horticulture sector had increased from Rs.5266 crore in 2006-07 to Rs. 6611 crore in 2010-11. However, while growth in production decreased sharply from 10.11 per cent in 2007-08 to 1.66 per cent in 2008-09, growth in credit disbursement fell from 12.23 per cent to 2.28 per cent. After an increase in the growth of both production and credit disbursement during 2009-10, there was a fall in bank credit from 5.99 per cent in 2009-10 to 3.18 per cent in 2010-11. On the other hand, horticulture production increased sharply from 3.91 per cent to 7.75 per cent, during the same period.

As the experiments on protected cultivation have demonstrated, there

has been a significant increase in production and productivity of horticulture and hi-tech crops, it is imperative that there should be a wider increase in the area under protected cultivation. With this, the demand for credit is also expected to increase manifold. NABARD and the Department of Horticulture, Government of Haryana have formulated a Model Bankable Project on Protected Cultivation. The Ministry of Agriculture, Department of Agriculture and Cooperation (Horticulture Division) had advised the Mission Directors and Directors Horticulture/ Agriculture in NHM States on 12 December 2013, to sensitize farmers for adoption of developed technologies under protected cultivation. NABARD offers concessional rates of refinance to banks for financing projects under thrust areas like plantation and horticulture sector including production as well as post-production activities. Banks have also been advised by NABARD to give preference to finance exotic/ high value vegetables, and cut flowers grown under protected cultivation. Banks, therefore, need to be sensitised to increase financing under protected cultivation.

Considering the growing importance of horticulture and hi-tech agriculture in the Indian economy, it

is pertinent that protected cultivation is encouraged in all parts of the country, but specifically in the north, north-east and hilly regions. There is a need to develop appropriate, efficient and affordable protected cultivation structures. Moreover, focus should be on identifying and developing suitable varieties of horticulture crops for protected cultivation. Further, crop nursery practices could be standardized under protected environment to optimize the use of available space. There is also a need to develop multi-tier protected farming techniques to maximize productivity per unit of ground area to cope up with the growing demands for vegetables, fruits, flowers, medicinal and aromatic plants, specifically in the context of increasing marginalisation of land holdings. It is also pertinent that development of post-harvest practices for handling, grading, packaging, transport and short term storage of produce from protected cultivation, are encouraged.

Finally, it is a matter of concern that only a small share of agricultural credit is directed towards capital investment, while protected cultivation involves high initial capital expenditure. Further, there would also be a growing need for working capital as well as post-harvest credit, with the increasing importance of protected cultivation for the development of horticulture and high value agriculture. Therefore, banks need to channelize credit for the promotion of this sector, which is starved of financial resources. It goes without saying that a thrust on the development of horticulture and high value agriculture, through protected cultivation, could bring about sustainable growth and prosperity in the rural economy and also play a critical role in taming inflation.

The author is Chairman, NABARD



“Swachh Bharat Abhiyan” needed for Indian Agriculture

The Prime Minister Narendra Modi has made a clarion call to the nation to embark on a “Swachh Bharat Abhiyan” by 2019 to commemorate Mahatma’s Gandhi’s 150th birth anniversary celebrations. The goal under the mission is to achieve 100% access to sanitation for all rural households, to make India Open Defecation Free (ODF) and keep villages clean through solid and liquid waste management. This is indeed laudable and would go a long way in improving the quality of life of the vast multitudes living in rural India. But is agriculture itself being carried out in a clean manner?

Available estimates reveal that nearly 120.72 million ha of land in the country is degraded due to soil erosion and about 8.4 million ha has soil salinity and water-logging problems. Besides nearly 0.8 million tonnes of nitrogen, 1.8 million tonnes of phosphorus and 26.3 million tonnes of potassium are lost during crop production cycle and indiscriminate use of fertilisers, insecticides and pesticides.

Similarly, the water-table is lowering steeply in most of the irrigated areas, and water quality is also deteriorating, due to leaching of salts and other pollutants. The green-revolution belt is exhibiting second-generation problems owing to over-exploitation and mismanagement of soil-and-water resources.

These trends have brought to focus more than ever before the need for “Conservation Agriculture” practices and within that the need to manage the crop residues in the farms. India produces a large quantity of crop residues on and off farm due to its cropping pattern. India produced close to 92.4 million tons (Mt) of wheat, 104.4 Mt of rice, 22.2 Mt of maize, 20.7 Mt of millets, 338.9 Mt of sugarcane, 45.3 Mt of fibre crops (jute, mesta, cotton), 18.4 Mt of pulses and 31.0 Mt of oilseeds crops, in the year 2012-13.

According to estimates, approximately 500-550 Mt of crop residues are generated per year in the country. The farmers use the crop residues for animal feeding, soil mulching, bio-manure

making and at times thatching for rural homes and fuel for domestic and industrial use. Predominantly the farmers also burn large portions of the residues to clear the field for sowing their second crop. It has also become convenient for them to burn the residue due to severe shortage of human labour and exorbitant cost of removing the crop residues by conventional methods.

Indiscriminate burning of crop residues causes great environmental pollution, is hazardous to human health, produces greenhouse gases causing global warming and results in loss of plant nutrients like N, P, K and S. Therefore it is of paramount importance that crop residues are managed in the appropriate manner so that the benefits derived from them are maximized and the hazards minimized.

The need of the hour is to have an appropriate policy environment to promote multiple uses of crop residues in the context of conservation agriculture and to prevent their on-farm burning. In fact today, with the advancements in technologies, these residues can be used for improving soil health, increasing crop productivity, reducing pollution and enhancing sustainability and resilience of agriculture. There are many examples of resource conserving technologies (RCTs) involving laser assisted precision land levelling, zero/reduced tillage, direct drilling of seeds, raised bed planting, crop diversification, bed planting and crop diversification with innovations in residues management like leaving them on the top soil as a protective layer that can act as possible alternatives to the input-intensive agriculture and have the potential to reduce GHGs emissions.

Integrated Pest Management (IPM) is also a critical component in conservation agriculture during times of increased pest and weed problems especially during the ‘transition period’.

It is also becoming more and more obvious that we need to take a holistic approach to solving the challenges faced by the farming community. It is important to offer integrated solutions for the farming communities for his soil, weed and pest problems. The farmers need to have the entire range of technologies from the tool kit – the right chemistry, biology and genetics to tackle the challenges.

Many innovative water-efficient technologies, drought-tolerant seeds, crop protection products, and optimized irrigation systems are available today. There are hybrid seeds that use moisture more efficiently and herbicides that reduce the need for plowing improving soil’s ability to absorb water, protecting it against erosion and water run-off. There is GM technology also that helps crops fight the climatic stresses affecting growth. Stewardship and curbing spurious products are also crucial to clean agriculture.

The public sector is also working to develop several technologies in the field of water harvesting, resource conservation technologies, integrated water and nutrient management, micro-irrigation, Integrated Farming System models, including agroforestry interventions, efficient cropping systems etc. to enhance crop productivity in the country, including dry land areas.

The public and the private sector need to join hands for a “Swachh Bharat Abhiyan” in agriculture as so aptly put by Mahatma Gandhi “To forget how to dig the earth and tend the soil is to forget ourselves”. And this would have adverse consequences.

Dr. K C Ravi, Vice President, Commercial Acceptance and Public Policy, South Asia, Syngenta India Limited

*Animal Husbandry, Dairy
and Fisheries*

Livestock production and agriculture are intrinsically linked, each being dependent on the other, and both crucial for overall food security. Livestock sector is an important sub-sector of the agriculture of Indian economy that forms an important livelihood activity for most of the farmers. According to 66th Round Survey of NSSO from July 2009 – June 2010, total number of workers in farming of animals was calculated as 20.5 million. Marginal, small and semi-medium farmers with average operational holdings of area less than 4 ha own about 87.7% of the livestock of this country. As shown in Table 5, India has vast resource of livestock and poultry of about 71.6 million sheep, 140.5 million goats and about 11.1 million pigs as per 18th Livestock Census in the country. This plays a vital role in improving the socio-economic conditions of rural masses.

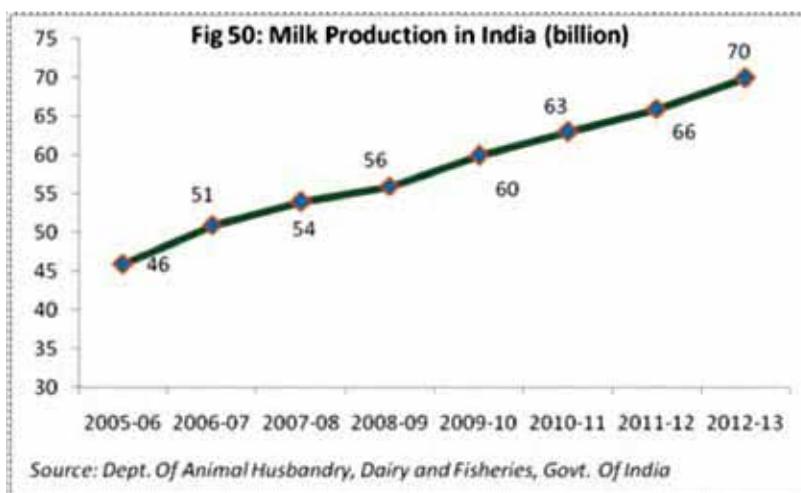
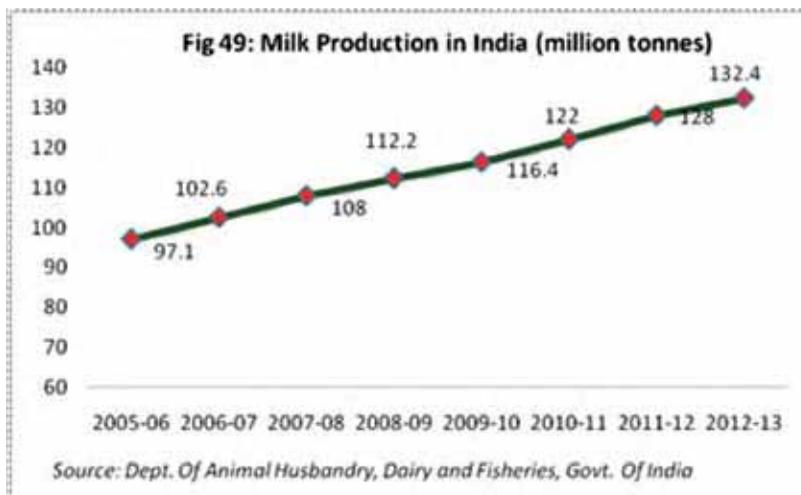
According to estimates of the Central Statistics Office (CSO), the value of output from livestock sector at current prices was about 537.5, thousand crore during 2012-13. This constitutes about 26% of the value of output from total agricultural, fishing, and forestry sector at current price and 26% at constant prices with base year as 2004-05.

India continues to be the largest producer of milk in world. As a result of several measures to increase the productivity of livestock, milk production has significantly increased by about 25% from the level of 102.6 million tonnes at the end of the Tenth Plan by the end of 2006-07 to 127.9 million tonnes at the end of the Eleventh Plan in 2011-12 (Fig 49). When the Twelfth

Table 6: Livestock and Poultry Population in India

Species	Livestock Census 2003 (no. in millions)	Livestock Census 2007 (no. in millions)	Growth Rate (%)
Cattle	185.2	199.1	7.5
Buffalo	97.9	105.3	7.58
Sheep	61.5	71.6	16.41
Goat	124.4	140.5	13.01
Pigs	13.5	11.1	-17.64
Poultry	489	648.8	32.68

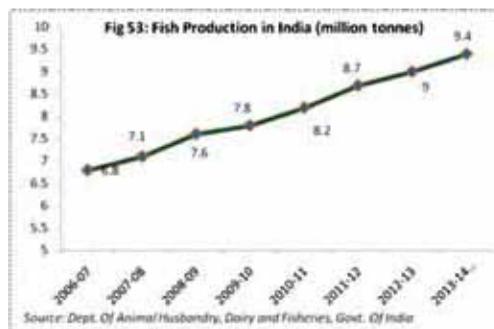
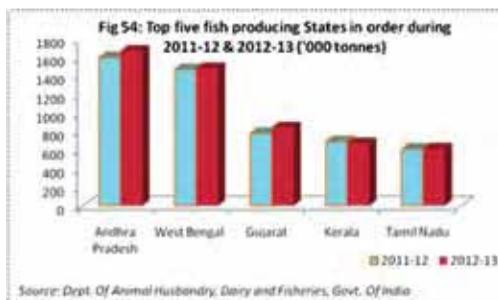
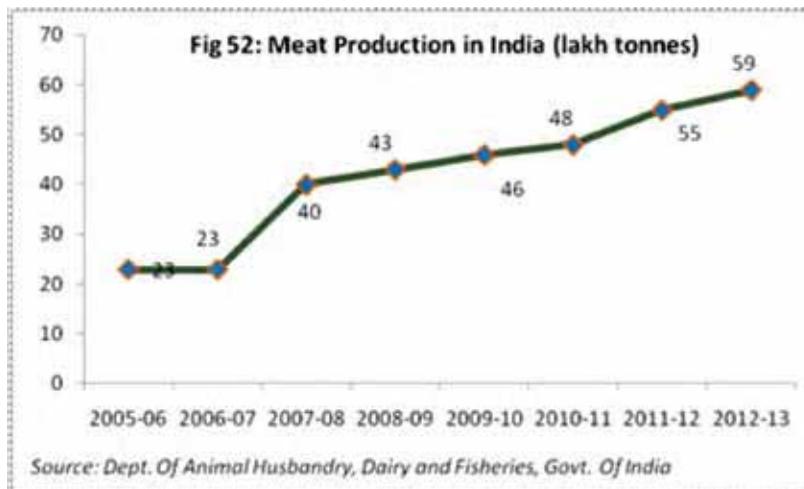
Source: Dept. Of Animal Husbandry, Dairy and Fisheries, Govt. Of India



Plan began during 2012-13, milk production was 132.43 million tonnes with an annual growth rate of 3.54%. The per capita availability of milk in India was around 296 grams per day in 2012-13.

Poultry production in India has come a long way from those unscientific and unorganised state of the sector about four decades back to a current state where commercial production is the norm of the day with a number of indigenous technological interventions. The total egg production of the country during the end of the tenth five year plan in 2006-07 was about 51 billion. By the end of 2011-12, the total production increased by 37% to about 70 billion.

Wool production declined marginally at the end of 2011-12 to 44.7 million kg from 45.1 million kg in the end of 2006-07 (Fig 51). Wool production in 2012-13 was 46 million kgs with a growth rate of about 3%. The average yield of wool per season at national level from different category of sheep



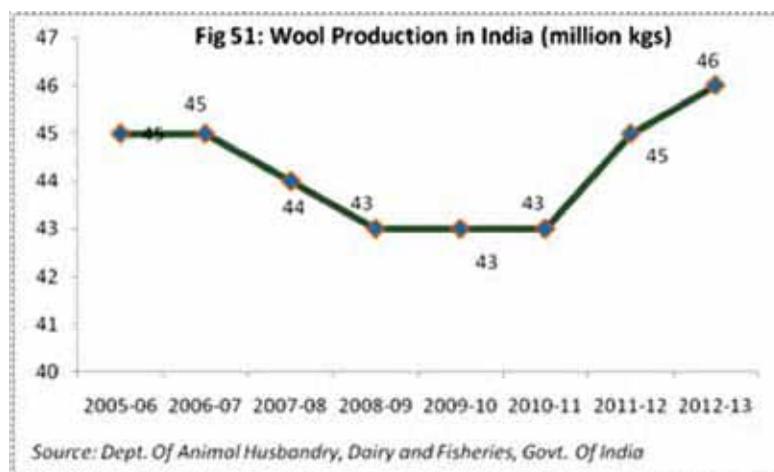
during 2012-13 is 1.09 kg/season from rams, 0.73 kg/season from ewes, 0.42 kg/season from lambs.

The Meat production has registered a healthy growth from 2.3 million tonnes at the end of 2006-07 to 5.5 million tonnes at the end of 2011-12. Meat production in 2012-13 was 5.95 million tonnes. The Annual growth rate

for production of meat is 7.87% in 2012-13. The production of meat from 2005-06 to 2012-13 is shown in Fig 52.

Fish production in the country has been increasing consistently over the years. Fish production in 2006-07 was 6.8 million tonnes. In 2013-14, the production increased to 9.4 million tonnes. As compared to 2006-07, this was an increase of 38% in 2013-14 (Fig 53).

Fisheries sector occupies very important place in the socio-economic development of the country as a whole and in many states. Andhra Pradesh, West Bengal, Gujarat, Kerala and Tamil Nadu are the top 5 fish producing states in the country as shown in Fig 54. It has been recognized as a powerful income and employment generator in these states and it stimulates growth of a number of subsidiary industries.





S M DEB

Sustainable development of the mountainous villages near international border by integrating yak husbandry

Yak is the most ecologically sustainable genetic resource of the Himalayas which provides livelihood support and nutritional security for highlanders, called Brokpas in Arunachal Pradesh. Yaks can utilize small blades of grasses on high altitude pastures and can travel on snow bound steep hills and hypoxic conditions, and are comfortable at 10°C and can sustain severe cold (up to -60°C). Yak population in India is around 84,000 distributed in J&K (62,000), Arunachal Pradesh (14,000), Sikkim (5,000) and Himachal Pradesh (2,000) (18th Livestock Census, DAHD, 2010). In spite of its low numbers amongst the livestock, yaks reared on migratory system, is the only source of livelihood for these highlanders who are poorest of the poor. They are totally dependent on yak husbandry and it is reported that yaks contribute to 62 per cent of their livelihood requirements. They are reared on pastoral system by the tribal people on high hills (above 3,000 meter MSL) where other livestock husbandry or crop production is not possible. They are multipurpose animal which provide

milk, meat, fibre, dung and are also useful for transportation of household goods. Thus, livelihoods of yak rearers are solely dependent on these animals.

Yak husbandry, in one hand is highly remunerative with cost-benefit ratio (B:C ratio up to 4:1) when yaks are reared on zero input system on alpine pasture during summer, on the other hand it faces the challenges of transhumance system of farming at present. Lack of scientific husbandry practices, weak marketing linkage and non-adoption of technologies for value addition of yak products are reducing the profit margins of yak rearers. And due to these difficulties, the youth from yak rearing communities are abandoning yak husbandry.

As also rightly argued by His Excellency the Governor of Arunachal Pradesh and former military strategists, Lt. General (Rtd.) Nirbhay Sharma, that population of 100 villages of Arunachal Pradesh across the international border with China are thinning out which may have serious long term security implication for the country. These villages have a very important



strategic role in the country's security aspect as these districts have a very extensive international borderline with China and Bhutan. He also emphasized that human population of the high mountainous border area comes to the lower altitude as any major agriculture activity is virtually non-existing above 3,000 meter MSL. The Sino-Indian international border of Arunachal Pradesh is at very high altitude of even 6000-7000 meter above MSL. The threats are similar in the villages near international boundary of J&K, Himachal Pradesh and Sikkim states of India also.

Here comes the role of ICAR-National Research Centre on Yak (ICAR-NRCY). Scientists of this species specific institute has studied traditional yak rearing, developed appropriate technologies, and also articulate future plans, strategies and programmes for overall development of sustainable yak husbandry in India. High end technologies like test tube calf (IVF), Embryo Transfer Technology (ETT), Cryopreservation of yak embryo, Estrus synchronization for fixed time AI in yaks etc. as well as other field-use technologies like Artificial Insemination (AI) in Yak, Complete Feed Block (CFB) using locally available ingredients, Area Specific Mineral Mixture, Management of highland pasture, Herbal medicines, Value added milk, meat and fibre products, Package & Practices of yak husbandry including use as pack animal etc. are in the kitty of this institute.

The Government of India has a very keen interest for the betterment of the citizens inhabiting the border and to protect Indian Territory from the alleged incursions into Arunachal Pradesh. Therefore, the present Union Government has already allocated Rs. 5000 crores for the construction



of the road and settlements of highlanders across the difficult hilly terrain of Sino-Indian international border. This policy decision is a ray hope for the improvement of the livelihood of the poor highlanders and betterment of yak husbandry in the state in coming future, which is complementary in nature. Due to the impending climate change scenario, yak rearers are forced to migrate in the search of congenial environment to the higher altitude which is near to the international border.

Therefore, yak rearing has to be seriously promoted among the local population (highlanders) so that they can settle in the Indian Territory near international border (States of J&K, Himachal Pradesh, Sikkim, Uttarakhand and Arunachal Pradesh) and earn their livelihood under sustainable and organic production system. For generating more income and to improve the livelihood of highlanders through scientific yak husbandry the following issues need attention:

- Animal husbandry has been an age old integral part of farming

system in the hilly regions of India. Among the livestock, the yak (*Poephagus grunniens* or *Bos grunniens*) is one of the most remarkable animals adapted to living in high altitude mountain terrains in harsh conditions. The yak is inherently associated with the culture, religion and social life of the pastoral nomads of highlanders for their food and livelihood security. Yaks are highly valued by the Himalayan people because of their contribution to human economy through milk, meat, hair, fibre, leather, and dung for fuel and manure and as pack animal. Conservation of this superior germplasm (yaks and its biodiversity) and their improvement is the mandate of ICAR vis-à-vis Government of India.

- As mentioned earlier, ICAR-NRCY is mandated to bring improvement of yak husbandry in India and uplift socio-economic conditions of yak farmers and has developed a good number of technologies.



Brokpas in Arunachal Pradesh

Yak husbandry has to be profitable employing available and upcoming technologies emerging out of research activities in dynamic mode. ICAR-NRCY also demonstrates and train farmers for adoption of scientific yak husbandry for enhancing their income and improvement of their livelihood. Yaks are traditionally reared on organic method, therefore, their products may fetch premium price for the organic produce.

- Yak is also known for its packability in difficult hilly terrain, even at -500 C and in hypoxic condition, where mule cannot be used effectively. ICAR-NRCY in a joint experiment with Indian army to study the packability of yak on hilly terrain (3500 - 4500 meter above MSL) and results suggested that the Indian Army can adopt yak as pack animal because of several advantages over mule at higher altitude/difficult terrain of the Himalayas. Yaks suffer less, comfortably move on difficult terrain, and carry more loads under harsh geo-climatic conditions

of higher hills which may give strategic advantages. If that happens, yak rearers (highlanders) of the border villages will be encouraged to train their yaks for packability for use of the Indian Army to carry their essential commodities on hire basis with a pre-fixed rate. Yak rearers will, thus, get more remuneration from their yak in addition to the milk, meat, hides and wool and will be tempted to settle at the border villages. Lt. General Sharma emphasized that deployment of the border population as part of the security structure will strengthen our border security. In this regard, hiring of yak from the border villages for transportation of necessary goods at the outposts may have three direct impacts: i) Firstly, human population density of the border village will increase, ii) Secondly, deployment of the village population in security forces, and iii) Thirdly, alleviation of poverty through sustainable yak rearing. The Indo-Tibetan Border Police (ITBP) are already using yak as pack animal. ICAR-NRCY trains

the ITBP employees for handling yak for transportation purposes.

- High altitude pastures are the lifeline of the yak rearing in mountainous bordering states of India. Quality of these high altitude pastures are degrading day by day due to several reasons like over stocking, infestation of toxic weed species. Without amelioration of the pastures, settlement of locals at the border is very difficult. ICAR-NRCY has identified several grasses and legume species to rejuvenate this degraded high altitude pastures. In addition with identification, conservation and value addition techniques of the grasses like ensiling, hay making and preparation of complete feed block has been standardized for the feeding in lean season. Therefore, for settlement of the local in these border villages, high altitude pastures must be nurtured along with the construction of road and other infrastructural facilities.

All the schemes targeted to address creation of basic amenities, welfare and settlement of the people in the states' border areas have to be converged and yak husbandry, employing modern scientific technologies, will enhance their economic return, thereby improving their livelihood in addition to addressing the national issue of border security. Therefore, ICAR-NRCY can play a major role for the welfare and settlement of the local people across the Sino-Indian mountainous International Broader areas of different yak rearing states of India to contribute significantly to alleviate the poverty of yak farmers.

The author is Director ICAR-National Research Centre on Yak West Kameng District, Dirang, Arunachal Pradesh

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DR R S GANDHI

Indian Cattle: Insurance for Livelihood Security for Smallholders in India

Cattle rearing being complementary to agriculture has been a part of social and cultural heritage of Indian civilization. Cattle have been the source of livelihood for landless and resource poor farmers, majority of them living below poverty line. Indigenous cattle have been instrumental in providing milk, milk products, draft power, bio-fertilizer and bio-fuel besides producing bio-molecules and other products beneficial for human health. The distribution of cattle amongst various categories of animal keepers revealed that marginal, small and semi-medium farmers on an average have about 89 per cent of cattle. However, the innate production potential of cattle is not exploited to the fullest extent by these farmers due to lack of awareness about

the improved resources, technologies and other inputs attributed to lower literacy of this stratum of the rural people.

Cattle Genetic Resources -Need Impetus for Higher Productivity

India possesses vast population of cattle (199 million), out of which 166 million are indigenous and 33 million crossbred/exotic cattle. Among the indigenous cattle, only 23.14 million heads (11.62%) have been described and categorised into 44 different populations including 37 distinct/registered breeds. Majority of the Indian cattle breeds were initially developed for draft animal power. Indigenous cattle breeds are generally classified on the basis of their utility like milch breeds (Sahiwal, Red Sindhi, Gir and Rathi), draft breeds (Hallikar, Khillar, Nagauri,



Kangayam, Red Kandhari etc.) and dual purpose breeds (Tharparkar, Hariana, Kankrej, Deoni, Ongole, Dangi, Kenkatha etc.). These unique breeds have been developed over a period of thousands of years through dedicated efforts of livestock keepers/pastoralists and other stake holders. Indian cattle appear to have many unique genes for higher thermo-tolerance, higher resistance to tropical diseases and better feed conversion efficiency under low or zero input system. However, majority of non-descript cattle are low producers mainly attributed to the poor genetic make-up and inadequate availability of feed and fodder.

The distinct biodiversity of our cattle breeds have been diluted during last few decades due to use of only few improver breeds and neglect of the low producers. This has attributed to lower milk production of only 2.36 kg/day of Indian cattle at the national level. Punjab tops in milk production (6.52 kg/day) followed by Haryana (4.91 kg/day). This is due to availability of good breeds like Sahiwal and Hariana in these states and better management of indigenous cows. The indigenous cattle of Rajasthan and Gujarat are also yield better milk production (3.54 & 3.85 kg/day respectively) due to availability of good breeds like Gir, Kankrej, Rathi, Sahiwal and Tharparkar in these states. Though in majority of the states, Indian cattle breeds are draft in nature, yet a slight improvement in their productivity will considerably increase the total milk production of the country. Considering the importance of indigenous cattle, a few breed improvement programs have been initiated to conserve and multiply these breeds. The associated herd progeny testing program is being carried out at NDRI, Karnal for

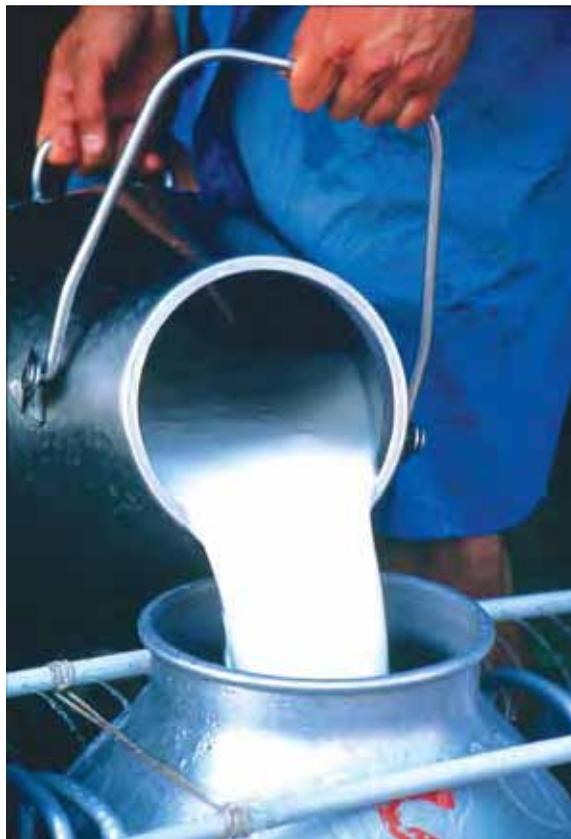


the genetic improvement of Sahiwal cattle. All India Coordinated Research Project on Hariana and Ongole cattle has been undertaken at different centres by Project Directorate on Cattle, Meerut. Lately, three more breeds namely Sahiwal, Gir and Kankrej have been included in the indigenous breed improvement program (IBP) and different centres have been identified as germplasm units and data recording units for different breeds under the program. The conservation and genetic improvement of indigenous cattle has been undertaken partially under the National Project on Cattle and Buffalo Breeding by Ministry of Agriculture. The National Project on Bovine Breeding and Dairy Development has been formulated with an integrated, holistic and scientific approach to improve and upgrade bovines for enhancing their production and productivity. A total of 31 cattle breeds and seven buffalo breeds will be conserved and developed under this program. National Dairy Plan I (NDP-I) has been launched focusing

on production of high genetic merit cattle through progeny testing and pedigree selection. Preservation and conservation of six indigenous breeds namely Gir, Sahiwal, Kankrej, Rathi, Tharparkar and Hariana is being undertaken under NDP-I. Recently, the government has taken initiative for the conservation and genetic improvement of the indigenous cattle under 'National Gokul Mission'. Under this mission, provision of Rs.500 crores has been made for improvement of indigenous cattle and dairy development. Under the program, Gokul Grams are proposed to be established in the outskirts of metropolitan cities.

Milk Production Scenario -A Paradigm Shift from Sustainability to Productivity

India has witnessed a white revolution in seventies of the last century which was largely due to manifold increase in milk production making India world topper in milk production. Estimated milk production in the country is 139.68 million tons during



Cattle to Climate Change – An Innate Potential

Indian cattle have special adaptive mechanisms to deal with extra thermal stress of tropics. The small body size with low energy requirement for maintenance and capacity to use poor quality feeds and fodders make Indian cattle superior to many breeds of livestock in feed conversion efficiency. The water recycling and economy in these cows is more efficient giving them higher capacity to

dehydrate and withstand higher thermal stress. Body appendages and higher body surface area per unit of weight help them in heat dissipation. Some of the zebu breeds (Rathi, Tharparkar, Ongole, Nagori and Sahiwal) well adapted to hot dry conditions are able to minimize their metabolic requirements and conserve energy for production (milk and/or work) without extra energy expenditure. Indian breeds from Rajasthan and Gujarat have the innate potential to tolerate desert conditions and temperature up to 50°C. This is because our indigenous cattle have been evolved over generations of natural selection under the stressful environment of tropics under low-input system. The dry matter intake is comparatively lower in Indian cattle as compared to crossbred cattle (2 kg versus 8 kg) as the average size

of local cattle is small and hence indigenous cattle are assumed to produce lesser greenhouse gases as compared to crossbred cattle and cattle from developed countries.

Indigenous Cattle – Performance Evaluation

The breeding policy for improving the indigenous cattle is selective breeding in well-defined breeds and grading up of non-descript cattle with the indigenous breeds prevalent in the area or adjoining area. The milk production of Indian cattle breeds range from low to medium and there is an ample scope to improve upon these breeds through selective breeding. However, some of the indigenous breeds like Sahiwal, Red Sindhi and Tharparkar in organized herds were almost as good as crossbred cattle under field conditions. The overall average 305-day lactation milk yield of elite Sahiwal cows was 2574 kg during 2010-11 at NDRI, Karnal. Further, indigenous cattle are more economical in terms of cost of maintenance. This was attributed to lower feeding, management and veterinary costs in local breeds. However, the cost of milk production was lower in crossbred cattle as compared to indigenous cattle under intensive production system. Higher milk production in crossbred cattle was responsible for lower cost of milk production.

Fitness of Indigenous Cattle – An Edge over Crossbred Cattle

Indigenous cows have an edge over the crossbreds in terms of comparatively higher milk constituents, disease resistance and overall fitness. The incidences of

2013-14 (Basic Animal Husbandry, Fisheries Statistics, 2013). About 38 million in-milk buffaloes produce 51 per cent of total milk, while 34 million in-milk cows produce 45 per cent of total milk. Out of 45 per cent of total milk produced by cows, 21 per cent is produced by indigenous cows and 24 per cent by crossbred cows. Further, about 28 per cent of crossbred cattle (12.29 million) are producing nearly 54 per cent of total cow milk. The average milk yield/head/day in indigenous, crossbred cattle and buffaloes is 2.36, 7.02 and 4.80 kg, respectively, during the year 2012-13. Five highest milk producing states together contribute 53 per cent of total milk share of the country - UP being on top (17.6%), followed by Rajasthan (10.6%), AP (9.5%), Gujarat (7.7%) and Punjab (7.5%).

Resilience of Indigenous

reproductive disorders are generally higher in crossbred cows. Similarly, comparatively more young crossbred bulls are culled due to poor semen quality than Sahiwal young males. Rearing and maintaining crossbred cattle has been a costlier affair and needs lots of rich input resources. Further, there are many constraints of adopting crossbreeding under field conditions. The major constraints reported were repeat breeding, higher mortality in young calves, lower milk fat content, lower price of milk, higher cost of critical inputs and higher cost of veterinary services. Sustaining higher milk production due to non-availability of superior semen and higher incidence of health disorders in general and reproductive disorders in particular in crossbred cattle are other constraints for farmers.

Constraints for Improvement of cattle

- Shrinking land holdings especially of marginal, small and semi-medium farmers having maximum number of indigenous cattle.
- Scarcity of water resources.
- Limited growth in crop production and productivity resulting in lesser availability of crop residues for consumption of cattle.
- Acute nutrient mining from soil due to intensive crop production leading to deficiency of minerals in fodder/crop residues influencing cattle health and production.
- Scanty mapping of soil minerals to design area specific mineral mixtures for livestock.
- Higher population density and lower pasture land availability. Shrinkage in grazing land affects 82 per cent of livestock kept

under crop-livestock production system and 2 per cent under pastoral system in India.

- About 34 per cent of the rural population in India is below poverty line having insufficient resources to rear quality cows.
- No increment in fodder production area of the country over the last several years.
- Poorer quality of feed/fodder resources with lower energy and protein content. Apart from energy and protein, deficiency of minerals is the major limiting factor for reproduction.
- Lesser availability of feed/fodder under field conditions. India is deficit by 10 per cent in dry fodder, 33 per cent in concentrate and 35 per cent in green fodder.
- Genetic erosion of cattle genetic resources.
- Lack of authentic breed wise census data.
- Lower milk production and higher inter-calving period in indigenous cattle.

- Lack of performance recording under field conditions.
- Insufficient number of superior/proven bulls/semen for AI and natural service.
- Higher proportion of dry cows (46%) than desirable level of 30 per cent in indigenous cattle. Besides this, 8.7 million breedable indigenous cattle (15.4%) are unproductive and even not calved once.
- Inadequate infrastructure for delivery of veterinary and AI services at the doorsteps of the farmers. Only 29000 veterinarians are available against the requirement of 76000 veterinarians in the country.
- Lack of knowledge about scientific management of livestock among farmers especially women folk.
- Smaller herd size under field conditions.
- Lower conception rate from AI under field conditions.
- Inadequate funding for conservation and breed improvement pro-



grams for livestock.

- Non-availability of credit and financial support to cow keepers in the face of natural calamities, diseases or accidental loss.
- Inadequate local institutions like breed societies/associations.
- Negligible insurance coverage for cattle.
- Lack of legal support for protection of farmers/livestock keepers' rights and IPR issues.
- Lack of effective linkages and coordination among different stake holders involved in cattle development and improvement.

Futuristic Approach:

Keeping in view the reduction in number of animals of indigenous breeds due to crossbreeding at organized farms and under field conditions, there is need to increase the population size of well-defined breeds of cattle along with enhancing their productivity by generating and utilizing superior germplasm. Further, non-descript cattle has to be upgraded with these breeds to increase their milk production. The following action plan is suggested:

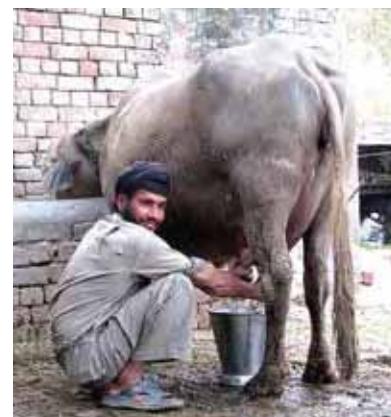
- Focus more on genetic up-gradation of indigenous/native cattle using superior semen from progeny tested/pedigree selected bulls and by expanding AI and natural service network to provide services at the farmers' doorstep. If 10 per cent of non-descript indigenous cattle are graded up to milch breeds in a period of five years and assuming 4kg/cow/day milk production in next generation, additional 27.2 million kg milk/day would be produced adding about 10 million tons milk/annum to national average.



- National priority should be given to conservation of cattle to maintain genetic diversity of breeds and preserve those showing decline in numbers or facing extinction. Breeding policy for different breeds should be revised. Breed association should be developed and strengthened for conservation of breeds.
- Creation/provision of national fund for conservation of cattle genetic resources.
- Allocate more funds for infrastructure development, cattle policy reforms and IPR issues.
- Provide economic advantage to cattle keepers for conservation and multiplication of endangered cattle breeds.
- Conduct breed-wise livestock census.
- Establish and/or strengthen nucleus farms in the breeding tract for each breed to produce genetically superior germplasm

for genetic improvement and conservation. Declare all the cattle breeding farms as in situ conservation and breeding centres.

- Effective use of more than 20 lakh cows maintained in 4355 gaushalas.
- Registration of cattle keepers and identification of farmers having elite cattle.
- Recognition of role model breeders for their contribution.
- Unravel the unique genes and bio-prospecting the special utility traits, biomolecules, products etc. of indigenous cattle for enhanced productivity using emerging biotechnological tools.
- Pasture development program with dual purpose of grass and seed production may be taken upto address the scarcity of fodder. Provision should be made for purchase of seed of pasture grasses at remunerative price by the farmers to establish pasture in dry areas on degraded land. Fodder depot in fodder deficient zones needs to be established along with infrastructure development for making compact feed blocks for effective storage



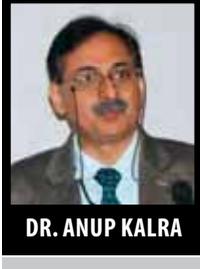
- for longer period ensuring fodder to livestock during scarcity. Production of hydroponic fodder needs to be encouraged for smallholder farmers.
- Effect of climate change on bovines has to be addressed judiciously. Suitable strategies and mitigation approaches should be developed by strengthening shelter, feed resources and disease surveillance and monitoring.
 - Develop branded products from indigenous cattle and creation of niche markets for these products.
 - Selection and use of bulls with A2A2 type beta-casein genes in cattle breeding programs.
 - Producing more number of semen doses from bulls of indigenous breeds. According to an estimate to cover 40 per cent population of 57 million breedable indigenous cows through AI, about 41 million semen doses per annum are required from indigenous cattle bulls. For production of these semen doses about 6000 indigenous bulls of well-recognized breeds would be required. To cover remaining 60 per cent population by natural service about 30000 superior bulls would be required.
 - Enhance coverage of cattle population of the country through AI from 25 to 40 per cent by 2020.
 - Effective use of reproductive biotechnologies like ET, ONBS, Ovum Pick-up and IVF under farm and field conditions for multiplication of superior germplasm.
 - Develop infrastructure for semen sexing of indigenous cattle breeds to save male wastage amounting to about Rs.10000 crores annually.
 - The disease diagnostic facilities need to be further strengthened in various regions of the country. Besides this, cheap pen side diagnostic kits need to be developed and vaccination schedule for various diseases needs to be followed religiously. Research on designing thermo-stable vaccines is an important key area and will help in effective delivery under field conditions.
 - Evaluate the genetic potential of the animals and economic status of the livestock keepers for providing the necessary inputs for a sustainable program for higher milk production. The zero input production system (ZIP) for landless and small holders is suggested for rearing local non-descript cattle. The medium farmers having limited resources may follow the low input production system (LIP) rearing mostly cows of indigenous breeds/graded up cattle with indigenous breeds available in the area/adjoining area. The intensive dairy production system i.e. high input production system (HIP) is advocated for the animal keepers having adequate input resources. Under this system rearing of high producing cattle is suggested.
 - Impart training and increase the number of awareness programs for smallholders especially women to ensure adoption of new technologies for enhancing productivity of cattle.
 - Import elite semen of indigenous breeds from other countries having superior germplasm of indigenous breeds.
 - Explore inter-country collaboration for breed improvement programs for indigenous cattle with neighboring countries.

India is endowed with large cattle population, and cattle rearing have been source of livelihood security to farmers in the face of natural calamities. Smallholders have played a vital role in contribution to national economy as majority of cattle population is reared by them. The milk productivity of bovines needs to be enhanced using breeding, feeding and health management interventions. Further, mining of unique genes and bio-prospecting of special utility traits, biomolecules, products etc. of indigenous cattle would enhance the net economic worth of Indian cattle. Improving indigenous cattle and developing branded cow milk and other products using ITKs available with pastoralists & smallholders and creation of niche markets for these products would empower these stakeholders in general and rural women in particular to ensure livelihood security. Food safety and quality enhancement of milk and milk products has to go a long way to narrow the gap between achieved and achievable. Conducting breed-wise livestock census, developing a roadmap for breeding and conservation of indigenous cattle and buffaloes, and creation of national fund for conservation of cattle genetic resources should be given priority.

The author is Assistant Director General, Animal Production & Breeding, ICAR, New Delhi



MJ SAXENA



DR. ANUP KALRA

Livestock Health and Role of Herbals

India is a country of villages. Almost 70 per cent of Indians live in its estimated half million villages and a majority of them are engaged in agricultural and livestock related activities. In fact agriculture and livestock are two strong arms of our farmers. The cultivation of herbs by the farmers is gradually becoming popular for its opportunity as additional source of agricultural income and its scientific use towards improving health and productivity of farm animals. The animals in turn provide milk for better nutrition. The animal dung provides additional income and also helps production of organic slurry towards helps in improving the quality of soil for better production of herbs. Herbals are integral part of most of the medical therapies mentioned in Ayurveda. Ayurveda not only takes care of treatment of human and animals, but also places great emphasis on prevention of illnesses and maintenance of health.

Changing Environment

The changing environment encompasses climatic change which poses food security as

emerging global challenges for the world. The increasing animal population to meet the food security is also considered as a major catalyst for climatic change, elevated carbon dioxide levels, combined with increases in temperature, precipitation and nitrogen deposition. The IPCC predicts that by 2100 the increase in global average surface temperature may be between 1.8° C and 4.0° C. With increases of 1.5° C to 2.5° C, approximately 20 to 30 per cent of plant and animal species are expected to be at risk of extinction with severe consequences for food security in developing countries.

Livestock contributing to climate change

Livestock contribute both directly and indirectly to climate change through the emissions of greenhouse gases such as carbon dioxide, methane and nitrous oxide. According to scientifically reported data, 18 per cent (7.1 billion tonnes CO₂ equivalent) of global greenhouse gas emission (GHG) is due to livestock. It accounts for 9 per cent of global CO₂, it generates 65 per cent of human-related



nitrous oxide (N₂O) and 35 percent of methane (CH₄), which have 296 times and 23 times the Global Warming Potential (GWP) of CO₂ respectively.

Direct and indirect sources of GHG emissions in animal production systems include physiological processes from the animal (enteric fermentation and respiration), animal housing, manure storage, treatment of manure slurries, land application, and chemical fertilizers.

In addition to CH₄ emission, Livestock is also responsible for CO₂ pollution. The CO₂ from respiration of livestock amounts to ~3000 Tg CO₂-eq/year, but this CO₂ had previously been absorbed via plants. According to EPA, FAO and the Kyoto Protocol (1997), emissions from livestock are part of continuous cycling biological system where plant matter that had once sequestered CO₂ is consumed by livestock and then released back into the atmosphere by respiration to be reabsorbed by plants.

Consequences of Climate change on Livestock production system

Climate change will have far-reaching consequences for dairy, meat and wool production, mainly arising from its impact on grassland and rangeland productivity. Heat distress suffered by animals will reduce the rate of animal feed intake and result in poor growth performance. Lack of water and increased frequency of drought in certain countries will lead to a loss of resources. Climate change is expected to change the species

composition (and hence biodiversity and genetic resources) of grasslands as well as affect the digestibility and nutritional quality of forage.

High ambient temperature exerts direct impact on reducing food intake and reproductive potential in livestock. In dairy cows, heat stress reduces the amount of milk produced, reduces milk fat and protein content, and decreases reproduction rates.



Climate change could also affect the distribution of vector-borne livestock diseases. These changes occur as a result of shifts in the geographical ranges of ticks, mosquitoes, flies and other vectors.

Meeting the challenge: Adaptation and mitigation livestock strategies

Given the magnitude of the challenge to reduce GHG concentrations in the atmosphere, it is imperative to receive the contribution of all sectors with significant mitigation potential. Agriculture is recognized as a sector with such potential, and farmers should be part of the solution. The mitigation measures those are easy

to implement and cost effective in order to strengthen the farmers hand needs to explored. These may include different animal feeding management, manure management. The growing of good quality herbs and their usage in animal feeding could be one such option. Improvements could be made to livestock efficiency in converting energy from feed into production and losses through waste-products can be reduced. Livestock can play an important role in both mitigation and adaptation. Mitigation measures could include integration of livestock and agriculture into broader environmental services.

Role of Herbs: Mitigation of livestock GHG emissions

The researchers have scientifically formulated the plant based products for manipulating rumen function. With these objective, novel strategies for enteric methane abatement has been scientifically evaluated to assess the antimethanogenic potential of polyherbal feed supplements.

Apart from efficient cellulose break down and digestion, these herbal supplements have facilitated maintenance of normal ruminoreticular and intestinal movement and effective restoration of ruminal micro flora and ruminal dysfunction. The research has also revealed these herbal supplements helped significantly the methane mitigating potential by 20 per cent besides its efficacy to improve nutrient utilization, digestibility, growth and productivity.

Role of Herbs: Reducing Nitrogen Emission from Livestock and Poultry



Better nitrogen retention in the herbal supplemented groups suggest efficacy of herbal products in improving nutrient utilization. The herbs *Allium sativum*, *Terminalia belerica*, *Zingiber officinale*, *Woodfordia fruticosa* etc. have been reported to modulate the ruminal enzymes and other parameters thereby increasing digestibility of ration. These herbs by means of modulating the ruminal microflora & enhancing the availability of substrate for microbial growth lead to better retention of nitrogen thereby lowering nitrogen emission.

The herbs namely *Andrographis paniculata*, *Eclipta alba*, *Achyranthus aspera*, *Solanum nigrum*, *Tinospora cordifolia* and *Phyllanthus emblica* are scientifically well proven for their hepatoprotective, anti-hepatotoxic, immunomodulatory, antioxidant performance enhancing and growth promoting activity. It is evident that besides their hepatoprotective, anti-hepatotoxic, hepatoregenerative properties, these herbs are responsible for optimizing

protein utilization, improved mucosal function and reduced cost of metabolic deamination thereby reducing nitrogen emission in livestock and poultry.

Herbs: Role as alternative to pesticides

Environmentalists argue that the use of pesticides leads to global warming and the destruction of the ecosystems around farming areas and livestock dwellings. Both global warming and pesticide use have been hot button issues in the world for decades. Increased pesticide usage is contributing to global warming. To address these global issues, herbs were evaluated for their natural insecticide and fly repellent properties. The oil of herbs viz. *Eucalyptus globulus*, *Cedrus deodara*, *Pinus longifolia* etc. in a fixed concentration were highly efficient against the ectoparasite infestation in animals. In addition it is found to be a suitable option to replace chemical pesticide and

insecticides due to its safe nature for animal as well as user, it is non-toxic and no resistance develops against the product.

Use of Hydroponics for growing Nursery for Herbs: The Ayurved Hydroponics ProGreen Technology has been useful in providing herbal plant nurseries. This has led to saving of land, time and water. Thus this initiative could also add value to sustainability and value creation.

Climate change is an ongoing process. There is a two-way relationship between livestock production and environmental health. The usage of herbs can play a significant role in animal health & environment sustainability. The scientific & technological advancement in the field of diagnostics, material analysis, instrumentation and introduction of the latest biological screening models in the last four decades has revived the interest of modern scientists & health care practitioners in herbals. Additionally, the development of the resistance of pathogens and parasites against the deadly chemicals developed in the last few decades coupled with ever growing concern of toxicity and damage to the environment has also helped in creating renewed interest in the science of herbals or Ayurveda. The Ayurved 5F programme is one such initiative to meet challenges of climate change, need of global food security and for sustainable agriculture & livestock production system.

The authors are respectively Managing Director and Executive Director, Ayurved Limited



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Tel : +91 20 27518300, Fax : +91 20 22932294



DR. P. K. GHOSH
AND
DR. S.K. MAHANTA

Forage resource development in India: Looking ahead

Livestock and fodder scenario

India, possessing around 529.7 million heads of livestock at present, is expected to grow at the rate of 0.55 per cent in the coming years and will reach about 780.7 million by the year 2050. The country accounts for around 15 per cent of world's livestock population in 2 per cent of world's geographical area indicating huge pressure on land. However, livestock is symbolic to wealth and power across civilizations for centuries. India is also blessed with diversified type of livestock. Its livestock sector is one of the largest in the world. It has 56.7 per cent of world's buffaloes, 12.5 per cent cattle, 20.4 per cent small ruminants, 2.4 per cent camel, 1.4 per cent equine, 1.5 per cent pigs and 3.1 per cent poultry. The importance of livestock in Indian agriculture is well recognized contributing about 4 per cent to national GDP, and source of employment and ultimate livelihood for 70 per cent population in rural areas. Livestock not only provides food security through supply of milk, meat and self-employment of both men and women, but also plays an important role for poverty alleviation of smallholder livestock farmers. It has been predicted that meat and milk consumption will grow at 2.8 and 3.3 per cent per annum, respectively, in developing countries like India. The demand for milk and meat will be around 400 and 14 million ton, respectively in the year 2050; whereas the present production (2013) is about 132 and 6 million tonnes, respectively. The productivity of our animals is 20-60 per cent lower than the global average due to constraints like improper nutrition, inadequate infrastructure and input delivery system for

scientific breeding, health and management. Half of the total loss in livestock productivity is contributed by inadequate feed and fodder (50.2%), followed by breeding and reproduction (21.1%), diseases (17.9%) and management problems (10.5%). In the past, growth in livestock production was largely number driven. This may not sustain in the long run and may stress the resources. The future growth should come from improvements in productivity. This will require overcoming feed and fodder scarcity, and improvements in delivery of animal health and breeding services. Thus, we have achieved horizontal growth in terms of animal numbers, there is need to achieve vertical growth in terms of improving productivity.

Forage based economical feeding strategies are required to reduce the cost of quality livestock product as the feed alone constitutes 60-70 per cent of the milk production cost. Thus any attempt towards enhancing feed availability and economizing the feed cost will result in increased margin of profits to livestock owners also. There is tremendous pressure of livestock on available total feed and fodder, as land available for fodder production has been decreasing. At present (2010), the country faces a net deficit of 35.6 per cent green fodder, 10.95 per cent dry crop residues and 44 per cent concentrate feed ingredients. The demand will reach to 1012 million tonnes of green fodder and 631 million tonnes of dry forage by the year 2050. At the current level of growth in forage resources, there will be 18.4 per cent deficit in green fodder and 13.2 per cent deficit in dry fodder in 2050. Green forage supply situation has to grow

Estimated demand and supply of dry and green forages (million tonnes)

Year	Demand		Supply		Deficit		Deficit as %	
	Dry	Green	Dry	Green	Dry	Green	Dry	Green
2010	508.99	816.83	453.28	525.51	55.72	291.32	10.95	35.66
2020	530.50	851.34	467.65	590.42	62.85	260.92	11.85	30.65
2030	568.10	911.67	500.03	687.46	68.07	224.21	11.98	24.59
2040	594.97	954.81	524.40	761.76	70.57	193.05	11.86	20.22
2050	631.05	1012.70	547.78	826.05	83.27	186.65	13.20	18.43

at 1.69 per cent. In India out of 55 micro-regions, as much as 43 micro-regions are deficient in fodder. There are regional and seasonal disparity in fodder production and availability. Due to lack of sufficient post-harvest and storage facilities, surplus fodder is not properly utilized. Diversion of fodder from surplus to deficit areas is meager. Edible crop residues diversion to non- agricultural use is a current practice which also adversely affects the nutrient availability to animals.

In spite of great contribution of forage resources in livestock sector, the forage production has not been received due attention so far. Timely availability of quality forage seeds is one of the important limiting factors. In case of fodder, seed chain from breeder to certified seeds does not exist at national level (NSC) as in food crops, and also the institutional mechanism does not exist in most of the states. The demand for forage seeds is increasing and the availability is very low, meeting only 15–20 per cent of the requirement. Despite huge demand for forage seeds, indented breeder seed is not fully lifted due to inefficient marketing. There is lack of awareness about fodder production, utilization and marketing aspects among the farmers as well as extension workers. Forage crops face unique problems in national perspectives as they are region and season specific. Each zone

Grazing resources in India

Resources	Area (million ha)	Percentage
Forests	69.41	22.70
Permanent pastures, grazing lands	10.90	3.60
Cultivable wasteland	13.66	4.50
Fallow land	24.99	8.10
Fallow land other than current fallows	10.19	3.30
Barren uncultivable wastelands	19.26	6.30
Total common property resources other than forests	54.01	17.70

of the country has its own preference and adaptability of forage crops. During the last few decades, several technologies in the form of varieties, cultivars, production, and protection technologies were developed in ICAR/SAUs and other institutions. However, these technologies have not reached the target group, and the adoptions of forage technologies have remained dismally low. The allocation of funds for fodder development is also very low when compared to the total fund allocation for the animal husbandry sector. Linkage among various organizations related with fodder in some or the other way is missing. A holistic viewpoint what is needed is not in existence.

Forage resources

The forage resources in India are mainly derived from crop residues, cultivated forages and grazing from pastures and grasslands. The crop

residues mainly constitute the major feed material in most of the states. The country has about 4.9 per cent of the total cropped area under cultivated forages. In India, cattle of intensive cropped areas obtain only about 25 per cent of their feed from grazing in nearby forests and other uncultivated lands; the balance comes from crop residues unsuitable for human consumption. In different, agro-climatic regions, the productivity of some prominent cultivated forage is highly variable. Among the Kharif forage crops, cowpea, sorghum, maize, pearl millet, NB hybrid and guinea grass have wide yield variables. However, during Rabi, the choice is limited to oat, lucerne and berseem. Grasses, perennial legumes, fruit and fodder trees, grassland and silvi/ horti pasture systems not only augment availability of forage to livestock but foster and ameliorate problem soils and regenerate vegetative cover, improve water resources under optimized



Cowpea+sorghum: the potential Kharif fodders



Berseem: A potential Rabi fodder



Cattle grazing on grass based pasture



Sheep and goats grazing on silvopasture

land use. Moreover, in India about 40 per cent of total area is available for grazing of livestock. In some states like Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland and Arunachal Pradesh, the grazing land availability is even more than 70 per cent of total land. The grazing activity depend on the availability of grazing resources like pasture lands, forest lands, cultivated wastelands, fallow lands, non-agricultural lands, miscellaneous tree crops and groves etc. Recently a survey, conducted by IGfRI using GIS and RS tools of five grasslands (Kuchh- Saurashtra region, Bundelkhand region, Himachal Pradesh, Jammu and Kashmir, Sikkim), indicated decline in their carrying capacity due to overgrazing and poor management, infestation of obnoxious weeds and diversion of grasslands for agriculture or other non-agricultural activities.

LOOKING BACK

Varietal development

A rich diversity of germplasm (total 8263) are being maintained at IGfRI, Jhansi collected through explorations and germplasm exchange. Concerted breeding efforts have resulted in release of more than 200 varieties in 30 fodder crops, range grasses and range legumes. Current breeding approaches are focused on using apomixis for rapid fixation of heterosis in cereal forages, developing biotic and abiotic stress tolerant as well as high protein and dry matter lines in

cereals and legumes; and dual types in sorghum and oats.

Resource management

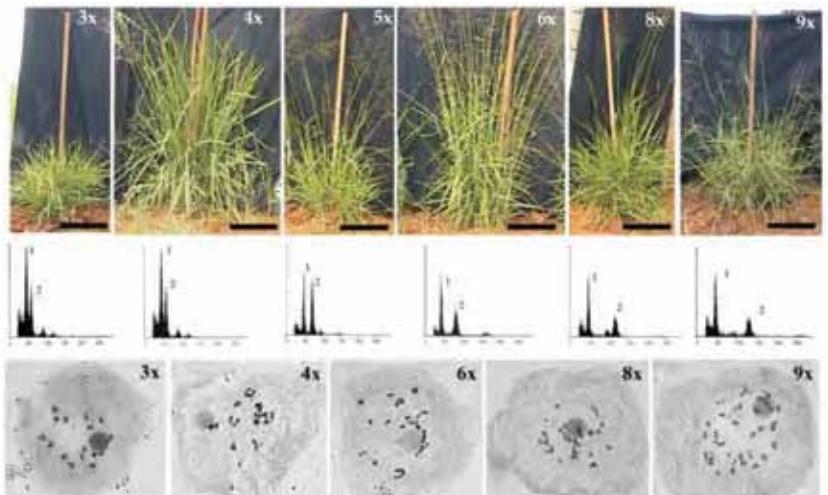
Production technologies for different situations have been developed for increasing fodder production with stability and sustainability of cultivated and non cultivated fodder crops. This includes intensive forage production

for different agro-climatic situations (75-255 t green fodder/ha/year), sustainable forage production from rain-fed lands (50-80 t green fodder/ha/year), integrating forages in existing cropping systems, forage production technology for specific situations like under plantation crops, rice fallows and non-competitive land use and forages from acidic, salt affected and

Few forage crop varieties released/identified during the recent past

Forage varieties

- Guinea grass – Bundel Guinea (JHGG-04-1); JHGG-08-1 (BG-4)
- Sehima nervosum - Bundel sen ghas 1 (IGS-9901)
- Chrysopogon fulvus – Bundel Dhawalu Ghas 1 (IGC-9903)
- Heteropogon contortus - Bundel Lampa Ghas 1 (IG-HC-03-4)
- Oats (3): Bundel Jai 991 (JHO-99-1), Bundel Jai 2004 (JHO-2000-4), Bundel Jai 992 (JHO-99-2)
- Pearl millet- Bajra (JHPM-05-2)
- Cowpea – (BL 4)- IL-1177



Ploidy series in guinea grass developed by novel hybridization derived apomixis components partitioning approach (HAPA)

waterlogged situations. Eco-friendly pest management in forages with botanicals (neem formulations) and bio-pesticides have been developed and validated in major forage crops.

Grassland management

The grassland restoration techniques based on ecological approaches e.g., protection for vegetation recovery, soil and water conservation, reseeding, improved range management techniques and grazing management have been developed. Silviculture systems were designed and developed for optimizing land productivity, conserving plants, soils and nutrients and producing forage, timber and firewood on a sustainable basis for degraded lands. It involves re-plantation, substitution or intervention in the existing vegetation by desirable species. The production potential of silvi-pasture in arid and semi-arid regions varies in the range of 2.5-3 t dry matter/ha and 4.0-7.0 t dry matter / ha, respectively.

Similarly hortipasture system, which integrates pasture (grass and /or legumes) and fruit trees, is an alternate land use system in arid and semi-arid regions. During the last few decades IGFRRI has developed several technologies for higher productivity (3-5 t dry matter/ha). The mean benefit: cost ratio of ber, aonla and guava based hortipasture system can be obtained to the tune of 1:1.45, 1: 6.7 and 1: 6.25, respectively. Over a period of 10 years, the employment of 4.74 man days/ month can be generated in aonla based hortipasture.

Forage seed

Seed standards in major range grasses and protocols for seed germination in major range legumes have been developed. Fresh/new seed standards have also been developed in seven grasses and four important range legumes. The demand of nucleus,



Round the year forage production



Hardwickia binata based silvopasture system

breeder and TFL seeds of various forage species is being catered by the institute. The breeder seed production of forages has been 15-20 per cent higher than indents received from DAC during last 10 years. There is significant increase in seed production at IGFRRI after the mega seed project came into existence. Additionally, the institute sold approximately 15 lakh rooted slips of various planting materials in 2010 and approximately 25 lakh rooted slips in 2011.

Forage evaluation

The precision in evaluation of feed/forage resources in relation to both animal performance and health is important, since our feed resources are varied and location specific. Concerted and continuous evaluation (both in vitro and in vivo) of fodder resources (grasses, cultivated legumes and cereals and tree foliage) for higher protein, low

fiber, higher digestibility and more animal production has resulted in the development of a number of nutritionally superior cultivars of fodder crops. Recent and precise methods of nutritional evaluation have been employed for screening the fodder and feeds for nutritional traits linked to the livestock productivity like carbohydrate and protein fractions, net energy efficiency for different animal functions (energy for maintenance, growth and lactation), rumen degradability characteristics (RDP and UDP) and gas production potential. Forage based feeding systems have been developed to sustain moderate level of growth (400 g/day) of dairy heifers and milk yield up to 10 kg/day in lactating animals utilising dry roughage (straw/dry grass), green fodder/legume hay with minimum energy source. Methane production (g/kg digestible dry matter) was lower (20.3-24.4) from green fodders (oat, barley, berseem and lucerne) compared to dry forages (27.67-47.37). Methane emission inventories have also been developed for ruminant animals.

Post-harvest management

Crop residues, straws, stovers from cereal and legume crops, dry grasses

from community lands and tree foliages from forests and social forestry lands constitute the basal roughage of both large and small ruminants. Due to low bulk densities, these feed resources not only require large volume for their storage, but make their transport tedious and costly affair. Use of appropriate post-harvest processing methods like drying, size reduction and baling/

densification/ pelleting etc. are practiced for specific product formulation, or when green fodder needs to be ensiled or dried, for conserving as hay or for adding in various products. Commendable efforts have been made for baling and densification, leaf meal processing technology and cover & plinth storage system for bales. Leucaena and stylosanthes leaf meal could replace concentrates up to 30 per cent in the diet of ruminants without affecting their production performances. Feed pellets of different constituents (crop residues, legumes and grasses) form a supplementary diet to small ruminants.

Looking ahead

To meet the current level of livestock production and its annual growth in population, strategies should include the measures that would address feed and fodder shortages; availability of quality fodder seed, conservation and processing of surplus fodder, suitable models for fodder based economic milk production and maintaining standards and quality of both feed and fodder. There is need to have breakthrough in technological advancement in grasses for higher biomass and reproduction, developing dual types and stress tolerant genotypes and soil-fodder-livestock interfaces for sustainable livestock de-



Leucaena leaf meal: a supplementary feed

velopment. Following approaches of research & development will go long way to solve the shortage of feed/fodder resources in the country.

Forage breeding

Effective breeding starts from appreciable germplasm resources. Hence, PGR activities in fodder crops, including grasses should get priority along with their effective management and characterization. Secondly, pre-breeding efforts are required to be taken up for generation of variability, and identification of better plant types. Efforts are to be strengthened to understand and utilize apomixis for desired manipulation in plant reproduction. A better understanding of this phenomenon, including genes and genetic mechanisms involved in the trait per se, as well as its components will be instrumental not only in generating variability in otherwise apomictic grasses utilizing sexual lines, but also will render a possibility to incorporate these genes into hybrid varieties of agriculturally important crops. Priority efforts on breeding are also required to incorporate multiple stress tolerance (both for biotic and abiotic stresses), for which effective utilization of PGR resources including wild relatives of respective crops will be a reasonable approach.

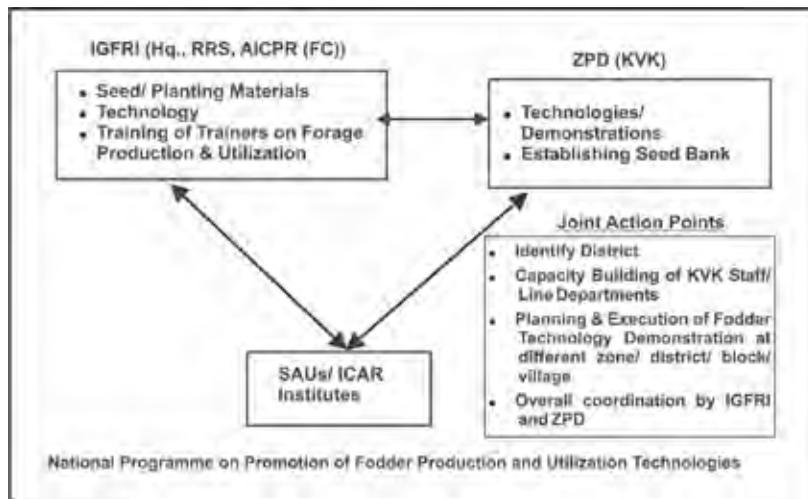
Crop-livestock mixed farming

Food-fodder cropping systems need to be promoted at large scale to provide balanced nutrition to livestock in mixed farming situations. The approach should cover nutritional enhancement of crop residue through proper storage and value addition, green forage based feeding system, use of legumes and top feeds, and also to minimize methane emission. Rehabilitation

of degraded grassland for livelihood support, especially in hill, semiarid and arid regions, and also utilization of wasteland for range grasses or legumes will have to be taken on participatory basis.

National initiative on forage technology demonstration (NIFTD)

A national initiative on feed and fodder in a mission mode is needed to address issues of fodder seed production, area expansion of green fodder, fodder conservation, establishment of fodder seed bank at various locations, capacity building and extension. The programme envisages accelerating production of fodder and enhancing livestock productivity by conducting forage technology demonstration (FTDs) through Zonal Project Directorates (ZPDs) in districts identified by KVKs and AICRP (FC) centres of the respective zone. IGFRI will provide training module, basic seed and planting material and capacity building of KVK staff. IGFRI team will also provide technical support and guidance. Training module will consist of aspects related to fodder production from arable and non-arable lands, balanced feeding and fodder conservation. Selected sites/villages will be promoted to develop seed and plant-



Schematic presentation of NIFTD activities

ing material bank of forages for catering the requirements of their vicinity. The whole programme will be monitored for effective implementation and delivery of the output. Further, the developed models and mechanism will be replicated in other regions for stepping up fodder production, and solving forage and livestock feeding related issues of the region.

Non-conventional feed resources

There are number of non conventional feed/fodder resources that can supplement green herbage to ruminant animals under varied management situations. Efforts should be made to improve the basket of feed resources through evaluation of nonconventional/underutilized feed resources like azolla (humid and sub humid conditions), turnip and fodder beets (intensive management system), cactus (semi arid and arid condition) for their inclusion and effective utilization in livestock diets. These are currently under-utilized and there is much potential for expanding their use by farmers. Identification and assessment of these feed resources for their nutritive value need to be given priority. There is need to carry out

long-term performance trials with practical method of removing the incriminating/toxic agents if any, limiting the utilization of nutrients from these resources.

Forage seed banks

The seed demand can only be fulfilled through continuous evaluation of released varieties for seed production potential and sufficient production of quality seeds in participatory mode. Seed banks on the pattern of seed village concept to be initiated on pilot mode by participatory forage seed production, organizing forage seed market and farmers training for forage seed production. Production

of seeds of range grasses and legumes in mission mode for at least five years in forest fringes need to be made compulsory for spreading of these grasses in deep forest areas. Common property resources (CPRs) should also be effectively re-vegetated with range grasses and legumes. Farmers are to be encouraged for maintaining grasses like NB hybrid, Guinea grass, Cenchrus for supply of rooted slips to meet local demands. The seed availability can be increased by strengthening the seed chain (breeder seed- foundation- certified/ TFL) and entrusting the responsibility of breeder seed to IGFR I & SAUs, foundation seed to RSFPD/DAHDF/ SAUs and certified seed to SAUs/Milk union/NSC/SSC.

Forage quality improvement and value addition

Concerted efforts should be made by the plant breeders with animal nutritionist to alter the plant composition for traits like narrow leaf to stem ratio, higher stem digestibility, higher sugar contents in cereal fodders with adequate protein to meet the requirement of animal with moderate production level. Development of grasses and forage crops with higher water soluble



Pasture development in Arunachal Pradesh

nutrients, increased polyphenol oxidase (PPO) activity, enhanced digestibility and more organic acids like malate and formate will open new avenues for forage based eco friendly livestock production with reduced CH₄ and N₂O emission from livestock rearing. Popularisation and adoption of fodder and feeds enrichment technologies (physical/chemical/biological treatments) to increase their nutritive value at farmers doorstep is another option for increased livestock production. Screening of natural biological agents as silage inoculants for effective preservation of green biomass as silage is the need of hour. Utilizing the leaf meal of the leguminous species (both woody perennials and herbaceous) such as lucerne, stylo, leucaena, glyricidia etc., hold promise to overcome the lean period fodder deficits and also improve the nutritive value of roughage based diets. There needs to have sufficient post-harvest and storage facility for utilization of surplus forages. The post-harvest technologies such as biomass processing, enrichment, densification etc. hold the key for improved and efficient utilization of available feed resources.

Forage banks

There exists the need for promoting 'forage bank concept' for preserving surplus production from rangeland during rainy season, in various forms, to use during the lean periods by transporting economically baled and nutritionally enriched dry fodder from surplus areas. Interstate transport of crop residues for fodder and feed security needs to be explored at harvest of paddy and wheat straw. The facility may be strengthened to promote commodity forage banks at Tahsil level, where surplus fodder can be stored as hays/silage/fodder blocks for use during scarcity. For enhanced



Schematic presentation of NIFTD activities

animal productivity, this can be supplemented with feed block, leaf meal and mandatory region specific mineral mixture supplementation. Establishment of forage banks near forest covers and bringing crop residues from surplus zones will meet out the forage requirement during scarcity and natural calamities.

Convergence and strengthening linkages

The forage resource development related activities should be tailored in harmony with the policies of Central Government with developmental and livelihood supporting projects such as Horti-Mission, MNREGA, and the National Rural Livelihoods Mission etc. Credit and market linkages to forage based livestock production needs support from Central and State Governments to enable livestock keepers for improving their income from animal husbandry. Establishment of producer companies, market linkage with private sector agencies involving ICAR institutions, SAUs along with farmers' participation

in a holistic manner can further strengthen the sector.

The technologies of forage based livestock production have percolated at very slower pace to the end users. Now strategies should be changed from simple minikit programme on cultivated fodder of DAHDF to focused technology demonstration. In the 12th plan, more emphasis should be given on FTDs in major forage crops with active participation of KVK network. Fodder development programmes in forestry projects need to be linked with livestock in the vicinity for effective utilization, resolving conflict between wildlife and domesticated cattle of forest dwellers; use of 25 per cent of fodder trees in JFM and social forestry programmes. Adoption and applicability of ICT in promotion of forages at field level need to be explored.

Strong policy support

The forage resource development is a more complex issue than food and commercial crops. Lack of momentum in feed and fodder development in the country owes much to poor organizational structure. Some prominent aspects related to policy which are required to provide favourable environment for accelerated forage development in India are – development of database of fodder production and utilization, investment in forage resource development, credit facility to forage production, support price for forage and marketing of seed, non-diversion of edible crop residues to other use like packaging, policy on grazing and common property resources, legal protection of grasslands etc.

The authors are respectively Director and Principal Scientist, IGFR, Jhansi, Uttar Pradesh

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POLICY MATTERS FOR AQUATIC RESOURCE

The occupational structure of our country reflects that the major portion of our work force is engaged in the primary sector which includes agriculture and allied activities like fishery, dairy farming etc. Though there has been progress in the secondary and tertiary sectors, till date the primary sector provides the bulk of livelihood factors in the country.

The central dogma of our planning process has been poverty alleviation, food security, health & education for all. It's often aired that there has been an increase in the per capita income however it also a fact that in almost all the states the BPL list is on the rise – so whose PCI is on the rise? Is it only the handful of people who are reflecting the rise by way of joining the millioner's club and what about the rest of the population who are reeling under economic stress?

A comprehensive planning is lacking at all levels of fisheries. Sand dunes in the river mouth and siltation of river bed causes extensive damage to the social and ecological fabric in the region. Huge amounts are spent on dredging of river beds to keep ports functional and the water ways navigable. But the root cause is being neglected. Permission is accorded for extraction of stones from the river beds in North

Bengal (Specially Teesta) causing damage to the breeding grounds and upsetting the migration pattern of local fish. The extraction of stones results in increased erosion and siltation in the river. Rampant deforestation in the Himalayas coupled with series of dam construction on the river, unrestricted encroachment of catchment area of river or serious aforestation, the Himalayan rivers are facing problems of erosion, siltation change in abiotic and biotic components of lotic ecosystem. Therefore, dredging without an orchestrated programme to eliminate the root cause of siltation is useless and wastage of public money-'just like watering a plant after severing its roots.'

IMPORTANT ISSUES

Resources Classification

Resources usually shown do not have equal potentiality. All resources cannot be used for culture purpose because of its other conflicting use. So resources may be classified into different categories according their agro-climatic (aqua-climatic) parameters.

Policy Reforms are required in the field:-

- Farming Systems Approach.
- Multi-Agency Extension Service.



- Public extension services.
- Promotion of farmer participatory approach.
- Promotion of demand-driven and farmer-accountable extension.
- Thrust on Marketing Extension.
- Enabling Farmers for Problem Solving Skills.
- Encouraging Private Sector Involvement in Technology Transfer.

Institutional Restructuring

Restructuring Public Extension
Farming System Innovations
Farmer Organizations
Natural Resource Management

The need of political will is a necessary condition for bringing required changes in fisheries governance. However, environmental issues are rarely reflected in political sphere in the region. Therefore, there is a need for sensitization of the decision makers and political leaders through sustained effort. NFDB as the largest platform of country should take lead in this regard. The sensitization can be brought through short-term residential interaction between leading scientists/experts and decision makers.

There is a need to highlight the plight of the rivers and wetlands and people depend on these resources for their livelihoods. Fisheries often suffered from unintended efforts of various developmental activities such as construction of dams, urbanization and dumping of waste, industrialization and pollution. The NFDB may consider carrying out a regional review of inland water resources such as rivers and wetland as a precursor to initiate a process of opinion formation and regional dialogue for responsible and equitable uses of inland water

Resources and opportunities of aquaculture in India

Total length of Coastline	8 129 Kms.
Exclusive Economic Zone	2.02 million Km ²
Continental Shelf area	0.53 million Km ²
Brackish water area	1.2 million ha.
Freshwater ponds & tanks	2.38 million ha.
Reservoir	3.15 million ha.
Estuaries	2.7 million ha.
Rivers and Canals	0.19 million Km.
Waterlogged saline affected areas	8.5 million ha.
Species diversity	2 200 species
	(M: 1 440, FW: 544, CW: 73, BW: 143)

Where we are??

Resources	Available	Utilization	Present production
Freshwater ponds and tanks	2.38 million ha	40%	2.4 t/ha/yr.
Reservoirs	3.15 million ha	??	100 kg/ha/yr.
Brackish water	1.2 million ha	13%	0.96 t/ha/yr.
Salt affected area	8.5 million	00%	--
Marine (EEZ)	2.02 million km ²	00%	--

resources. The voluntary guideline on small-scale fisheries has emphasized on recognizing the right of the small-scale fishermen dependent on inland water resources. This could be the rallying point.

While there is a need to provide additional and alternative options to fishermen to improve their livelihood, it is also necessary to ensure their livelihoods within fisheries.

There is a need for capacity building at various levels. But first it is necessary to evaluate the past and existing training programmes in the region. The region has a long history of implementation of various capacity building programmes. The point to consider here is that whether training of individuals is leading to institutional capacity building or not, and second whether such programmes has a "trickle down" effect. The focus of capacity building

programmes should be to change the institutions positively and not creating personalized knowledge banks.

There is a need to establish a method to share regional and global scientific and business innovation, especially in the case of aquaculture. For example, in the case of freshwater aquaculture, Bangladesh and India can learn from each other. However as there is no organization-to-organization linkage, countries often end up in repeating the same research and wasting resources. NFDB may take a lead in this regard. Such cooperation is also necessary in dealing with climate change as only by developing a large and versatile data set, can we design effective mitigation strategies.

Shrimpfarm-mangroveplantation may be promoted to reduce the effect of Storm, CycloneandErosion of

Aquaculture production (2007) India vs China

	CHINA	INDIA
Aquaculture Production	52.00 MMT (2010-11)	9.06 MMT
World position	1	2
Share in world Aquaculture Production	61.7% WORLD SHARE	6.63% WORLD SHARE
No. of species farmed	>75	<15

dyke. This type of culture practices is termed as "Silvi Culture" in other parts of the world (Like Vietnam) and also recommended by Dr. Swaminathan, Former DG, ICAR in our coast. Coastal Aquaculture Authority may be requested to include this point as mandatory for registration of any brackish water farms. NFDB may join hands with Forest department on this issue and fund such plans.

As such there is no fish sanctuary in our country in true sense, while Bangladesh has more than one such sanctuary and China has 200 of them. Fish sanctuaries should be encouraged to conserve the diversity and gene pool. Another aspect is the control of water bodies within the sanctuary and forests. Here the forest department has the sole control whereas the expertise in aquatic recourse management lies with the Fisheries Department. These water bodies should be jointly controlled by both the Departments as in case



of many countries like Bangladesh and Indonesia. Perhaps nowhere else there is such complexity in the control of a natural resource by so many departments leading to complications and delay in decision making. In planning a fish sanctuary, one can easily begin with the water bodies within a sanctuary provided the management of the water body be jointly monitored by fisheries and forest department.

Fisheries

Due to deterioration of water quality (because of city sewage, agriculture runoff etc.), destruction of breeding grounds, stone picking, sand mining, siltation due to afforestation, construction of multi purpose river valley projects etc., there has been a rapid decline of the fishery resources

in all rivers of India. Consequently, in addition to the huge drop in production and quality of catch from capture fishery, several species of commercial importance have also reached the stage of vulnerability. The National Bureau of Fish Genetic Resources, Lucknow

(2007) has lately identified several species of fishes that are vulnerable, rare and endangered. As rivers are not confined to a state boundary, a new approach to fishery management and conservation in view of these changes are urgently needed by framing National level law for riverine fisheries.

The M.P. riverine fisheries rules, 1972 may be consulted for this, though few grey areas Protection of the habitats which are Protection of endangered and vulnerable fishes,

NATIONAL LAWS for Riverine

Policy is defined as guide to action and it should be spatial rather than linear. For better effectiveness it should have three dimensions comprising of functional, time horizon and intervention type. Functional part comprises finance, marketing, production, HRM, supply chain, logistics etc. Time horizon- short range, midrange, and long range. Intervention – strategic, operational, tactical.

WORLD TRADE (Fisheries) 2007

Total world production	148.5 mill.tonnes
Total world Trade	US\$ 129.2 billion
India Export	US\$ 5.0077 billion (Year 2013-14)
China's export	US\$ 13.3 billion
India production	9.06 mill.tonnes
China production	52.0 mill. tonnes (2010-11)

Punishment for violation of law and Provision for non-cognizable offences.

It should be ensured that, all river resources are used responsibly and adverse impact on environment and fisheries community be minimized and biodiversity preserved.

Development Administration by Knowledge Management System in Aquaculture (Technical Director for all state and in NFDB)

"The punishment suffered by the wise who refuse to take part in the government, is to suffer under the government of badmen"- Plato

Concept of development administration is gaining importance for its special emphasis on people, society, economy and subject technicality. Agenda of United Nation and its specialized body like Food and Agricultural Organization (FAO), international convention and treaty had made the policy maker to pursue for technical and professional stance because to perceive a technical problem, technical knowledge is needed. Aquaculture subject has witnessed aspect acularenrichment over last decades. The paper discussed the agenda, commitment and international code of conduct imposed by FAO. The horizon of the subject has been widened due to application of the microbiology, biotechnology, hydrodynamics, soil and water chemistry, genetics, GIS and post-harvest.

The planning commission also adopted a forward looking and progressive, aquaculture plan for XIth five year plan. The implementation of plans adopted by international and national bodies needs proper knowledge management system for externalization, internalization,

CONSOLIDATED FISHERIES DEVELOPMENT IDEAS

1	Like MPEDA, NFDB might have separate cell, which have freedom to implement schemes, research project etc.
2	National level advertisement for 'Health benefit, role of Fish as Food' at DD channels to promote pisciculture
3	New scheme for promotion of 'waste water culture' at all urban area which will give two fold benefits- a. Creation of livelihood opportunities, b. Clean river which will support river fisheries.
4	River cage culture/canal culture for Fish cop. NFDB will give fund only.
5	Collaboration with Industry- University-Fish cop-led to demand driven research.
6	Direct foreign collaborative project funding for fisheries. NFDB may provide fund for consultancy charges. We may avoid duplication of same research on the back drop of global villages.
7	The vast available inland waterlogged saline affected areas can be utilized for the culture of striped mullet. Striped mullet can be cultured in cage inside bays and open seas and inland reservoirs, lakes and lagoons by using artificial feed. NFDB may take initiative on development of domesticated high quality brood stock of striped mullet, Mugil cephalus. Development and refinement of seed production technology of striped mullet, M. cephalus. Development of nursery technology for raising fry to fingerlings of striped mullet, Mugil cephalus.
8	Fish refujija – to support Aqua Biodiversity
9	Provision should be there in all big fish market for ornamental decorative unit, fish feed, value added product, medicine, Pituitary gland for breeding, pond fertilizer, net etc. Collection of fish waste to form fish silage to supply protein supplement for animal & fish feed.
10	Aquaponics project has to be initiated for all kind of housing estates to combat global warming and production enhancement of aquatic animal.
11	Automation of hatchery-multiplier recirculation system for hatchery.
12	Biotechnological aspects- i. Improved strain preparation with progressive farmers, ii. Packaging and transport, iii. Medicines and drugs development
13	Exposure visit for NFDB technical staffs for preparation of new technical proposal/ collaboration for better tomorrow.
14	The Integrated Multitrophic aquaculture (IMTA) which combines the cultivation of fed aquaculture species(e.g. finfish/shrimp) with organic extractive aquaculture species (e.g. mollusks and macro algae), NFDB may introduce scheme for establishment of front line demo farms on integrated farming of fish with seaweed & mollusks through direct consultancy from Korea or Taiwan.

transfer and socialization of technologies.

The article tries to establish through theories of knowledge management and technology management like Michael Polanyi model, Nonaka and Takeuchi (SECI model), Leonard and Barton, D (Technology transfer model) that tacit knowledge can only be perceived by technical persons to make it explicit for onward transfer. So, the knowledge management can be done by a knowledge based organization structure comprising of cohesive technical persons. The department and the service rendered by the department should be recognized as technical. So, all the state Directors of Fishery and NFDDB should be headed by a Technical Director. The end objective of the governance is to develop a knowledge society.

Clean Sea and Sea

Ranching:

Fishermen from coastal area regularly complain of becoming victims due to alarming levels of ocean pollution. According to them, they used to get assured catch within 10 Km from coast, about ten years ago. Now, none is venturing to fish in that area due to depletion of catch because of industrial effluent and domestic sewage and dumping of plastics, carry bags, polystyrene cups and other non degradable wastes. In this process other fish consume the released material. Dumping of plastics in the sea has turned into a serial killer for several marine species. On this back-drop, Clean Sea and Sea Ranching- should be made a National Programme to mitigate this problem.

Sl. No.	Research need of the state/Farmer	Institute who may be requested to take R & D Project in collaboration with State Fisheries Research Station
1.	Standardization of breeding, seed production & culture of various economically important catfishes found in River Ganga viz. Rita rita, Pangasius sp., Bagarias sp. etc.	CIFRI /CIFA/ Univ
2.	Standardization of breeding, seed production & culture of economically important brackish water fish species viz., Mugil parsia, Mugil tade, Polynemus) and different indigenous varieties of prawns and Tangra sp.	CIBA/Univ
3.	Standardization of breeding, seed production & culture technology of economically important edible marine water fish species and marine ornamental fish, invertebrate and coral varieties.	CMFRI/Univ
4.	Standardization of breeding, seed production and culture technology of different varieties of hill stream Loaches, Barbs, Danios, Green prawns etc. for the promotion of exportable ornament fish.	
	Directorate of Cold Water Fisheries, Bhimtal / Central Institute of Fresh water Aquaculture, Bhubaneswar/ Univ	
5.	Development of suitable probiotics for culture of Asala and Katli in hill areas	Directorate of Cold Water Fisheries, Bhimtal / Central Institute of Fresh water Aquaculture, Bhubaneswar/ Univ
6.	Development of suitable aqua soluble drugs to combat fish/ prawn/shrimp diseases	CIFA/CIBA/CMFRI/ CIFT/ NBFGR./Univ
7.	Formulation of specific feed for ornamental fish viz., Koi carp, Discus, Tetra, Oscar etc. For variation in coloration.	CIFA/ CIFE/Univ
8.	Development of user friendly solar operated aerator and different types of filter for ornamental fisheries sector.	CIFT/Univ.
9.	Development of Solar operated aerator for seed transporter /carrier / banki. Cage designing for algae and mussel culture as a component of marine cage culture (Multi trophic aquaculture)	CIFT/Univ

Algae: An Untapped Resource

The algae as a group represent the third largest aqua-cultured crop (after fresh-water fishes and mollusks) in the world today. Algal aquaculture worldwide is estimated to be a USD 5-6 billion per year industry. The largest portion of this industry is represented by macro-algal production for human food in Asia, with increasing activity in South America.

Macro and micro algae are essential food for aquaculture animals like for fish, molluscs and crustaceans. Macro-algae are farmed for their hydrocolloids as well as for food and microalgae are cultured commercially for use as health food and as a source of valuable chemicals which have nutritive roles. Different macro and micro algae are a good source for aquaculture feed for different larvae and juvenile animals also.

The establishment of production and marketing team to develop and carry out algae-related industries are the need of the day (we are still in infant stage). Academic cooperation with Taiwan, establishment of aquaculture industry of country based research and development scheme for the application, to provide services for the industry has to be supported by NFDB.

Research must get to know its markets

There is a huge gap between research and practical application. There are so many central and other institutes which till date could not popularize

the standard breeding technique of most local catfish or other indigenous fish species. Therefore the more easily manageable exotic species has been adopted for breeding and rearing by the farmers of Naihati in West Bengal after they standardized the techniques of breeding and seed rearing. Pangas, Paku and Black carp are the most glaring examples. Pangas and Paku seeds produced by the farmers in Naihati find their way to Andhra Pradesh and subsequently



are reared there and are supplied to various places both within and outside India.

This is a success story in its own right and no amount of restriction will make any headway unless the stakeholders are provided with alternative indigenous species to replace the exotic ones. Gauging the situation, the NFDB has recognized Pangas for cultivation. This is a case of learning from the 'land' and not from the 'lab'.

The ICAR institutes needs to be evaluated from time to time to assess the contribution in fishery section as a lot of fund is being pumped in these institutes for result oriented research.

Last but not the least, the following have been observed to be the research need of the State and Aqua farmer, respective Central Fisheries Research Institute(s) and Universities may be requested to take up research projects in collaboration with the State Fisheries Research Station infrastructure. Work together with market parties in a targeted manner and service accordingly.

In India 35 per cent population are under the poverty line having daily caloric intake of 2400 Kcal. In order to fulfill the minimum nutritional requirement as stipulated by the WHO standard, a person needs 11 kg of fish per year. Assuming 1.152 billion of population, the country needs 12.67 million tonnes of fish. Therefore, current shortfall will be a minimum of 6 million tonnes and that will mostly have to come from aquaculture.

“Of all diseases hunger is the greatest”- Lord BUDHA

For promoting sustainable intensification of aquaculture for food and nutritional security in India, aquaculture products to meet the market requirements, improvement of aquaculture governance and management practices, responsible aquaculture feed and seed production for sustainable intensification, increase the Resilience of small farm holders in India-- a concerted effort must be made considering all the complexities of the situation and responsibilities at hand.

The author is Executive Director, National Fisheries Development Board, Rajendra Nagar, Hyderabad



DR. C. N. RAVISHANKAR

Agri Business Incubation Initiatives in Fisheries

Business incubators can make use of the increasing demand of high level of entrepreneurship development and integrate its activities into the fabric of the community for achieving economic development. The heart of a true business incubation program is the on-going, personalized, and comprehensive services that are provided to its clients. By following best practices, an incubator can merge innovation and entrepreneurship, and support and guide entrepreneurs to market their business concepts, work effectively to reduce the failures and attain ability of free standing in the global market.

Fisheries sector with its important role played in the socio-economic development of the country has become a powerful income and employment generator, and stimulates the growth of a number of subsidiary small, medium and large scale industries. In order to translate the research results arising from the field of fisheries and other agricultural sectors,

ICAR have set up an innovation based Business Incubation Centre (BIC) at the Central Institute of Fisheries Technology (CIFT), Cochin. BIC is managed by Zonal Technology Management – Business Planning and Development (ZTM-BPD) Unit and aims at establishment of food business enterprises through IPR enabled ICAR technologies.

BIC supports operations on business projects as a measure of enhancing the foundation for new technology based industries and establishing a knowledge-based economy. It focuses on finding new ways of doing business in fisheries and allied agricultural fields by finding doors to unexplored markets. The Centre helps prospective entrepreneurs, by providing pro-active and value-added business support in terms of technical consultancy, infrastructure facility, experts' guidance and training to develop technology based business ideas and establish sustainable enterprises. It acts as a platform for the speedy commercialization of the ICAR technologies, through an interfacing





Pilot Plant at CIFT for Business Incubation

and networking mechanism between research institutions, industries and financial institutions. The Incubator at CIFT differs from traditional Business Incubators as it is tailored specifically for technology based industries and is operational at an area with a high concentration of fish production. This industry-specific incubator also allows new firms to tap into local knowledge and business networks that are already in place. BIC offers their services to industries not only in Cochin, but also all over India through virtual incubation. Beyond promoting business growth, the Centre is also trying to bring its benefits to all the fisheries communities in India.

This unique Business Incubator is now known as a "One Stop Shop", where entrepreneurs can receive pro-active, value-added support in terms of technical consultancy, and access to critical tools such as entrepreneur ready technologies, vast infrastructure and other resources that may otherwise be unaffordable, inaccessible or unknown. With the aim of transforming the incubator into a symbol of entrepreneurship and innovation, the ZTM-BPD Unit has created an environment for accessing timely scientific and technical assistance and support required for

establishment of technology based business ventures. The activities of the ZTM-BPD Unit focuses on finding creative and innovative ways for linking public sector resources and private sector initiatives within and across regional and national boundaries for promoting economic growth. The Centre uses the right expertise in relevant fields to identify and analyze the constraints and barriers hindering the growth of a business, and devise appropriate strategies. It explores the various structures and strategies to help small enterprises to grow and ensure a promising future in the global market. It fosters corporate and community collaborative efforts, while nurturing positive government-research-business relationships.

Process of Incubation

The Business Incubation Centre targets entrepreneurs -from fledgling start-ups in need of basic small scale processing capacity to sophisticated businesses in need of R&D back up, office infrastructure and pilot / test market processing facility for the development of new products. It possesses good infrastructure facilities suitable for providing direct incubation of nine entrepreneurs in a corporate environment within

the premises of CIFT, at a time. The purpose of direct incubation is to support emerging companies through their infancy. BIC apart from being a multi-tenant facility with on-site management that delivers an array of entrepreneurial services to clients operating within the facility, it also serves clients that are not located in the facility through virtual incubation or incubation without walls.

The Centre regularly conducts industry interface and technology promotional programmes for sensitization of entrepreneurs and to identify interested potential candidates for physical and virtual incubation. The Clients at BIC gets the privilege of meeting Scientists, Business Manager and Business Associates directly, to discuss and finalise the strategies to be adopted to take the business forward. It is also the peer-to-peer relationships that develop within the incubator, that ensures the delivery of basic services such as how to actually incorporate a business; what are the legal issues; how to take intellectual property protection; how to do basic accounting and cash flow; how to do business presentations etc. Those kinds of skills are transmitted as part of the incubation process.

The residency period for direct incubatees is normally for two years, extendable by another year in special cases, depending on the progress of incubation. As the business venture becomes mature enough, the concessions and the facilities provided to the incubatee companies will be gradually withdrawn. Each incubatee of the Unit will have to pay to the Institute a charge for utilization of space, at a rate concessional to the benchmark rate which is the prevailing market rent realizable. Incubatee mentoring will continue in virtual mode after graduation, on need basis.

Services and facilities offered by CIFT Business Incubator

The Centre through its business support services provides links to supporting industries; upgrade technical / managerial skills; provide scientific / technical know-how; assist in market analysis, brand creation and initial test marketing; protect IP assets; and find potential investors and strategic partners.

Incubation facilities under one roof are:

- Furnished office suites within the premises of CIFT, with shared facilities like secretarial assistance, computing, copying, conferencing, video conferencing, broadband internet and communication services.
- Pilot level production lines
- Culinary facility
- Access to modern laboratory facilities for product testing and quality control
- Access to well-equipped physical and digital libraries



Fish Bite – A retail outlet for fish based value added food products, established at Karnal

Pilot Level Production Lines

A state-of-the-art generic semi-commercial production facility is made available to incubating entrepreneurs for developing value added products from fish. BIC provides access to these facilities along with support of manpower, and assists the entrepreneurs in production and testing of new product formulations. For the tenants, the pilot plant is an ideal testing arena to determine the commercial viability of new products. The plant also serves as a process lab, a place to see how processing equipment impacts food products under varying conditions. There are production lines for pre-processing, cooking, retort pouch processing, canning, sausage production, extruded products, chitin & chitosan, smoking, curing & drying, breading & battering and product packaging. By providing access to these resources, the Centre greatly reduces one of the major barriers to the commercialization of institute technologies by smaller firms - the high capital cost of intermediate or large scale process equipment.

Business Services

The business oriented services offered by BIC include assistance in complying with business regulations and licensing procedures, financing, information services, marketing, and tailor-made services designed

for the various tenant enterprises. Incubator clients can also gain special advantage in terms of tax savings through special regulations for Business Incubators. BIC also offers a wide variety of services, with the help of strong associations throughout the Business Incubation Network.

Successful Business Incubation ventures in Fisheries India's first integrated- zero waste agri-business venture, pioneered by CIFT Incubatee

The Central Institute of Fisheries Technology (CIFT), Cochin under Indian Council of Agricultural Research (ICAR) has set a model for the public private partnership through the establishment of India's first inland fish processing facility in the village of Bhutana, District of Karnal, Haryana. The hard work and consistent efforts of a progressive fish farmer cum entrepreneur, Mr. Sultan Singh has brought the village of Bhutana into the limelight. He is the man behind the establishment of the 'Sultan Singh's Fish Seed Farm', 'Sultan Singh's Food Court' and the Processing Unit for the production of value added products from fish. The unit was inaugurated by Dr. S. Ayyappan, Secretary DARE and Director General, ICAR on 26th February 2011. Mr. Sultan Singh is a registered incubatee under the Zonal Technology Management – Business Planning and Development Unit, South Zone, an agricultural business incubation initiative of ICAR at CIFT, Cochin. The processing unit at Karnal was set up in technical collaboration with the Fish Processing and Quality Assurance & Management division at CIFT, Cochin. He has been associated with CIFT, Cochin since 2008. He is the



International Consultancy undertaken by BIC at Horizon Fisheries, Maldives

first incubatee from CIFT, to establish a successful business venture in the field of inland fisheries in India. Scientists from CIFT have provided the technical guidance in setting up the zero waste fish processing unit and have imparted training in the production of fish based value added products. The products like fish nuggets, burger, fingers, balls etc are being prepared and marketed under the brand name 'Fish Bite'. The Unit is designed in such a way that even the waste from fish processing would be converted into fish feed, thereby setting a fine example of zero waste agriculture. The fish and fish products from the farm are of superior quality.

The project is expected to open a new gateway to the entrepreneurs of Haryana, to market their produce. With the vision of establishing more successful ventures in this field, the Unit is also acting as a training center for progressive farmers and scientists. The ZTM-BPD unit is providing further assistance to Mr. Sultan Singh in strengthening their marketing channel by establishing retail kiosks at Delhi, Punjab, Haryana

and Maharashtra. It is envisaged that in the near future, this initiative shall reach new heights through setting up of food chains, with a large variety of fish and fish products all over India and abroad.

Commercialization of CIFT technology- Chitin & Chitosan

The Central Institute of Fisheries Technology (CIFT) has developed a technology for the extraction of Chitin and Chitosan from crustacean wastes, which has various industrial applications in biotechnology, food processing, pharmacy, cosmetics and medicine. The technology was commercialized to Uniloids Biosciences Pvt. Ltd. Hyderabad, who are specialized in the domain of bio fertilizers and respective chemicals. The company was given the technology know-how and training to convert the seafood process waste to Chitin and Chitosan using the scientific methods developed at CIFT. Uniloids Biosciences is a registered incubatee under the ZTM-BPD Unit, an Agribusiness Incubation Centre established at CIFT. The company is provided busi-

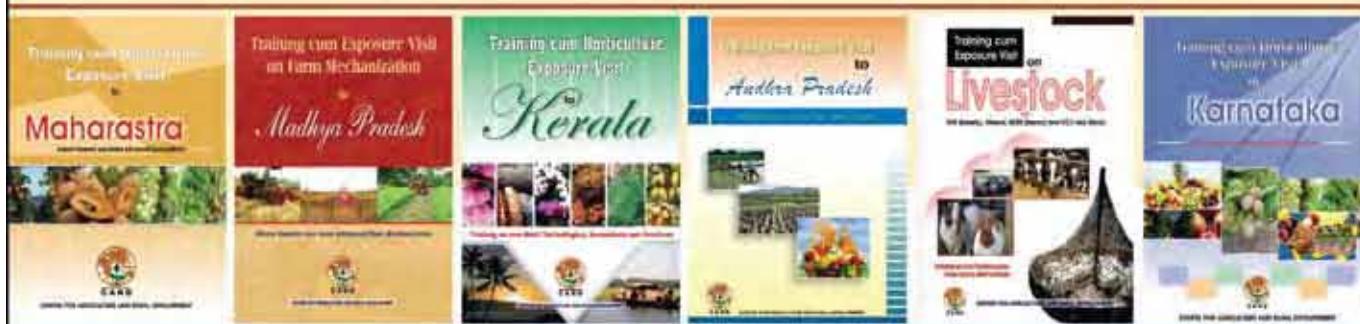
ness support services through the ZTM-BPD Unit and technical support through the Fish Processing and Quality Assurance & Management Divisions at CIFT. Uniloids is successfully manufacturing, supplying and exporting Chitin and Chitosan to major market players in this field.

International Technical Consultancy on Thermal Validation at M/s. Horizon Fisheries Pvt. Ltd, Maldives

The ZTM-BPD Unit, South Zone has provided technical consultancy to Horizon Fisheries Pvt. Ltd., Mandhoo Fisheries Complex, Mandhoo, Republic of Maldives in the area of thermal validation of seafood. Horizon Fisheries Pvt. Ltd. is a leading fish processing and marketing company in Maldives. The activities of the company include collection, storage, processing and marketing of Tuna and Tuna related products which are supplied to major international markets at Thailand, China, Japan, Iran, Oman and New-Zealand. The scientific team from CIFT visited Maldives and conducted thermal validation studies during the period 23rd April to 2nd May 2011. The consultancy was carried out as per the standard guidelines of National Food Processors Association, USA and guidelines of Campden and Chorleywood Food Research Association, UK. The team also provided training to the management and technical staff of the company on various aspects of thermal process validation, retort operation and optimization of process for thermal processing of products from tuna in retortable pouches and rigid cans.

The author is Director, Central Institute of Fisheries Technology(CIFT), Cochin

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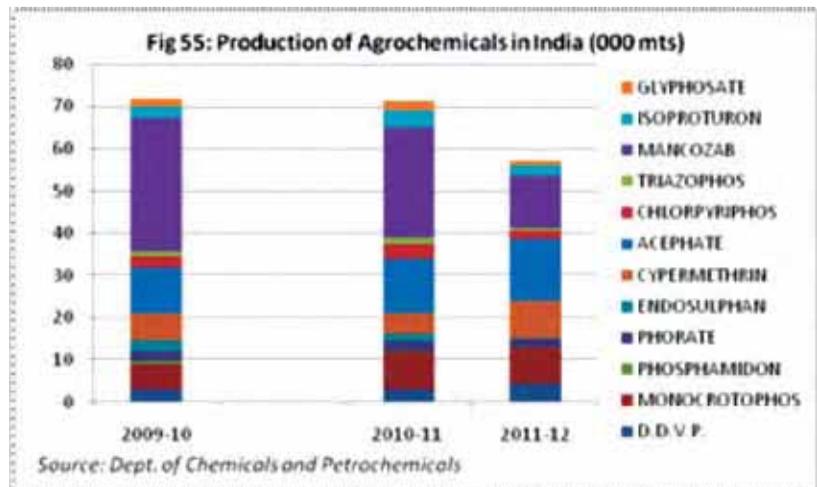
The Technical Manager
Centre for Agriculture and Rural Development (CARD)
306, Rohit House, 3 Tolstoy Road, Delhi - 110001
Ph: 011-23731129, 46569160 Fax: 011-23731130
E-mail: agritours@card.org.in, Website: www.card.org.in

Agri Industry

Indian Agrochemicals Market

Per capita consumption agrochemicals in the total agriculture inputs in India is one of the lowest in the world. Although India as a country is the fourth largest producer of agrochemicals, consumption by its own agriculture sector is only 600 gms/hectare which is extremely low when compared to countries like China (13 kg/hectare) and USA (7 kg/hectare). The current India agrochemicals industry is estimated to be USD 4.2 billion out of which almost half of this constitutes export value. The overall market is growing at an annual rate of 12%. In the coming years, the growth of Indian agrochemicals market will be largely driven by the export market which is growing at an annual growth rate of about 15-16%. The domestic market is expected to grow at 8-9% p.a. in the next couple of years. The future years is also expected to experience significant growth in the biopesticides whose current share of the total agrochemicals market is about 4%. Driven by environmental concerns, this segment is expected to witness double digit growth in the coming years. Currently, Indian agrochemicals industry is dominated by insecticides which form about 65% of share of the industry with other segments like herbicides, fungicides and rodenticides/nematocides constituting 16%, 15% and 4% of the total market share respectively.

Globally though, herbicides constitute about 44% of the crop protection market followed by fungicides at 27%, insecticides at 22% and others at 7% of the global agrochemicals mar-

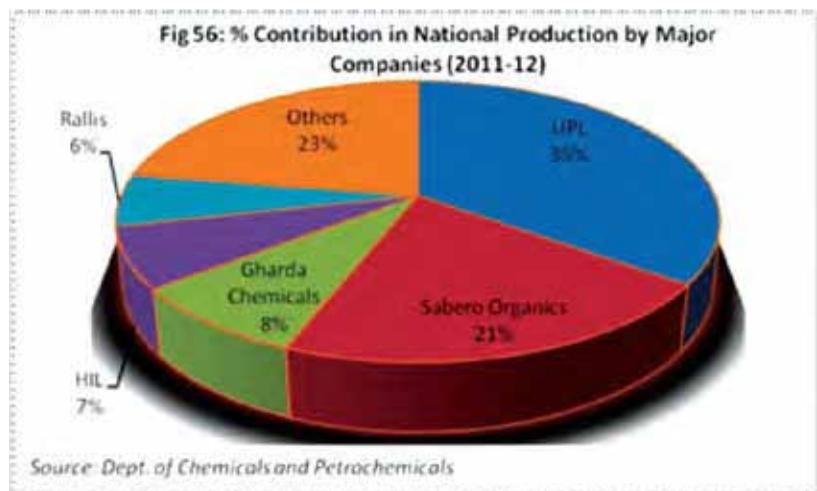


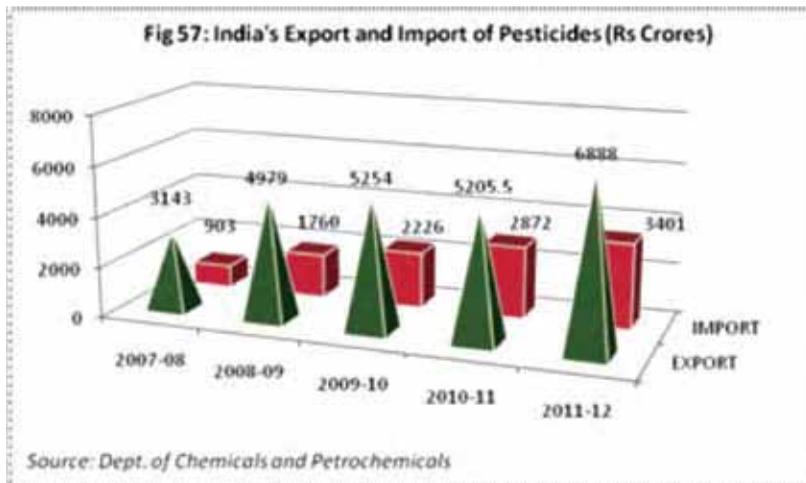
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Fig 49 shows the level of production of various agrochemicals in the country. In 2009-10, Mancozeb had the largest share (31.5 thousand MT) of the total quantity of agrochemicals produced in the country. It had the highest share again in 2010-11 (26 thousand MT) but the production of mancozeb in 2011-12 reduced significantly to 12.4 thousand MT. Pesticide like acephate, DDVP, monocrotophos, cypermethrin etc. witnessed increase in production from 2009-10 to 2011-

12. However, pesticides like phosphamidon, endosulphan, chlorpyrifos and glyphosate witnessed reduction when compared between 2009-10 and 2011-12.

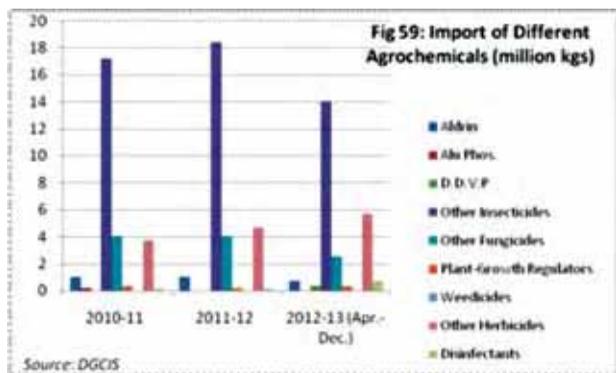
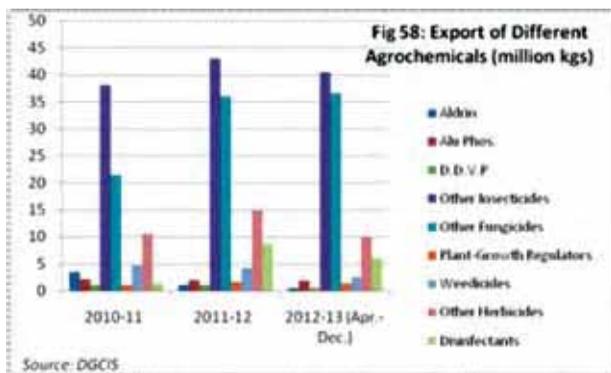
According to statistics available from government sources as accessed by Agriculture Today magazine, United Phosphorus Ltd. (UPL) in 2011-12 was the largest contributor to the total agrochemicals production in the country. The share of UPL was 35%. Sabero Organics Ltd. had 21% share of the total production of agrochemicals





corresponding previous full year was 47.1 million kgs while that in 2010-11, the quantity was 44.6 million kgs.

Similarly, import of various pesticides also experienced growth when one compares the figures in 2010-2011 to 2012-13 (April-December). Import of aldrin, aluminium phosphate, DDVP and other group of insecticides together was 15.12 million kgs during the nine month period of 2012-13. The import figure for the corresponding previous full year was 19.45 million kgs while that in 2010-11, the quantity



while Gharda Chemicals, Hindustan Insecticide Ltd. and Rallis India Ltd. had a share of 8%, 7% and 6% respectively (Fig 56).

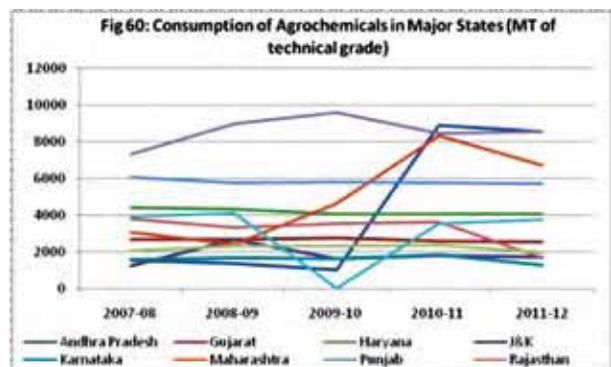
Market prices of agrochemicals are not regulated by the Government of India. They are determined by market forces of demand and supply making the market more competitive and believed to be beneficial to the farmers as no company can extract exorbitant price from the farmers. Perhaps this is also a reason that while India produces and exports a large quantity of pesticides, it also at the same time imports a large quantity of them. In fact, between 2007-08 and 2011-12, the growth of imports of agrochemicals in the country outpaced the growth of exports in the country. In 2007-08, India exported Rs 3143 crores of total agrochemicals which increased at a CAGR of 17% and reached Rs 6888 crores in

2011-12. On the other hand, the total value of imports in the country was Rs 903 crores in 2007-08 which increased at a CAGR of 30.4% and reached Rs 3401 crores in 2011-12 (Fig 57).

Export and import trends of various types of agrochemicals are shown in Fig 58 and Fig 59. Year 2012-13 represents the nine period from April to December for both export and import. Various insecticides witnessed increases in export figures. Export of aldrin, aluminium phosphate, DDVP and other group of insecticides together was 43 million kgs during the nine month period of 2012-13. The figure for the

was 18.44 million kgs.

Agriculturally important major Indian states over the past few years have shown varying trends in the use of pesticides. Consumption of pesticides in states like Gujarat, Haryana, Karnataka, Punjab, Rajasthan, Tamilnadu and West Bengal reduced abruptly in 2011-12 as compared to the previous year of 2010-11. When compared

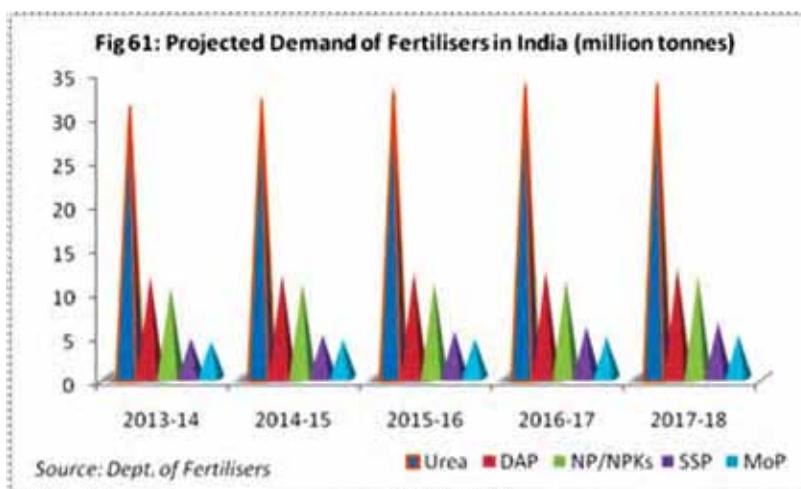


between year 2007-08 and 2011-12, states like Andhra Pradesh, Maharashtra and Uttar Pradesh has experienced significant increase in the consumption of pesticide. Consumption of pesticide in Andhra Pradesh witnessed a massive increase of 453% where consumption in 2007-08 of 1541 MT of technical pesticides increased to 8529 MT in 2011-12 (Fig 54).

Indian Fertiliser Sector

As shown in Fig 62, India has 30 manufacturing units of Urea with an installed capacity of 21.6 million tonnes till 2013. There are 12 units of DAP producing plants with a combined capacity of 8.3 million tonnes. Complex fertilisers in the country have an installed capacity of 6.4 million tonnes from 19 units. Highest number of fertiliser units in the country belongs to Single Super Phosphate (SSP). India has 85 SSP units with a combined production capacity of 7.7 million tonnes.

Production trend of different fertilisers from 2008-09 to 2012-13 is shown in Fig 63. Production of has grown by CAGR 2.5% for the period from 2008-09 to 2012-13. In 2008-09, India produced 20 million tonnes of urea in 2008-09 which increased to 22.6 million tonnes in 2012-13. India produced 3 million tonnes of DAP in 2008 which increased by 3.7% CAGR to 3.6 million tonnes in 2012-13.



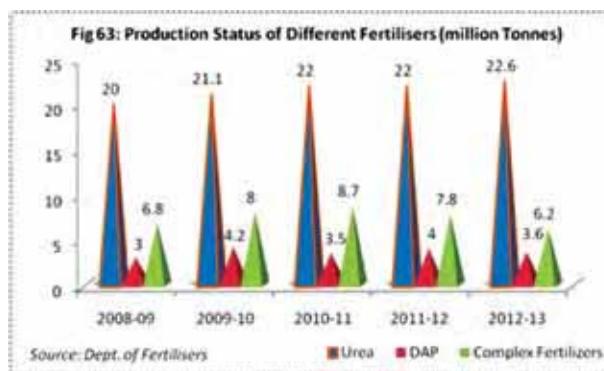
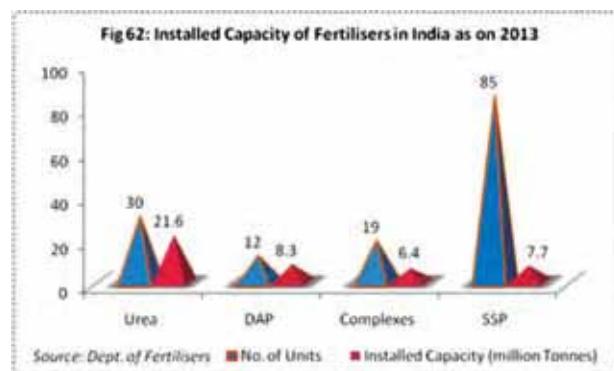
However, complex fertiliser category witnessed a negative growth during the same period. It decreased by 1.8% CAGR from 6.8 million tonnes in 2008-09 to 6.2 million tonnes in 2012-13.

In India, complex fertiliser is produced by public sector, cooperative sector and private sector players. Taking a closer look at the production scenario of complex fertiliser in the country which has witnessed an overall negative growth for the period from 2008-09 to 2012-13, maximum fall in production by both cooperative and the private sector was witnessed between 2010-11 and 2012-13. Public sector production somewhat was consistent over the period (Fig 64).

Table 10 below shows the production figures of different complex ferti-

lisers in the country in the period from 2008-09 to 2012-13.

During the first 10 months of 2013-14 financial year, India imported 6.8 million tonnes of urea valued at USD 1.92 billion. The cost of inward shipments was comparatively less during this year. The country had imported about 8 million tonnes of urea in the entire 2012-13 fiscal. Oman India Fertiliser Company (OMIFCO) is a joint venture between Oman Oil Company, Indian Farmers Fertiliser Cooperative Ltd and Krishak Bharati Cooperative Ltd. In 2012-13, 1.83 MT of urea was from imported from OMIFCO. Import of urea increased from 5.7 million tonnes in 2008-09 to 8 million tonnes in 2012-13. DAP and MoP witnessed a decrease in the same period (Fig 65).

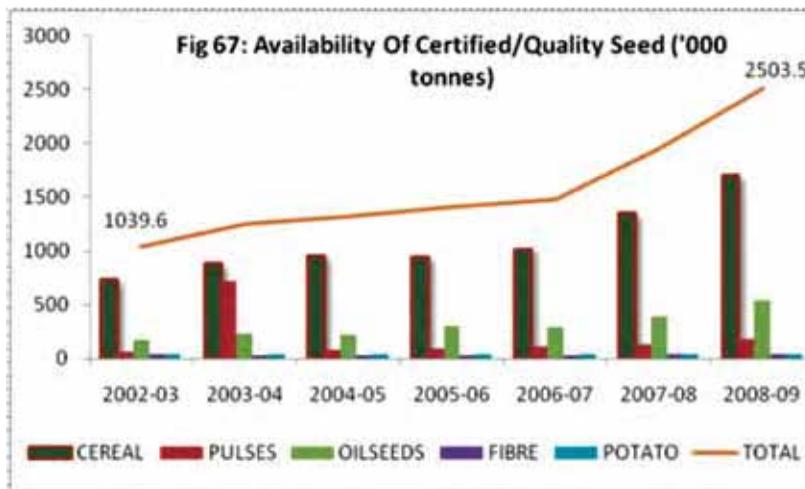
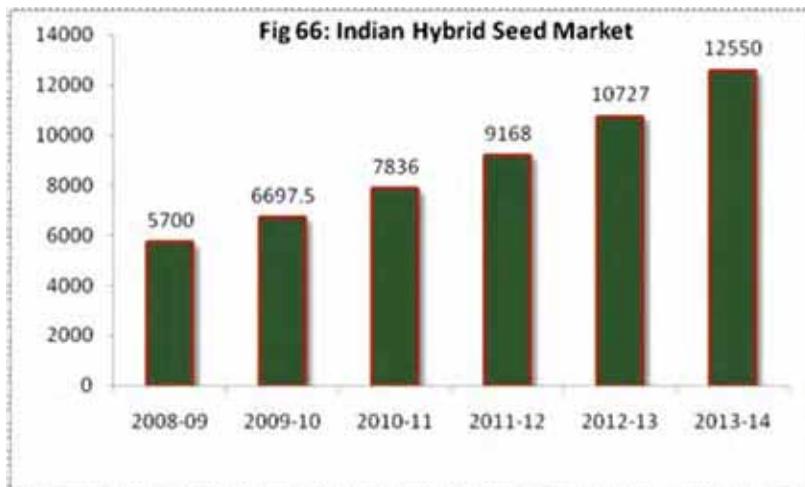


Indian Seed Sector

India, other than the government owned public sector seed organisations engaged in producing and selling seeds, currently there are over 500 private seed companies including a few multinational companies. The private sector seed companies in particular are mainly focussed on producing low volume, high value crops with the main effort on developing hybrid for oilseeds, maize, cotton, and vegetables crops. The private sector accounts for almost 70% of market turnover of processed seed in the country, whereas public sector has greater share in term of volume. Several companies have governmental recognized research and developmental units also. In the public sector, at present there are fifteen State Seeds Corporation and two national level seeds Corporations in the form of National Seeds Corporation of India and State Farms Corporation of India are functioning in the country. Besides, significant quantities of seeds are also produced by the State Departments of Agriculture, where the State Seeds corporations are not in existence. The Indian hybrid seed sector is believed to be growing at about 17.5% annually and has grown from estimated Rs 5700 in 2008-09 to an estimated Rs 12550 in 2013-14 (Fig 66).

The private seeds players in India are engaged in different related activities. Some of the companies are purely local and dealing predominantly with open pollinated varieties. There are also several Indian companies marketing hybrids sourced from abroad. Apart from these two types of seeds companies, currently there are also some companies who are developing, producing and marketing hybrids.

Following is a representation of some important dynamics and trends observed in the current seed industry



in the country:

- Several financially sound Indian and MNC large seed producers are eyeing to buy cash trapped smaller seed companies or companies with promising and strong product pipelines and with a sizeable geographical reach and distinct product portfolio
- The Indian hybrid seed market is composed of over 300 companies
- About 10 domestic and multinational companies constitute over 80 per cent of the total seed market
- Several seed companies were actively scouting for small- and medium-sized seed producers and going through multiple M&A

deals Nuziveedu Seeds, which bought two seed companies over the past three years is believed to go for more in the near future

- Companies are targeting to bring more value, increase market share and help in expanding presence either in the existing or newer hybrid product segments
- The major M&As in the seed industry in the past few years, include
 - o Rasi Seeds acquiring Bayer's corn seed business
 - o Delhi-based Crystal Crop Protection buying Rohini seeds
 - o French company Limagrain buying out vegetable seed firm Cen-

tury seeds

- Some companies are looking at partners not to infuse more equity but who could provide with innovative technologies to help strengthen research capabilities
- Few major Indian companies are also exploring opportunities to expand their presence in some of the untapped geographies and newer seed segments

Varietal Protection through Protection of Plant Varieties and Farmers Rights Act (PPV&FR), 2001-

A Case Study

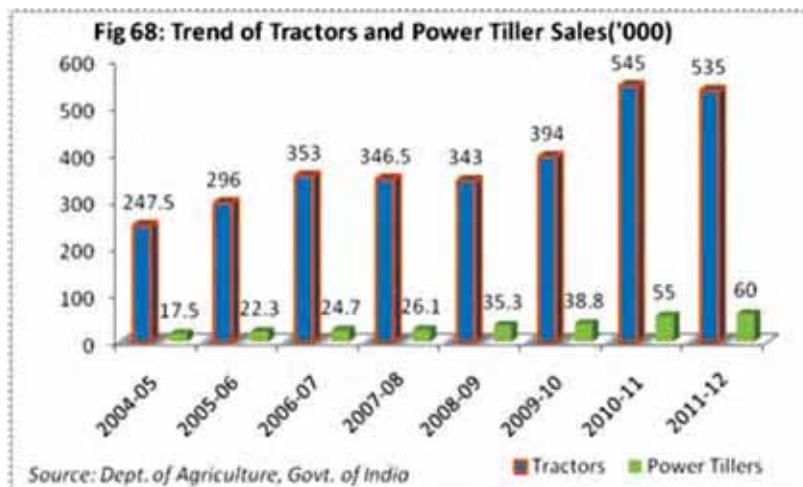
Genesis: India is signatory of World Trade Organization (WTO). In compliance to the TRIPS Agreement India established Protection of Plant Varieties and Farmers Rights (PPV&FR) Authority, under the Protection of Plant Varieties and Farmers Rights Act, 2001. PPV & FR Authority has become operational since 11th November, 2005.

Main Objectives of PPV&FR:

- Protection of plant varieties, the rights of farmers and plant breeders
- Encourage development of new varieties of plants
- Recognition and protection of the rights of farmers in respect to their contribution in conserving, improving and making the available plant genetic resources for the development of new plant varieties

Who can make an application to the PPV & FRA for registration of a variety:

- Any person claimed to be a breeder of a variety
- Any person being the assignee of the breeder of a variety
- Any farmer or group of farmers or community of farmers claiming to



- be the breeder of a variety
- Any University or publicly funded agricultural institution claiming to be breeder of a variety

Fees for Registration:

- For Extant variety about which there is common knowledge:
 - o Individual: Rs. 2000/-
 - o Educational: Rs. 3000/-
 - o Commercial: Rs. 5000/-
- New Variety/Essentially Derived Variety (EDV)
 - o Individual: Rs. 5000
 - o Educational : Rs. 7000
 - o Commercial: Rs.10000
- Farmers' Variety: Free of Cost

Status Crop wise (From 2007 till Aug 2014)

- Number of application from public institutions: 1314
- Number of application from private institutions: 2552
- Number of application from farmers: 3664
- Out of this, number of extant varieties were 2137, new varieties were 1598 and EDV were 137

Overall Impact of PPV&FR Act:

- With the protection given under PPV&FR Act, the private sector's

participation has increased in R&D of Open Pollinated varieties particularly in Rice and wheat.

- It has also facilitated larger participation of production and supply of improved seed by the private sector.
- New varieties combined with proper extension shall have significant effect on the growth of Seed Industry due to increased SRR

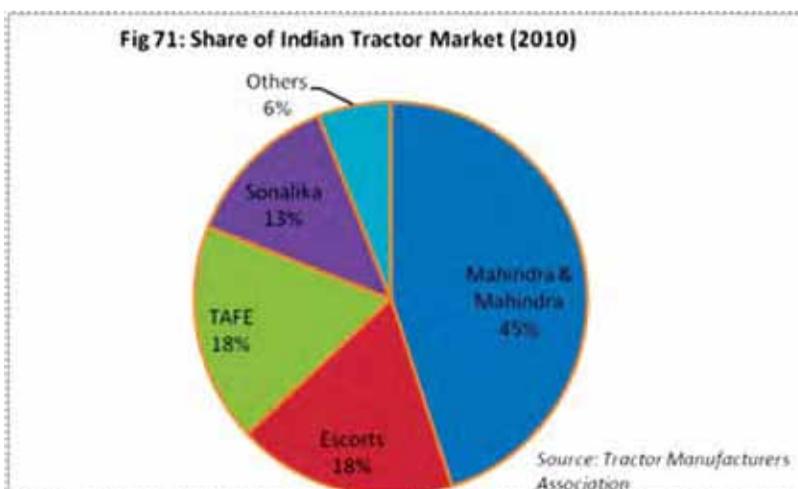
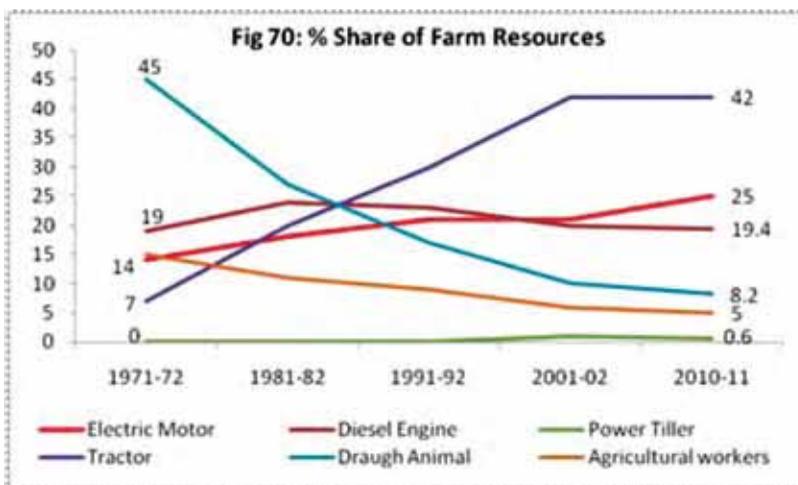
Farm Mechanisation

Agriculture operation in India has changed significantly in the last few decades with advances in science and technology. At the time of independence and also during the time when green revolution in India took place, large parts of the country had traditional agriculture that was mostly dependent on human labor and draught animals. Over the time, modern agricultural practices have been adopted in many places that are mainly based on machines especially high-speed, powerful tractors and its implements.

Tractors with mounted and trailed implements allow the mechanization of many agricultural operations. Agricultural mechanization has not only changed the characteristics of labor in agriculture India but also influenced

the workload. Amongst various positive aspects, agriculture sector of the country has witnessed a sustained shift from use of human and draft animal power to adoption of farm mechanization. Mechanical power is proving before the farming community to be more economical, efficient and easy. However, the increase in adoption of farm mechanization is not uniform across the country and a scenario prevails where some states has made remarkable advancements in the area where as several other states are still lagging behind. Though the agriculture sector has witnessed greater adoption of farm mechanization, there is still a lot of scope left to increase the intensity of mechanization across various states.

Government of India has drawn up elaborate plans to boost the intensity of farm mechanisation in the country. Technologies being developed by institutes like ICAR, CSIR and those identified from within the country and abroad for areas like cultivation, harvesting and post harvest management. Government is promoting farm mechanization by making agricultural equipment available among farmers at cheaper rates. A level of 25-50% subsidy on procurement cost is made available under “Macro Management of Agriculture (MMA)” scheme for different categories of equipment.



The subsidy on tractors and power tillers is available on the models approved by the department under institutional financing. Besides tractors and power tillers, combine harvesters are also available to the farmers as per approved pattern of subsidy. As an individual farmer may not be in a position to purchase high cost equipment on his own, Self Help Group of farmers (SHGs), user groups, cooperative societies of farmers etc are also made eligible for assistance under the programme. Various coordinated activities like these have resulted in increase in total farm power availability from 0.295 kW/ha in 1971-72 to 1.71 kW/ha in 2010-11 (Fig 70).

Indian farm machinery industry

is a heterogenous mixture of big and small players. From multinational companies like John Deere, big Indian players like Mahindra and Mahindra to various small and medium enterprises are contributing to the growth of the farm machineries market. Clusters like Karnal in Punjab are striving with various small and medium enterprises. Table 13 provides an idea about the status of farm machinery industry in India.

The total Indian farm machinery sector is estimated to be anything in the range of Rs 1110 Crores to Rs 1350 Crores. The export volume is estimated to be between Rs 50 to 100 crores and the import between Rs 30-70 crores.



R. G. AGARWAL

ACCELERATED TRANSFER OF TECHNOLOGY FOR SAFE AND JUDICIOUS PESTICIDE USE FOR ENHANCED FOODGRAINS PRODUCTIVITY

India achieved more than five-fold increase in foodgrains production from 50.8 million tonnes in 1950-51 to 264.38 million tonnes in 2013-14 (Agricultural Stat. at a Glance-2013), which itself connotes that by yield-augmenting technological change (blend of improved technology, adoption of location-specific 'package of improved practices', accelerated transfer of technology, favourable political climate, and necessary inputs including crop protection, etc) such an appreciable growth is achievable. Though the total foodgrains production increased, yet per hectare yield did not increase at the same pace due to 'technology fatigue'.

Several research studies in the Indian context have shown the significant positive contribution of chemical pesticide in the increase in productivity and production of foodgrains.

CHALLENGE OF PRODUCING MORE FROM LESS FOR MORE

There was no single panacea for overcoming

all the constraints posing major challenge to 'produce more from less for more' for sustainable foodgrains production and nutritional security. Therefore, several strategic interventions are necessarily required to be implemented in parallel and in series.

Assured Pesticides Use-More Area and Crops Coverage

Key-Role during Green Revolution

The benefits of crop protection chemicals for enhancing and protecting crop productivity is difficult to separate from the effect of high yielding varieties, which are responsive to chemical fertilizers and irrigation. Undoubtedly, the pesticides umbrella played an important role in safeguarding the yield potential of high yielding varieties and hybrids, which was practically impossible in its absence. The question for urgent consideration is, Whether India can afford to forego the productivity gains during the green revolution era by doing away with chemical pesticides and plummeting



foodgrains, pulses and oilseeds yields to a level of again 'ship-to-mouth situation'?

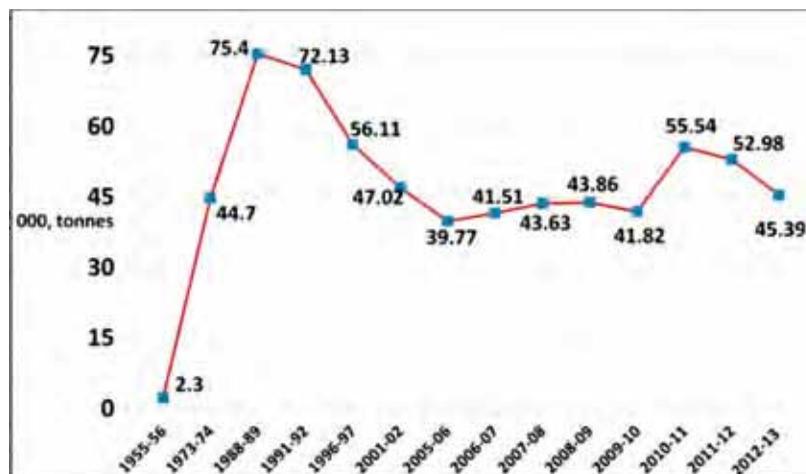
Losses caused by different pests and economic return of pesticide use

The loss in crop yields caused by insect pests, diseases and weeds are quite high in the Indian context. The highest loss (CPCB, 2007) was due to weeds (28%), followed by plant diseases (25%), insects (23%), in storage (10%), and rats (8%). However, the extent of loss could vary depending upon the climate, crop and extent of pests attack. As per IARI (2008), highest cost: benefit ratio of 1:28 for chemical control was in groundnut, followed by in sugarcane (1:13), mustard (1:12), sunflower (1:8), cotton/rice/vegetables (1:7), and in pulses (1:4). In general, it is estimated that **every rupee spent on plant protection saves on an average the produce worth five rupees**. Therefore, the decision to use or not to use chemical pesticides is of the farmer who often takes a rationale decision based on his management options.

Pesticides Registered in India vis-à-vis other Countries

In India the number of pesticides registered by CIB & RC (<http://www.cibrc.nic.in>) was only 248 (as on 14 May 2014), however in Europe there were 600 molecules, in Pakistan -495, and in USA over three times that of India. Today, the cost of delivering a molecule from the laboratory to the farmers is estimated to be around \$ 250 to 275 million, spread over 10 years (Proc. & Recommendations, National Seminar 2011). In order for the Indian farmers to be not kept deprived of the new molecules, the Central Insecticides Board & Registration Committee (CIB & RC),

Pesticide Consumption (TG) over the Years



of the Ministry of Agriculture, Govt. of India may introduce a system of 'fast-track registration' of such eco-friendly molecules already registered in developed countries. A regular complete relook of the rules & regulations for registration from all aspects to make it more user friendly is urgently called for.

Initiatives by Pesticide's Industry for Introduction of Eco-friendly Molecules

The pesticide industry is continuously introducing low dose active pesticides, and Eco-friendly formulations, which are safe to non-target organisms and have high bioactivity against the target pests at low dosages, greater shelf-life, little or no persistence in environment, eco-friendly manufacturing technology, and low risk to contaminate ground water, etc. The Industry has introduced several pesticides which are very effective against their target pests even at a very low dose of a.i. Earlier Dimethoate was used at 1250-1500 ml/ha against sucking insect pests while now new insecticide Imidacloprid, Thiamethoxam and Acetamiprid give effective control of these pests even at 100-150 ml/g/ha.

There is a shift in pesticide formulations to make them more eco-friendly. Earlier most of the pesticides were available as Emulsion Concentrate and Wettable Powder but slowly a new trend has emerged like Wettable Granules, Water Dispersible Granules, Soluble Granules, Suspension Concentrate, Soluble Liquids, Suspo Emulsions, Capsule Suspension, and off late ZC (Oil Dispersion & Dry Flowable). These concentrates are a step forward towards IPM as some of them are quickly biodegradable while some are effective in small quantities.

Pesticides Consumption Pattern

Pesticides consumption in India is only 0.57 kg/ha, while it is 17 kg/ha in Taiwan, 11 kg/ha in Japan, 6.6 kg/ha in Korea, and 2.25 kg/ha in USA. In comparison to all countries, India is at 48th position in the world. Plant protection chemicals in India are being used in about 30 per cent of the total arable area.

The pesticide consumption got impetus with the introduction of first green revolution and the consumption in 1973-74 was 50432 tonnes as against 2353 tonnes in

1955-56. The maximum consumption of 75418 tonnes was in 1988-89, however, it stabilized around 40000 - 45,000 tonnes during 1997-98 to 2004-05, and again showed a rising trend during 2010-11 and 2011-12, while there was decrease in 2012-13. The demand of pesticides is cyclic in nature and is mostly influenced by timely rainfall and its distribution. Due to intensive farmer's education on judicious use of pesticides, there had been expansion in area under assured crop protection.

State-wise Consumption

The state wise consumption is highly skewed as Five States- AP, Maharashtra, Punjab, UP, and Haryana together consumed 72% of the total consumption during 2012. In order to provide assured plant protection coverage to a large area to save the colossal loss of an estimated Rs 3 lakh crore per annum, a favourable policy climate need to be created to expand the use of pesticides, though judiciously, in other States as well.

Crop-wise

The pesticides consumption is also highly skewed in favour of a few crops only. Nearly half of the pesticides are applied to Cotton, followed by 18 per cent in Rice, and eight per cent in Plantation Crops. Since area under fruits and vegetables is fast increasing, intensive education and training programmes are required for the farmers to encourage judicious and safe use of this very essential input to enhance productivity and production.

Need for Accelerated Transfer of Technology

As per a study by the National Sample Survey Organization (2005) of the



Govt. of India, nearly 40.4 per cent of farmers access different sources for getting awareness about new agriculture technology. Further, in the area of crop protection, this percentage was only 24. Another common observation was that the State Extension Services alone were not able to meet the technology needs of the farmers and therefore, it was necessary to have 'multi-agency 'dispensation of agricultural Information Services to the farmers.

Farmers often in their eagerness to control pests are either overusing, not following proper spray schedule and spray technology, or don't allow prescribed cooling period after spray before harvest. The person undertaking spraying operation, due to ignorance / illiteracy, does not read and follow the instructions, etc. Thereby, there are issues of pest resistance, and pesticide residue in the foodgrains, vegetables, fruits and environment. Several reasons for this have been reported including lack of credible information from the agri-input dealers; spray often carried by unskilled labour on contractual basis, spurious and misbranded pesticides. Under such a scenario, it is all the more important that the Public and Private sectors intensify their reach to encourage adoption of 'Good Agricultural Practices', training of field extension personnel and farmers, skill up-gradation of 'agri-input dealers' etc.

Public Sector

In the States Extension Services, one major constraint was a large number of unfilled vacancies. Further,



extension personnel are engaged in multiple roles, leading irregular or no contacts with farmers. Although farmers require information from seeding to production to marketing, the public extension system largely concentrates on on-farm activities related to enhancing production.

In the plant protection sector, a centrally sponsored scheme on Promotion of IPM is in operation since 1991, having mandate of Training of Master's Trainers, Extension Personnel and farmers. Directorate of Plant Protection, Quarantine & Storage, Ministry of Agriculture, Government of India and the State Departments of Agriculture do have the responsibility of 'Weekly Pest Forewarning', issue of 'Do's and Don'ts for safe use of pesticides', 100 per cent seed treatment campaign, etc. However, much needs to be done to make them operational for fulfilling the mandated activities.

Extending Reach with Richness: Since State Extension Services are neither available nor competent enough to meet the knowledge demand, it is necessary to either provide technology backstopping and/or have accelerated transfer of technology on judicious use of

pesticides by having public-private partnerships. At present, some programmes on safe and judicious use of pesticides are individually being implemented by the government as well as the Pesticides Industry.

Private Sector

Many extension initiatives in India emerged without any active State support. Some such programmes include field extension activities by agri-input companies (seeds, fertilizers, pesticides, farm machinery and implements), Web-based knowledge providers, Farmer's Organizations /Federations, NGOs, Credit Delivery, Consultancy Services. As is the common practice, the Private Sector Extension is largely limited to the area of their specialization / product, instead of the Integrated Crop Management (ICM), because of their specialized training or Company's requirement. It is necessary to have better integration skills as the farmers operate in a farming system requiring knowledge of different components from production to marketing.

Initiatives by Dhanuka Agritech Limited

The Dhanuka Group is a leading pesticide manufacturing company with a pan India presence. Since the beginning, its large network of field staff is focusing on ICM through training, education, on-farm demonstrations, field exhibitions, face-to-face contacts, advisory services, etc. to assist them in diagnosis of insect pests, diseases and weeds, crop specific pest management, 'Good Agricultural Practices', appropriate spray technology and skill learning, mass awareness campaigns through Press & Media for accelerated reach.

Public - Private partnership for Improved Technology Reach: Recognizing the important role played by agri-input dealers as first step agriculture technology information provider, National Institute of Agricultural Extension Management (MANAGE), Hyderabad have started an off-campus Diploma in Agricultural Extension Services for Input dealers (DAESI) in 2003 and Dhanuka Group was the first to join hands with MANAGE by providing financial support to meet 50 per cent of the fee for training of Agri-Input Dealers of East Godavari District in Andhra





Pradesh. Since MANAGE alone could not reach all the Dealers, Dhanuka Group took initiative and under PPP with the Anand Agricultural University, and Navsari Agricultural University in Gujarat started similar out-reach Diploma for Agri-Input Dealers in 2012 and 2013 respectively.

Blending Traditional Extension Methods with Modern ICT

The present-day transfer of agriculture technology is not entirely focused on one-to-one approach but also on one-to-many so that the message reaches quickly to even the otherwise unreached places. Thus while creating a dynamic content which has more visuals and interactive, the modern Information Communication technology has a significant role to play. The e-modules, interactive websites, messages through mobiles, time sensitive field surveillance reports for onset of pests, etc. offer a wide and credible support for accelerating transfer of technology. Since a large Indian population is directly involved in agriculture, it is through strong agriculture knowledge back-

stopping of agricultural specialists/ extension personnel and farmers that we can look forward to achieve quantum jumps in food production, which in turn, will contribute to inclusive growth and bring a sea-change in the Indian Economic Scenario.

Overcoming Misconceptions about Pesticides

Sometimes there is News about pesticides residue in fruits, vegetables, etc. The mere presence of pesticides in trace amount does not mean that the product is unhealthy. The Ministry of Agriculture, Government of India had replied in the Lok Sabha and Rajya Sabha to starred and unstarred questions on 10 May 2007 and on 27 April 2012. The Government of India has set-up a Division which continuously monitors pesticides residues in fruits and vegetables available in the markets across the country. In order to educate the farmers about adoption of 'Good Agricultural Practices' with a focus on Integrated Crop Management need to be intensified by implementing time-bound programme.

Summing-Up

If the country has to ensure sustainable foodgrains production and meet the nutritional requirements of its burgeoning population, assured crop protection holds the key. The scenario of pests and their natural enemies has undergone a considerable change after green revolution, and is likely to continue changing due to intensive agriculture, diversification in farming, introduction of exotic plant species and new cultivars, and genetic manipulations for development of new plant types for high yield, better quality and tolerance to biotic and abiotic stresses, etc. Therefore, the complexity of pests is likely to increase, with more frequent pest outbreaks in future. Climate change is likely to pose a potential threat. There were both strengths and opportunities for further updating the existing approaches of pest management in the country. The country needs to adopt a holistic approach towards ICM and initiate more intensive pro-active steps like accelerating registration process of new molecules, higher allocation of resources for R&D to the ICAR Institutes and SAUs, incentives to the Pesticides Industry for more R&D, education and training of Agri-Input Dealers and farmers, intensive on farm demonstrations on judicious and safe use of pesticides, enhanced exposure to the State Department personnel about new eco-friendly molecules, assuring availability of quality products, etc. An effective control of weeds and seed and soil-borne diseases alone offer enormous opportunity for significant yield gains in foodgrains and pulses.

*The author is Group Chairman,
Dhanuka Agritech Limited.*



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SATISH CHANDER

Issues Affecting Health of Indian Agriculture and Fertiliser Industry

India witnessed remarkable growth in fertiliser consumption particularly after the introduction of high yielding varieties of rice and wheat in mid sixties. The fertiliser (NPK) consumption increased from 0.8 m.t. in 1965-66 to 28.1 m.t. in 2010-11. Increased use of fertiliser played a determining role in India's self sufficiency in foodgrain production. The country emerged as the second largest consumer of fertilisers in the world. The Indian fertiliser industry has made significant contribution in this achievement by performing the onerous task of arranging supplies through production and imports for timely availability of farm nutrients to farmers. The domestic fertiliser industry has also been helping the government in reaching fertiliser subsidy to millions of farmers without any disbursement cost to the government. However, the industry is now finding it difficult to continue its operations due to unprecedented liquidity crisis.

The fertiliser industry is facing constraints in maintaining viable operations due to difficulties in various areas particularly fertiliser pricing policies and their implementation; availability of feedstock and raw materials; and an ever increasing interest cost due to delay in payment of subsidy. The lack of reforms on policy front has not only put the future of fertiliser industry in danger but has also put the fertiliser supply security of the country under shadow of doubt. More importantly, the current situation has led to imbalanced use of primary nutrients harming the soil health in process.

Lack of Policy Reforms in Fertiliser Sector

The fertiliser sector, which provides the vital input of plant nutrients to Indian agriculture, has often been neglected in introduction of economic reforms right from the beginning. Government of India expressed its intention a number of times to bring reforms in the sector with ultimate objective of payment of subsidy directly to the farmers. However, the progress on reforms in fertiliser sector has been dismal. The government took a significant step forward in liberalizing the phosphorous and potassium (P&K) fertiliser sector by implementing Nutrient Based Subsidy (NBS) Policy w.e.f. 1st April, 2010. However, the full benefit of NBS could not accrue as urea the most significant fertiliser, has not been brought under the NBS policy. Urea sector continues to remain fully controlled with unrealistic low retail price. Urea units are not able to produce to their full capacity due to very unrealistic policy parameters. Even in P&K fertiliser sector, there are unwarranted and unreasonable interventions in implementation of NBS policy which has affected the production, import and sale of P and K fertilisers.

Threat to Viability of Industry

The pricing policies in 1970s and 1980s encouraged fertiliser industry to make investment both for increasing capacity and improving efficiency. India became self sufficient in production of urea in 2000-01. However, the changes in urea policy parameters which started

Growth in Production and consumption of N and P₂O₅

(million tonnes)

Year	N			P ₂ O ₅		
	Production	Consumption	Gap	Production	Consumption	Gap
2000-01	10.9	10.9	-	3.7	4.2	0.5
2005-06	11.3	12.7	1.4	4.2	5.2	1.0
2008-09	10.9	15.1	4.2	3.4	6.5	3.1
2012-13	12.2	16.8	4.6	3.8	6.7	2.9
2013-14 (P)	12.4	17.0	4.6	4.0	5.6	1.6



in 1990s have been detrimental to the viability of the industry. Fertiliser industry continued to suffer on account of inadequate availability of natural gas from domestic sources. Gap in availability is filled through high cost imported LNG. Limitation in availability of intermediates (ammonia and phosphoric acid) is also experienced by some of the DAP / NPK plants leading to loss in production and profitability of domestic industry. It has affected the health and growth of the industry. There has been no new fertiliser plant commissioned since the year 2000 due to environment of uncertainty in fertiliser sector. It is worth to mention here that the sole objective of changes in policy parameters was to somehow reduce subsidy without addressing the real issues of increasing cost of inputs, increase in consumption and stagnant retail prices of fertilisers.

New investment policy notified on 2nd January, 2013 addressed the issue of increase in gas price by allowing floating floor and ceiling linked to delivered gas prices. The revised policy received encouraging response from the prospective investors. A number of fertiliser companies intimated their intent for setting up additional urea capacity to the Government. However, the revised policy has been put on hold by the Government for further revision which is blocking fresh investment.

Liquidity Crisis

Fertiliser industry is reeling under severe liquidity crisis and it is mainly due to under provision of fertiliser subsidy in Union Budget. Insufficient allocation of funds and roll over of unpaid subsidy to the next year has become a common practice rather than an exception. The amount of carry forward has been increasing year after year resulting in tremendous pressure on the financial

position of fertiliser companies. The amount of unpaid dues has escalated from about Rs. 7,200 crore at the end of 2010-11 to Rs. 22,000 crore by the end 2011-12 and Rs. 32,000 crore at the close of 2012-13. Subsidy Allocation of Rs.72,970 crore for 2014-15 is grossly inadequate compared to requirement of over Rs.1.15 lakh crore. Funds will again be exhausted in the middle of the year. The industry will be left with no option but to pursue with the government for allocations through supplementary grants or for bank loans as a last resort to run the business.

In addition to inadequacy of budget allocations, non updation of costs and cumbersome payment procedures also hamper the payment of legitimate dues of the industry in time. The unnecessary expenditure of industry on account of interest on



working capital has gone up manifold in last few years.

Scarcity of Domestic Gas

Inadequate availability of domestic gas for manufacture of fertiliser is posing a constraint in maximising production from already installed capacity. Fertiliser industry is already using almost 35 per cent imported LNG. Efforts should be made to reduce use of LNG in order to reduce cost of production, and hence fertiliser subsidy. Pricing of domestic gas has been subject of much debate in last few months. It is imperative

that domestic natural gas is priced in a manner that domestic industry remains competitive and continues to operate at optimum level. India's over all dependence on import of fertilisers and fertiliser raw materials is of the order of 68 per cent. It may be mentioned that India is the second largest consumer and the largest importer of fertilisers in the world. Such a high level of dependence on import for a country of India's size is not desirable.

Increasing Dependence on Imports

The adverse operating environment has affected the production of fertilisers during last 15 years. The production of nitrogen (N) has increased by merely 1.5 m.t. since 2000-01, whereas consumption increased by 6.1 million tonnes. The production of P2O5 has registered a marginal increase of 0.5 m.t. between 2000-01 and 2005-06, and thereafter there was drop in P2O5 production.

The slow growth in production coupled with sharp increase in consumption has increased the gap between production and consumption leading to increased dependence on imports. India was self-sufficient in production of urea in 2000-01. Thereafter, the quantity of import kept on increasing, and touched 8.04 million tonnes in 2012-13. The cost of imported urea has been much higher than the cost of domestic urea. The import of DAP

Increasing dependence on fertiliser imports

Year	Urea	DAP	MOP
2000-01	0.00	0.86	2.65
2005-06	2.06	2.44	4.58
2010-11	6.61	7.41	6.36
2011-12	7.83	6.91	3.98
2012-13	8.04	5.70	2.50
2013-14	7.09	3.26	3.18

(Quantity in million tonnes)

Price Ratio of Urea, DAP and MOP

* = Average MRP

Year	Urea	DAP*	MOP*	Ratio			
	MRP (Rs. / tonne)			DAP :Urea		MOP: Urea	
2009-10	4830	9350	4455	1.94	1	0.92	1
2010-11	5310	10150	5055	1.91	1	0.95	1
2011-12	5310	15525	9040	2.92	1	1.70	1
2012-13	5360	24000	17000	4.48	1	3.17	1
2013-14	5360	22500	16000	4.20	1	2.99	1

also increased from 0.86 m.t. in 2000-01 to 7.41 m.t. in 2010-11. The country imported a record level of 6.36 m.t. of MOP in 2010-11. India is now the largest importer of fertiliser and fertiliser raw materials in the world. The import of DAP and MOP has dropped after 2010-11 due to decline in demand after the implementation of NBS for P&K fertilisers.

Imbalanced Fertiliser Use

The pricing policies for fertiliser sector were formulated and implemented in 1970s with the main objective to promote increased and balanced use of fertilisers. The policies worked well during 1970s and 1980s. However, the government decision of sudden decontrol of phosphatic and potassic fertiliser in August 1992 distorted NPK consumption ratio from 5.9:2.4:1.0 in 1991-92 to 9.5: 3.2:1 in 1992-93. Government had to introduce adhoc concession scheme on P&K fertilisers to improve the NPK ratio. The country took 15 years to reach again the NPK consumption ratio of 5.9:2.4:1.0 in 2006-07. Of late, the policy decision of selective implementation of Nutrient

Growth in Fertiliser consumption in India

YEAR	N	P2O5	K2O	Total	NPK Use Ratio
	(million tonnes)				
2009-10	15.6	7.3	3.6	26.5	4.3:2.0:1
2010-11	16.6	8.0	3.5	28.1	4.7:2.3:1
2011-12	17.3	7.9	2.6	27.8	6.7:3.1:1
2012-13	16.8	6.7	2.1	25.5	8.2:3.2:1
2013-14	17.0	5.6	2.1	24.7	8.3:2.7:1

Based Subsidy (NBS) scheme on P&K fertilisers w.e.f. 1.4.2010 has again affected the balanced fertilisation programme in the country. It has created distortion in nutrient prices.

The use of primary nutrients has become highly imprudent in favour of excessive use of N compared to use of P&K. This has happened due to continuous increase in prices of P&K fertilisers and stagnant price of urea for the last five years. There has been drastic reduction in subsidy on P&K fertilisers and massive increase in subsidy on urea. The present subsidy level on urea is about of 70per cent of its cost of production compared to 35per cent on P&K fertilisers. This has distorted the ratio in selling price of DAP to urea from 2:1 to 4:1.

The distortion in retail prices of N, P and K fertilisers is reflected in nutrient consumption pattern. There has been sharp drop in consumption of P and K fertilisers since 2010-11. NPK consumption ratio distorted from 4.3:2.0:1 in 2009-10 to 8.3:2.7:1 in 2013-14. This has happened due to selective application of Nutrient Based Subsidy (NBS) scheme only to P&K fertilisers and keeping urea out of its ambit. Government of India is providing fertiliser subsidy to the tune of Rs. 70,000 crore annually to increase agriculture productivity. But the subsidy policy is promoting imbalance

use of nutrients (N,P&K) defeating the very purpose of providing subsidy on fertilisers.

Way Forward

It is mentioned here that India is a developing country with 1.23 billion population. Ensuring food security of second largest country in the world is necessarily the first priority of the government. For continued food security, increasing amount of fertilisers has to be made available at affordable prices to the farmers.

The industry has rendered the yeoman service in reaching the fertiliser subsidy to the 138 million farmers for last 30 years without any cost to the government. It is high time government shoulders this administrative responsibility of disbursing subsidy directly to farmers. Till it does so, government should ensure timely payment of industry's legitimate dues both by making adequate provisions in the budgets and promptness in computation, notification and disbursement of subsidy with simplified payment procedures.

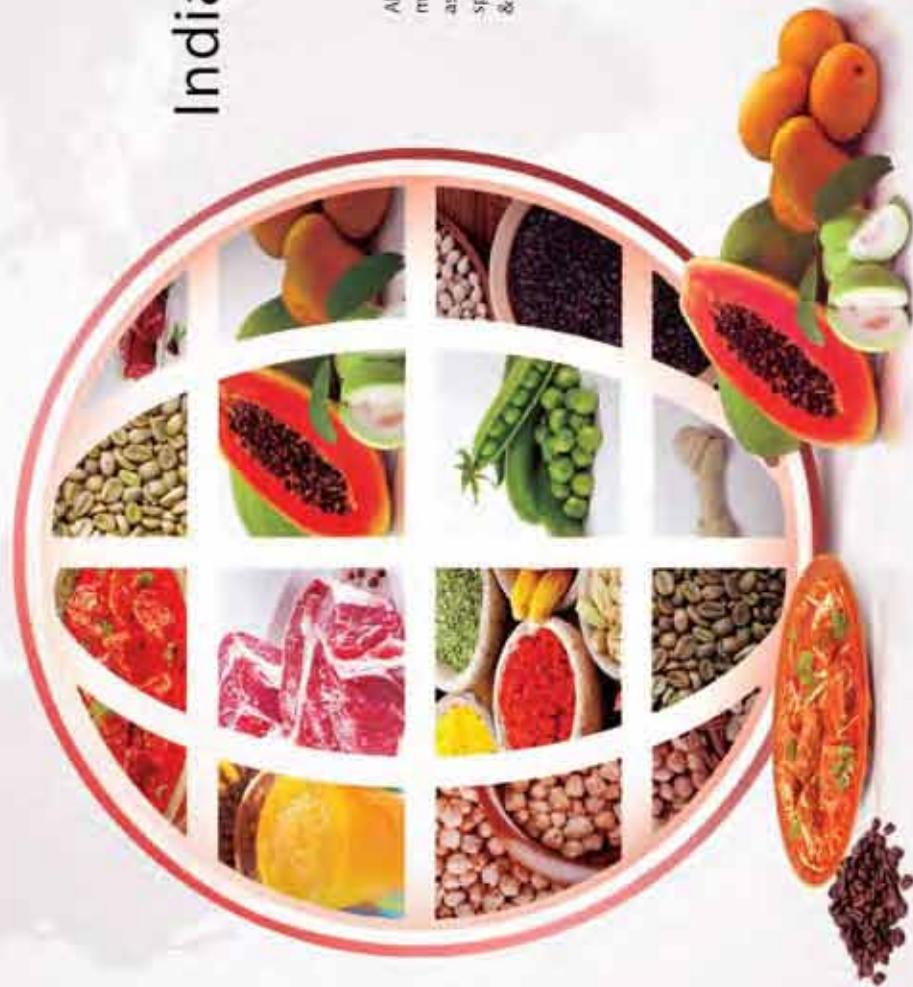
Fertiliser industry hopes that the new government would implement its intent to bring reforms in fertiliser sector. Reforms are necessary in the interest of balanced fertilisation and health of Indian soils, for restoring health of existing industry and to inspire confidence for investment in new capacity. In the absence of any progress in reforms, even the present manufacturing capacity may become nonproductive, and thus increasing our dependence on imports. This will expose the country to vagaries of volatile international markets and will threaten the fertiliser security, food security and economic viability of Indian agriculture.

The author is Director General, The Fertiliser Association of India, New Delhi

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PRATAP NARAYAN

URGENCY OF A RATIONAL FERTILIZER PRICING AND SUBSIDY POLICY

The “unsustainable and unaffordable burden of fertilizer subsidy” continues to be in focus and various experts and media continue to call for its drastic reduction, if not complete elimination. One of the myths being continuously propagated is that the fertilizer industry is the beneficiary of the subsidy to cover its inefficiency and not the farmers. In the process, some essential fundamentals are forgotten.

Who is the beneficiary of fertilizer subsidy?

Basically, there are three parties involved, namely resource poor small and marginal farmers from the point of view of affordability, Industry from the point of view of its viability and the Government from the point of view of subsidy. Out of this, any two interests can be taken care of:

(i) If farmers cannot afford cost based price and industry has to be viable, there is no alternative to government, but giving subsidy to the extent of difference between farmer price fixed by it and the reasonable cost of production/import and distribution also fixed by it. In such a situation, the industry is only used as a channel to route subsidy to benefit farmers by supplying material below its reasonable cost;

(ii) If the Government cannot afford subsidy and the industry has to remain viable, there is no alternative to the farmer but to pay the cost based price; and

(iii) If the farmer cannot afford cost based price and the Government cannot afford subsidy, there is no alternative to industry (including import) and it will be rendered unviable.

There is no magical formula under which the farmer does not pay cost based price, the government does not subsidise and the industry/import also remains viable.

Is direct payment of subsidy to farmers practicable and more cost effective?

The second issue is with regard to the suggestion advocating transfer of subsidy directly to the farmers, instead of the present system of routing through the suppliers (producers/importers) by controlling the market price at an affordable level and making good the difference between reasonable cost of production/import and distribution. This ignores following implications:

- Lack of infrastructure, like banking facilities, in rural areas; in India, there are some 135 million farming families (out of which about 85 per cent are small and marginal farmers (cultivating between 1 to 2 ha and less than 1 hac. land respectively) spread over some 600,000 villages.

- Even if it is possible to do so, what will be the cost of administration as compared to the



Item	Size of farm (hectare)				
	Below 1	1-1.99	2-3.99	4-9.99	10 & above
1. Distribution of cultivator households (%)	63.90	18.65	11.15	5.30	1.00
2. Gross Area cultivated (%)	23.42	20.95	22.95	22.46	10.22
3. Fertilizer consumption to total (%)	29.03	23.84	22.05	18.95	6.13
4. Consumption/hac of gross cropped area (Kg)	139.74	128.33	108.34	95.13	67.64

present system where a small office in Delhi makes payment to about 100 odd plants/importers on receipt of monthly bills based on predetermined amount representing the difference between farmer price fixed by Government and reasonable cost of production/import and distribution also fixed by the Government.

- With the shifting of payment of subsidy from industry to the farmers directly, the industry/importers will issue material to the distribution channel at the full cost and the latter will have to finance the higher inventory carrying cost. This will discourage small retailers spread in the interior from surviving in the business particularly where supply is continuous but off take has acute seasonality.

- At what stage will the subsidy element be transferred to farmers account? If it is before he purchases the product, where is the guarantee that he will not use this money for his other pressing social needs? If it is after purchase on production of the proof of purchase, where does he get the resources to do so in the first instance before receiving the intended subsidy?

- How will the inadequacy of budgetary provision for fertilizer subsidy be tackled? Even today, there is gross under provision from year to year and industry faces serious liquidity problems. How will the majority of resource poor farmers be able to purchase fertilizers in the absence of non payment of subsidy component in time due to inadequacy of budgetary provision?

Are only so-called rich farmers beneficiary of fertilizer subsidy?

It is generally argued that the benefit of the present subsidy accrues mainly

Year	MRP Rs/Kg of nutrient*			N:P:K Price ratio	N:P:K use ratio
	Nitrogen	Phosphate	Potash		
1991-92	7.17	8.15	3.03	2.37: 2.69: 1	5.9 : 2.4: 1
2003-04	10.50	16.22	7.43	1.41: 2.18: 1	6.9 : 2.6 : 1
2012-13	11.65	47.62	28.33	0.41: 1.68: 1	8.2 : 3.2 : 1

* Through Urea, DAP and MOP

Year	MRP of Urea (Rs/MT)	Gas price at land fall (Rs/1000 M3)	RLNG (Rs/1000M3)	Naphtha Price (Rs/MT)
2002	4830	2850	NA	14370-15240
2009	4830	3200	13796-15204	22048-37606
2012	5360	8387	21469-31879	47548-61807

Year	Import of Urea (mil.MT)	Subsidy on imported Total (Rs crores)	Urea Rs/MT
2005-06	2.06	1211	5879
2008-09	5.67	10079	17776
2012-13	8.04	15398	19152

Country	Total farm subsidy (Million \$)	Subsidy (\$)/capita	Subsidy (\$)/hac.of arable land
European Union	103,181	205.48	864.71
Japan	61,098	483.00	13395.75
USA	30,579	97.67	187.87
India (food & fertilizer)	30,595	24.64	181.42

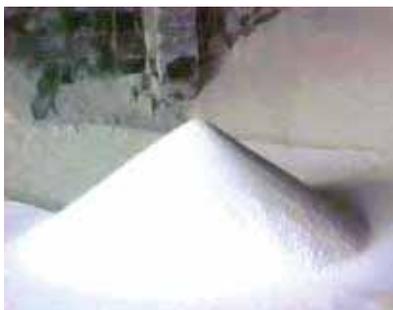
to the rich farmers as the poor small and marginal farmers use only limited quantity of fertilizers. First, this is contrary to facts as can be seen from the following particulars of fertilizer consumption by size of Farms (2006-07):

It will be seen that the cultivated area and fertilizer consumption, percentage as well as per hectare, is much lower in respect of the so-called rich farmers as compared to resource poor marginal, small and

medium farmers. Second, in fixing the procurement price, the price of fertilizers is taken into account and, if the so-called rich farmers are denied the benefit of subsidy on inputs, either the procurement price will have to be increased, in turn, affecting the poor consumers of foodgrains, or their operations will become unremunerative.

Malady of imbalanced use of nutrients

Another fundamental issue is about the relative pricing of the nutrients, particularly primary nutrients N, P and K. Notwithstanding the oft repeated laments of the Government about imbalanced use, particularly skewed in favour of urea, the pricing policy followed over the last few years by keeping urea price fixed while the price of phosphate and potash has





been allowed to increase significantly is itself responsible for encouraging such imbalance. This will be clear from the following particulars of relative price and N:P:K use ratio:

Clearly, if balanced use of nutrients has to be promoted to increase productivity, the comparative nutrient price ratio has to sub-serve this objective. The policy followed by Government of keeping urea price low and allowing runaway increase in the price of other products supplying Phosphate and Potash is solely responsible for skewed consumption pattern affecting agricultural productivity.

Causes for sharp increase in fertilizer subsidy

First, the consumption of nutrients has increased by about 75 per cent between 2002-03 and 2011-12 and consequently even if the subsidy per unit of product had remained the same, the overall outgo would have increased correspondingly. Second, while the Government has allowed sharp increase in feedstock prices, the consumer price of urea has not kept pace with the widening gap between the MRP and reasonable

cost of production, as can be seen from the following particulars, over which the industry has no control:

Even in respect of phosphatic fertilizers, there was sharp increase in C&F price for Ammonia from \$180-348/MT in 2006 to \$250-705/MT in 2012 and phosphoric acid from \$340-400/MT in 2006 to \$740-980/MT in 2012, aggravated by depreciation of rupee from 42.25 to 47.92 during the period. Even rail freight has nearly doubled during the period. Consequently, sharp increase in subsidy is entirely of Governments own making.

Is increasing import a viable alternative?

India being one of the largest importers, its entry in the international market led to increased international price leading to increased subsidy as can be seen from the following particulars:

With higher import due to stagnation in domestic production in the face of increasing consumption, the international price and consequently the level of subsidy will shoot up. Consequently, increasing

import does not appear to be a viable option.

Farm Subsidies a universal phenomenon

Farm subsidies are universal and not peculiar to India and the level of subsidy in developed countries is much higher than in India and that too not for increasing production but to subsidise exports or reduce production while ensuring high income to their farmers for whom it is a commercial operation, unlike in India where in 2011 are relevant in this regard:

The only way to protect the resource poor farmers is to give them inputs at affordable prices which, in turn enables supplying agricultural products to poor consumers at reasonable prices.

It is hoped that a conducive fertilizer pricing and subsidy policy will be formulated by the new Government keeping in view the above fundamental points.

The author is former Director General, Fertilizer Association of India

*Micro Irrigation- Path to
“More Crop per Drop”*

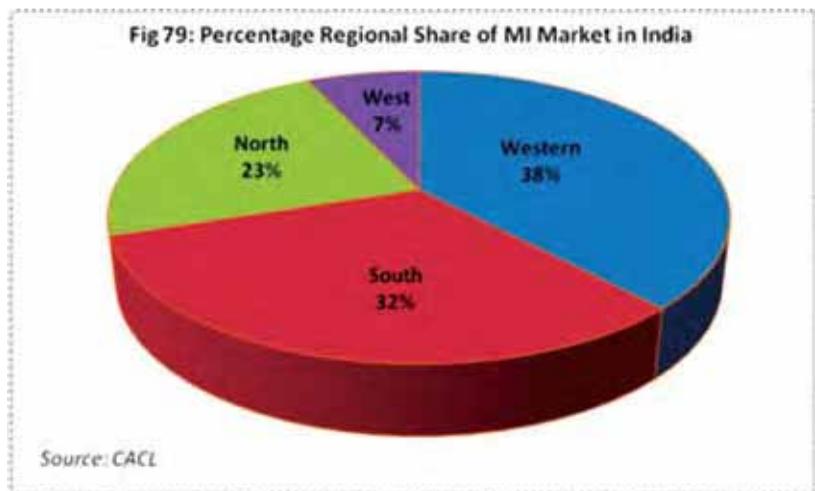


Global micro irrigation market size is estimated to be USD4 billion in 2013-14 which is expected to grow at a CAGR of 18 % for next five years. Among this, drip irrigation system is expected to grow faster at a CAGR of 19.0% where as the sprinkler irrigation system is expected to grow at a CAGR of 17.4 %. The important micro irrigation market segments are:

- drip irrigation system,
- sprinkler irrigation system,
- Sprinkler irrigation system,
- center-pivot irrigation system,
- lateral move irrigation system.

Orchard crop is leading crop segment for micro irrigation industry and is expected to grow at a CAGR of 19.3% during next five years. India and China are expected to drive growth in the global MIS market in next decade.

The Indian estimated market size of micro irrigation is approx Rs. 5300 Crores. The majority share of 80% of



this market is constituted by drip irrigation while the remaining 20% market share belongs to sprinklers. Currently, in India, more than 250 micro irrigation companies selling their products in India, however most of them are local / regional in nature.

Jain Irrigation Systems Ltd, is leading player in India with market share of around 38% followed by Netafim India (14 %), Nagarjuna Palma, EPC Mahindra, Finolex Plasson,

Azud-Harvel, John Deere are other major players. As seen in Fig 79, Western region is the largest market with 38% of total market share, followed by South (32%), North (23%) and West (7%).

Broadly micro irrigation market consists of two type of segment, Subsidy driven market (around 65%) and Non-subsidy driven market (around 35%).

Strengthening the hands that feed the Nation





BY S MAKHIJA

Micro Irrigation Based Solutions for Sustainable Agriculture

Food is the primary concern of all citizens. Food for all citizens is the primary concern of all governments. Food security is the fountainhead of all government policies as there can be neither peace nor development when hunger exists. In the present day context, in any underdeveloped society, concerns of food security include nutritional security as well, in order to ensure good health for all citizens particularly infants, children and younger generation. Therefore, apart from ensuring sufficient availability of biological life support mass, i.e. wheat, rice etc., we need to improve production of oilseed, pulses, vegetables, fruits, milk and other dairy products, eggs, meat.

The key challenges in respect of sustainable agriculture in India:

- Projected increase in population from current 1250 million to 1500 million by 2050 and consequent food demand from 280 mt to 450 mt.
- To meet the increased demand of fiber and fodder crops
- Adverse impact of climatic changes and global warming on crop yields.
- To reach out to millions of small and marginal farmers to bring about the much needed transformation to ensure a sustainable food security.

In order to meet these challenges, we have to tackle the essential elements of sustainability in Indian context.

Essentials of sustainability are

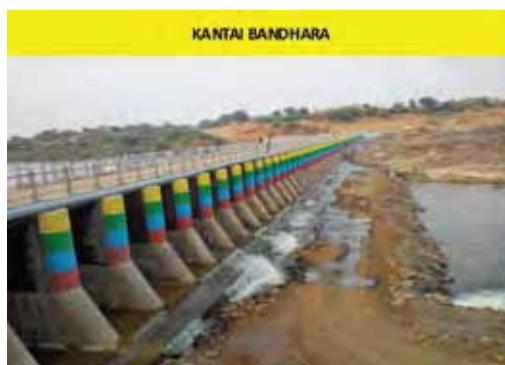
Optimal utilization of resources. With intensive cultivation using better seeds, irrigation, mechanization, chemical fertilizers and plant protection systems, the big question is - Are we producing MORE WITH LESS?

Affordability. Unless our input costs are low, we cannot ensure low output or affordable price to consumer. In a high cost market, neither producer nor the consumer will happily survive.

Availability: Will there be enough resources at all times to ensure desired growth in food items? We must take care to conserve our resources like water, soil and ecosystem to ensure sustained growth.

Water takes the center stage in all the above key factors. Without water, there can be no agriculture, and without enough water, there can be no sustained growth of agriculture, industries and urbanization. Water is also a source of societal, regional and international conflicts. With increasing industrial activity, urbanization and increasing demand of food items, the intra-sectorial conflicts on water are evident. Unlike developed countries, agriculture sector in India uses anywhere near 90 per cent of available fresh water. This luxury cannot continue in the wake of pressure from other sectors.

If sectorial use of water is an indicator of development level of a society, India is nowhere



KANTAI BANDHARA



KANTAI BANDHARA, JALGAON

in the list. Problems are well known. Mainly, increasing population, loss of cultivated land to other sectors and higher demand of food items which include lot more than mere wheat and rice. Increased mining of ground water and unbridled wastage is very aptly depicted in a graphic which appeared on social media sometime back.

Conserve in use and avoid wastage. Conservation, be it in farm, industry, home or an office, must become a habit. A stewardship approach by all stakeholders in water is the only solution. Each stakeholder, be it a farmer, an urban consumer or an industry must adopt a custodianship to water.

Optimize its use. Produce more with least. So far, the approach was to improve the irrigation efficiency by reducing the field and conveyance losses. This approach must give way to achieve higher WATER USE EFFICIENCY. There are various definitions of water use efficiency but most relevant and simple way is that - "Water use efficiency is a quantitative measurement of how much biomass or yield is produced over a growing season, normalized with the amount of water used up in the process." Same applies to industries, such as steel, power generation and cement where the road to water optimization which is not to be measured in terms of percentage of water saved compared to previous years but in terms of how less and less water is used to produce per ton of steel or cement or unit of power. Each and every consumer of water will have to be committed to higher productivity levels with least amount of water used in process.

Store more. We have to augment storage capacity in the river basins using small dams, age old practice of having storage tanks in villages and

DRIP IRRIGATION RESULTS –A WIN -WIN SITUATION

Crop	Yield (MT/ha)				
	Conventional	Drip	% Yield Increase	Water Savings (%)	Increase in water use efficiency (%)
Banana	57.5	87.5	52	45	176
Grapes	26.4	32.5	23	48	136
Sweet Lime	100	150.0	50	61	289
Pomegranate	56.0	109.0	96	45	167
Tomato	32.0	48.0	50	31	119
Water Melon	24.0	45.0	88	36	196
Chillies	4.2	6.1	44	63	291
Sugarcane	128.0	1.70	33	56	204

Food security
Water security
Energy security

small habitats, rain water harvesting in ever increasing urbanization and industrial domains. Climatic changes are posing a grave threat to established rainfall patterns across the globe. Changes seen indicate a shift from historical rainfall patterns to "too wet or too dry" like precipitation. It may be noted that traditional water bodies, once a part of Indian rural and urban landscape, not only help to augment surface water storage but also help in increasing sub-surface storage. Water levels in wells and bore wells are seen to improve due to large surface storage.

It is important that all stakeholders must adopt a stewardship approach to water as key resource, as has been done by Jain Irrigation Systems Ltd. by building "Kantai Bandhara", a check dam across a seasonal river Girna near Jalgaon, at a cost of Rs 10 crore, borne by this company. Additional storage space created is approximately, 1.7 million cubic meter of which only 50 per cent will be used by Jain Irrigation Systems Ltd for their plant and drip irrigated farms and the rest will be used by farmers in 8 villages along the water body.

This is an excellent example of water stewardship and can be emulated by other industries as a part of their CSR activity.

Recycle: This not only helps in off take of fresh water, but goes a long way in arresting pollution. In countries such as Israel, city waste water is being used for irrigation purpose. Untreated city waste is filtered using simple process and pumped across the country in purple colour pipelines for specific use in irrigation of crops.

Considering that agriculture is the largest user of water in India, a mere 10 per cent saving in water used in this sector will not only help in bringing additional cultivated land under irrigation but also ease pressure on other competing sectors. Micro irrigation systems, such as drip irrigation systems and sprinkler irrigation systems not only result in large water savings, but combined with better seeds, crop management and Fertigation, they can give phenomenally high yields with less water, fertilizer, electricity/diesel and man-power. Some of the results are given in table below.



Even within the agriculture sector, some crops like rice, sugarcane and cotton are bulk users and saving made in cultivation of these crops, both in terms of reducing water application with drip irrigation and enhancing the yield with better planting materials, fertigation and crop care has shown the way to optimize water and other input use, thus minimizing the input cost and maximizing the returns with very high increase in yield levels. Drip irrigation therefore will provide sustainable solution to food security in the country. Indeed what was said in 1890 by Alfred Deakin is most relevant now. He said

“It is not the quantity of water applied to a crop, it is the

Quantity of intelligence applied which determines the result -

There is more due to intelligence than water in every case”

Only when we IRRIGATE THE CROP AND NOT THE LAND WITH DRIP IRRIGATION, that optimization of all inputs is possible. Drip irrigation system helps in closing the chemical

nutrients cycle by preventing run off with unused chemicals which are polluting our water resources.

Since rice cultivation with traditional methods is not only the major consumer of water, but also a source of methane gas. Sincere efforts are now being made to change the entire eco system in this crop regime. SRI and direct seeded rice are some such methods and now trials are underway by using drip irrigation system on rice cultivation. Even though results achieved are very encouraging, it won't be easy to create this paradigm shift from traditional method to drip irrigated rice crop in a country where water is not valued.

One of the major reasons for over use of surface water and over withdrawal of ground water in India is the highly subsidized power and non- volumetric rate of water supplied from canal network. Value of water can be gauged from the fact that if irrigation water is priced at one paise (Rs 0.01) per liter then it will cost

anywhere between Rs. 1,20,000 to Rs 1,80,000 to irrigate just one hectare of land. Unless a judicious value is placed on water in agriculture sector, shortage of water will become an order of the day.

Conveyance of pressurized water through pipes, in place of open canals/channels is now being practiced in many countries to supply water on volumetric basis to farmers. Such a system prevents losses of water in conveyance, and since water is supplied at adequate pressure to operate a low pressure sprinkler system or a drip irrigation system, adoption of these water saving devices at the farm level is easily accepted and becomes an economical proposition, considering that water supply is metered on volume basis. In countries like Spain, water outlets are like ATM machines where a specific quantity of water can only be ordered/drawn from an outlet only after requisite cost is paid through a credit card.

Like rice, sugarcane is another

water guzzling crop. While only five per cent of cultivated area in Maharashtra is under sugarcane, nearly 60 per cent of total water used in agriculture in this state is used to irrigate sugarcane. However, in water stressed states like Maharashtra and Tamil Nadu, farmers have realized the multifaceted advantages of drip irrigation system and now a new avatar "sub-surface drip irrigation system" has proved to be boon for enterprising farmers in many states. From an average yield of 25-30 tonnes per acre, many farmers are getting 100 tonnes per acre of sugarcane, while using 30 per cent less water. This has resulted in quantum jump in water use efficiency from 2.5 kg/m³ (at 63 tonnes per acre) to as much as 21 kg (at 250 tonnes per acre) of sugarcane produced per m³ of water. As of now, there is 1,00,000 ha sugarcane cultivation under sub-surface drip irrigation in Maharashtra, Tamil Nadu and some other states in South India.

We have to increase our food production from current level of 270-280 million tonnes per annum to 450 million tonnes per annum by 2050 and this quantum jump can be made possible by –

- Increasing irrigated area from the current area of 78-80 mha to minimum 120 mha by creating additional water storage capacity and water conservation through drip irrigation.
- Improving yield levels in rainfed and dryland areas, where a combination of creating water storage, drip irrigation and plastic mulch can change the fortunes of poor farmers. In fact, we should encourage production of vegetables and other horticultural crops in such areas using protected cultivation and solar pump sets.
- Prevent wastage between farm to fork by creating necessary infrastructure, value chains and food processing industries.

Time to ponder:

On Feb 06, 2014-Former UN Secretary General Kofi Annan, while speaking at New Delhi warned India against too many populist subsidies. Speaking on the issue of the Food Security Bill and Delhi government's water and electricity promises, he said that subsidized water and power take away their value

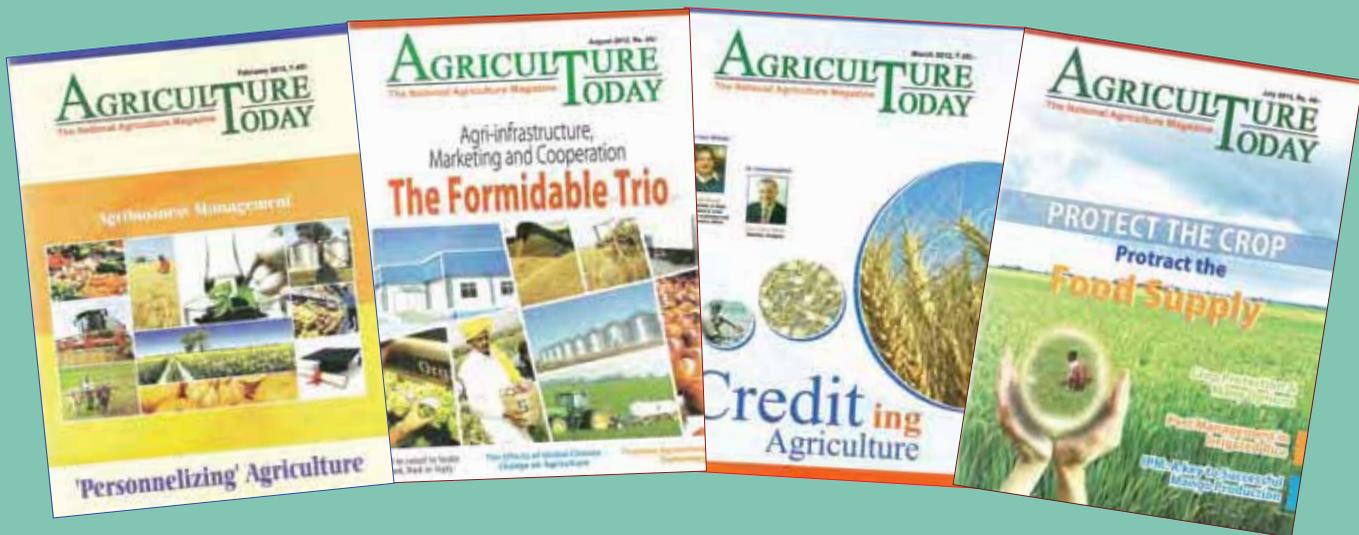
"We need to think differently

about water and its uses for food and energy production—and take action," Mr. Takehito Nakao, President, Asian Development Bank told delegates in a keynote speech at the 14th Delhi Sustainable Development Summit in New Delhi.

Traditional approach of crop production is just not sustainable at this point. We have to shift from peasant farming to AGRIBUSINESSES. Our approach must be to produce more with less water, fertilizer, land and energy." More crop per drop" must be the mantra that we have to vehemently follow. Pressurized irrigation through pipes should replace canals and field channels to avoid wastage of water and water logging. Food processing must be encouraged. Value chains should be established between farm and fork. Large scale adoption of micro irrigation system, protected cultivation and precision farming must be incentivized. We have to develop sensitivity to conserve water in all walks of life. To find comprehensive solutions for water problems, communities and social networks can be involved. Childhood can be a great starting point to inculcate disciplines of water conservation. Environmental consequences for inaction can be explained to them. Water saving can be introduced as a part of all skill development processes. Additional storage of water created with check dams on seasonal rivers, ponds and lakes under MNREGA, combined with use of solar pump sets and drip irrigation will be a game changer. Regulatory framework for sustainable development can be evolved. Many serious reforms are needed to reduce transaction cost of incentives to ensure targeted impact.

The author is strategic Advisor & Vice President, Jain Irrigation Systems





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AGRICULTURE
TODAY

General



RAVI KHETARPAL

Knowledge Solutions for Managing Problems of Agriculture in South Asia

In the past, agricultural production increased through area expansion and increased use of high yielding seeds, chemical fertilizers, pesticides and irrigation water. Now, with a shrinking non renewable resource base, the prospects of increasing agricultural production through area expansion and application of existing technologies appear to be severely constrained. Additionally, green revolution technologies have now been widely adopted, and the process of diminishing returns to additional input usage has set in. Thus, the need of the hour is to ensure maximum resource efficiency if the food and fibre needs of an ever-growing population has to be met.

This has been realised globally by the development of intergovernmental agencies who have pressed the panic button through aggressive campaign to feed the world, increase production and make agriculture more sustainable. Of the many efforts being done globally, one of the thought provoking effort is 'Lose Less, Feed More' practiced presently in 38 countries of the world by CABI.

CABI is an inter-governmental, not-for-profit, science-based development organisation working towards achieving this goal. Established in 1910 by a United Nations treaty-level agreement, it is governed by its 48 member countries, most of which are developing countries. CABI's activities contribute directly to achieving these development objectives by generating and increasing access to scientific knowledge, and delivering change through

development projects. Through its activities, CABI strives to improve crop yields, combat agricultural pests and microbial diseases, protect biodiversity and safeguard the environment, thereby enhancing the overall productivity. It systematically captures, repurposes and transfers knowledge to stakeholders from farmers, extension workers, researchers, policy makers and governments to help address food security and alleviate poverty.

For more than a century, CABI, through its local partner organizations, has been working with the smallholder farmers in India, Latin America and Africa, helping them with agriculture information and advisories through its various flagship programmes. CABI's international development work in the fields of agriculture and environment is diverse and multidisciplinary, but may be broadly grouped into four core areas which define the strategic direction: supporting farmers, improving food security and market access, protecting biodiversity, and sharing knowledge.

CABI works in over 60 countries on local, global and regional projects. It has over 400 staff based in 16 countries around the world. Having commenced its operations in India in 1950s in Bangalore through its Commonwealth Institute of Biological Control (now known as National Bureau of Agriculturally Important Insects under ICAR), CABI is now located in the capital since 2001, at the National Agriculture Science Centre, where it works closely and in partnership with organizations like the Indian Council of Agriculture Research, the Ministry of Agriculture, the Ministry of Commerce, CGIAR Institutes, corporates and certain NGOs such as MS Swaminathan Research Foundation etc.

To take on the mission to have more food for the world, CABI focused on minimizing the crop losses by following systems approach for empowering the entire plant health system. This was planned and executed through its flagship programmes (Plantwise and Direct2Farm) which are being executed in many countries of the world. Such programmes are not only helping in information management but also making it available to the lowest denominator of the food producing chain as a dynamic process. The CABI India centre caters



to the need of South Asian countries in general but has a global roll out plan for the mobile initiative that it initiated through one of its flagship programme Direct2Farm.

Flagship Programmes of CABI for Food and Nutrition Security

A. Plantwise

Crop losses may be caused by abiotic and biotic environmental factors, leading to the reduction of crop performance and resulting in a lower actual yield than the site-specific attainable yield/production of crops. Of the major biotic factors, insect pests, diseases and weeds are the major limiting factors in achieving agricultural productivity and potential growth. It is a common practice in the developing countries to use unguarded pesticides to save the crop. This has eventually resulted in developing resistance in pests and causal organisms of diseases. Due to the disturbed ecological balance by such interventions, the world is facing another problem of secondary pest outbreak and resurgence further adds to the cost of plant protection.

Major focus of CABI's work worldwide relates to plant health management through ecological and economically friendly ways, and to helping farmers to lose less of their crops to biotic and abiotic stress. Launched in 2010, Plantwise supports national and regional plant health systems through an expanding network of plant clinics run by Government and private extension services. These plant clinics are free at the point of use. These plant clinics are manned by trained plant doctors who are technically equipped and supported by an open access global plant health knowledge bank. The long term vision of Plantwise is to strengthen national plant health systems that integrate the efforts and interests of extension, research,

regulation and input supply in order to create long-lasting crop advisory services needed by millions of farmers.

Plantwise works by enhancing the local capacity through various relevant trainings and field experiences. Being run by local people, it helps in maintaining the continuity of the agro-advisory. There is a very strong monitoring and evaluation system in place to constantly work for quality assurance of delivery of the service. The trainings to the plant doctors involve diagnosis of signs and symptoms of plant problems, writing simplified extension material, differentiating between biotic and abiotic problems, plant nutrition and deficiency symptoms, IPM based recommendations, etc. Plant clinics are run by diverse organizations with a common interest in providing practical support to farmers. Government extension bodies, NGOs, farmer organizations, and community-based organizations are amongst the largest groups of plant clinic operators, as well as universities, research institutes and private companies. These plant clinics are an important innovation which constitutes a new approach to strengthening plant health system. Plant clinics accept any crop and any problem and are run by existing organizations. In addition to crop problems, the clinics also focus on soil and seed health and encompass detailed modules on Good Agricultural Practices (GAP's) and Integrated Pest Management (IPM).

Thus the clinics contribute towards increasing production for smallholder and marginal farmers by reducing the losses caused by biotic and abiotic stress.

So far, in India, plant clinics have been established across Tamil Nadu, Puducherry and Maharashtra. Additionally, high-level round table and cluster meetings have been held for next steps to expand the breadth

and impacts already seen with Plantwise activities in the country as well as to link key actors and exchange knowledge of plant health challenges and solutions across the system. Talks are on for further establishment of the plant clinics in order to empower local farmers to deal with endemic pests and plant health problems, and help create an early warning system for those pests that are spreading.

In the longer term, collecting and collating distribution information will also allow greater insights to be developed into the impact of pests and diseases and their potential for outbreaks or further spread. Forecasting the imminent outbreak of a disease will allow farmers to be forearmed with the means of management and control. Predicting how climate change might alter ecosystems, and how pests and diseases will adapt to these changes, will allow governments or researchers to plan policies or programmes aimed at varietal improvement or quarantine vigilance. Modelling the impact of a pest outbreak on specific commodities will allow commercial suppliers to secure the food supply chain, bolstering trade. As data build within the knowledge bank, such opportunities will grow for furthering the battle against crop pests and diseases.

B. Direct2Farm

Across the developing world, around 40 per cent of people now actively subscribe to mobile services, with 130 million new subscribers every year (GSMA Mobile for development Intelligence: "Scaling Mobile for Development – A Developing World Opportunity", 2013). CABI aims to tap this communication technology with its Direct2Farm initiative - a mobile-enabled agriculture infomediary service aimed at making high quality information readily accessible to farmers. The programme strives to translate research findings into practical, accessible, bite sized information

that can have a direct, positive impact on the livelihoods of smallholder farmers.

The Direct2Farm initiative grew out of collaboration with IFFCO Kisan Sanchar Ltd (IKSL) in 2009 to provide voice-based agricultural information for farmers and extension workers. IKSL is a tri-lateral venture between the Indian Farmers' Fertiliser Cooperative Ltd (IFFCO, the largest farmers' cooperative in India), Airtel (the largest mobile network operator), and Star Global Resources Limited, supported by the GSMA mAgri Programme. It functions by distributing 'Green SIM cards', to farmers with an added functionality of providing agriculture related information. Green SIM users can also access an Agri Helpline where they can get answers to farming questions from agriculture experts, in local languages. By providing adequate and timely information, the initiative empowers farmers to deal with pests and diseases, receive tailor made analytics as well as access higher value markets for their produce.

CABI's expertise in indexing and managing vast amounts of complex data, combined with its experience in agricultural best practice, soil health, plant pests and diseases provides the basis for developing a powerful core of farming information. The Direct2Farm service synthesizes this data into short SMS and voice messages, which can be delivered via mobile phones. It works towards bringing dispersed agri-extension information under a single window digital repository and enabling farmers to access information on demand by using their mobile phones. In addition to the information pushed to the farmers, the farmers can also pull information as and when required from a virtual helpline, the cloud contact centre.

Thus it fosters a digital ecosystem of agriculture research, agri-business,



policy makers and development organizations through partnerships, alliances and linkages. CABI aims to ensure that subsistence and smallholder farmers have access to and benefit from the outcomes of scientific research. The information transmitted on agricultural issues help smallholder farmers to improve their profitability and consequently their livelihoods.

Through IKSL, Direct2Farm has reached about three million farmers in all states of India except in the North East, J&K and Goa. The customised version of Direct2 Farm for coffee growers in India was Café Móvel which was launched in 2013 in partnership with Coffee Board (funded through ICO/CFC) and piloted in Karnataka. So far it has 1000+ regular users of the service. Additionally, mKisan agro-advisory (funded by GSMA mAgri & BMGF) was initiated in 2012 in a consortium mode along with ILRI, Digital Green & Handygo Technologies. 1.5 million trials were generated during 2013-2014 in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Karnataka and Uttar Pradesh. So far it has about 400,000 active users.

Other Key Activities Research and Development

CABI UK Scientists are undertaking collaborative research projects on biological control of invasive species of *Rubus* spp and wild ginger with ICAR. CABI India is further strengthening its relationship with ICAR on a Joint-Laboratory proposal to be based at the Indian Agricultural Research Institute which will endeavour to research on bioprospecting of microbial cultures

for their applications in agriculture, environment and industries.

CABI has also recently started a project on sustainable production of tea to address the problem of excessive use of pesticide in tea. This is in partnership with Unilever involving Tea Board as the main stakeholder. CABI in India also focuses on capacity building in various areas of food security with partners like CINI of Sir Ratan Tata Trust and for promoting Direct Seeded Rice (DSR) for cultivating rice with managed water resource with Bayer Crop Science. CABI has been taken as a partner by World Bank for addressing the invasive species management component of their UNEP-GEF funded project on 'Integrated Biodiversity Conservation and Ecosystems Services Improvement' that is soon to be initiated and will be involving Ministry of Environment and Forests, Indian Council of Forestry Research and Education, and State Forest Departments. CABI is further scoping for possibilities for working on risk communication, market linkages and nutrition and health themes.

CABI Publishing in Agriculture

CABI Publishing specialises in applied biosciences, biotechnology, environment, forestry and allied fields in Agriculture and is amongst the foremost publishers, worldwide. It is best known for its flagship CAB Abstracts. The Indian wing encourages Indian-authored text and so far has been instrumental in publishing 30 books in the fields of Plant Sciences, Microbiology & Parasitology, Environmental Sciences and Agriculture from Universities across India and institutes of ICAR and NARS. CABI endeavours to be the publisher of choice for the Indian academia.

The author is Regional Director, CABI South Asia – India, NASC complex, Pusa, New Delhi

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Food and Nutritional Security in India : 12 Point Action Plan

Agriculture is a critical sector of the Indian economy. Its contribution to the overall Gross Domestic Product (GDP) is about 14 per cent, and it employs nearly 58.2 percent of the total workforce. Agriculture also serves as source of raw material for a large number of industries. India accounts for only about 2.4 percent of the world's geographical area and 4 percent of its water resources but has to support about 17 percent of world's human population besides 15 percent of livestock. Accelerating the growth of crop production is therefore necessary not only to achieve an overall GDP target of more than 8 percent but also to increase incomes of those dependent on agriculture for their livelihoods. To keep pace with the rise in population, the country will need to produce about 8 to 10 million tonnes of additional food grains every year. The additional food grains will have to be produced keeping in view the current challenges of diversion of agricultural land for non-agricultural use, decreasing land holding size, depleting trend in ground water, deteriorating soil health and

biodiversity and climate change.

The solution to above challenges will call for increasing productivity per hectare and producing more food on less land with less water. Farming must need to adapt to climate change and predicted weather scenarios. There will be strong need to develop more productive, better quality, more input efficient and environmentally less degrading crops and livestock.

Point 1 : Rain Water Management

Availability of good quality water in adequate quantity for agriculture is likely to reduce from present level of about 83 per cent to 70-72 percent by 2050. Reuse of waste water including domestic and industrial effluents in agriculture will substantially increase. The country is fortunate to receive about a 100 cm of average rainfall every year. However, at present hardly 30 per cent of this is conserved and utilized for agriculture and other purposes. Efforts are needed to increase rain water conservation, storage and reuse through precision irrigation techniques to at least 45 per cent of the total



water that falls through rain on the ground. This will help providing supplementary life saving irrigation, ground water recharge and reuse of waste water after mixing or alternate use. This one initiative will help substantially in building the country's future food and nutritional security.

Point 2 : Soil Health Management

Soil is a medium for plant growth. To achieve potential yield from different agricultural crops and their varieties, its health in terms of supply of 17 essential nutrients needed by plants to complete their life cycle must be maintained above the needed threshold values. The quantity of organic matter present in the soil determines the fertility status of the soil - higher the carbon content more fertile the soil. High input intensive agriculture and unbalanced use of fertilizers during the last five decades have resulted in deterioration of soil health in terms of increased gap in N:P:K ratio, multiple deficiencies of secondary and micro nutrients, contamination with heavy metals (like arsenic, selenium and fluoride etc.) and depleting organic carbon content. There seems strong need for rejuvenating our soil resources to sustain production and productivity in the future. Some of the workable solutions to rejuvenate soil health include, (a) application of nutrients as per soil health card prescription, (b) large scale promotion of green manure crops like sesbania and sunhemp, (c) inclusion of green manure/legume crops in the cereal based cropping systems, (d) integrated use of fertilizers (50%), organic manures (25%) and biofertilizers (25%), (e) integration of fertilizer trees with crops, (f) large scale promotion of vermicompost and biofertilizers and (g) adoption of



conservation agriculture practices.

Point 3 : Energy Management

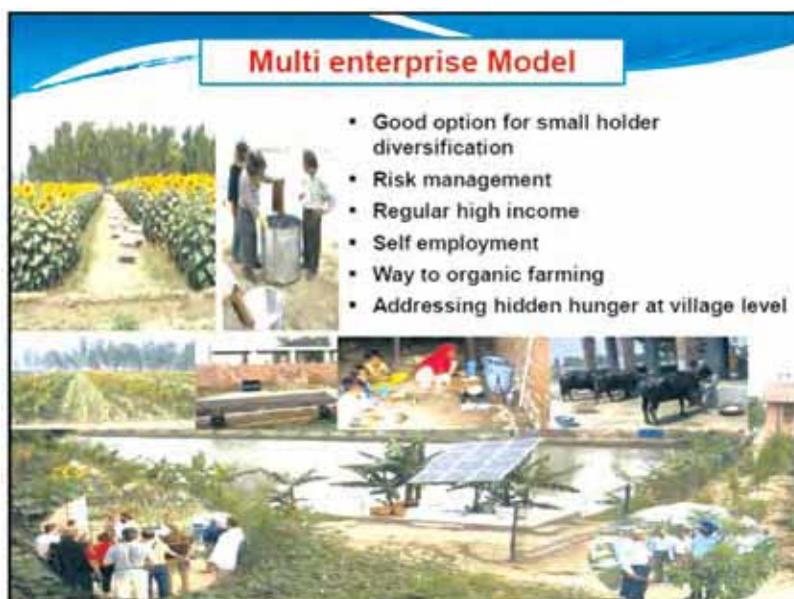
After water, energy is going to be one of the important challenges for food security in India. Major emphasis will be required to explore all renewable sources of energy such as solar, wind, water and biomass. A sizeable part of the crop residues like rice is currently burnt and is a source of green house gas emissions in the environment. Such residues need to be utilized to produce energy/electricity at village/group of villages level to meet domestic energy need.

Point 4 : Management of Wastelands

Nearly 120 mha area in India is constituted by waste/degraded lands and most of these lands are contributing less than 20% of their potential. Waste lands, if utilized judiciously, have tremendous scope for achieving future food, nutrition, environment and livelihood security. Major efforts will be required to use these lands for growing multipurpose tree species plantations, raising bio-diesel and petro crops, establishing agro-forestry/silvipasture/hortipasture systems. This use of so far neglected land resource will help moderate predicted climate change through sequestration of carbon, provide much needed resilience to 142 mha cultivated land and also ensure increased availability of timber, fuel wood and fodder.

Point 5 : Multi-enterprise Agriculture

More than 80 per cent farmers in India cultivate less than 2 ha land holding and nearly 50 per cent less than one ha. Promotion of Integrated farming



system approach involving synergetic blending of crops, horticulture, dairy, fisheries, poultry, etc. seems viable option to provide regular income and at site employment to small land holder, decreasing cultivation cost through multiple use of resources and providing much needed resilience for predicted climate change scenario.

Point 6 : Managing Post Harvest Losses

Post harvest losses in food crops/commodities vary from 5-30 per cent. Food saved is food produced. Major efforts are needed to strengthen grain storage infrastructure, cool chain systems for perishables, post harvest processing and value addition, transport, marketing, commerce and trade.

Point 7 : Climate Resilient Agriculture

The frequency of climate change triggered weather related aberrations has significantly increased in the last two decades. The country experienced one of the severest droughts of last century during 2002 and 2009 that lowered our food grain production by several million tonnes. Each year cold wave is adversely affecting vegetables, flowers and even pulses in one or the other region of the country. The heat wave of March 2004 in Punjab, Haryana, UP and Bihar coincided with reproductive phase of wheat and a loss of 4.4 million tonnes in production was modelled. The maximum temperatures in Himalayas remained 4 to 100C above normal during March 2004. Continuation of such trends is expected to melt ice/glaciers, re-distribute water flow in rivers, raise sea level, submerge coastal habitats, islands, generate Tsunamies and dislocate human and livestock settlements. Predicted spatial re-distribution of precipitation, droughts,



floods and water balance will change land use, pests, diseases and other ecological parameters. Adaptation of agriculture to climate change will call upon pro-active or anticipatory research on enterprises, commodities, crops, varieties and farming systems insensitive to cold, heat, disease, pests and moisture stresses. Agronomic manipulation such as improved fertilizer use to reduce gaseous losses of methane and nitrous oxide, irrigation management of rice for minimum methane production and conservation agriculture practices are important for achieving desired goals. Ex-situ and in-situ harvesting and conservation of rainwater, raising tree plantations on all kinds of wastelands, substitution of fossil fuels with bio-fuels (Jatropha and Pongamia plantations), weather based forewarning for agricultural practices and operations can play a significant role in moderating climate change.

Creating awareness about dangers of predicted climate change and mobilizing community effort will go a long way in tackling climate change at local, regional, national and global scale.

Point 8 : Enhancing Production and Productivity of Pulses & Oilseeds

- Development of pulses and oil-seeds varieties and hybrids with yield advantage of 25-30 per cent over the present stock. ICRISAT has developed pigeonpea hybrids with yield potential of about 5 t/ha. Such hybrids need to be promoted through farmer participatory research and demonstration mode.
- Development of pulse varieties having resistance for pod borer, sterility mosaic and yellow vein mosaic. Similarly, oilseed crop varieties having multi stress tolerant traits is the need of the hour.
- Exploiting potential of hardy minor pulses such as mothbean and lathyrus for non favourable pulse production environments,
- Development of short duration, high yielding, water logging tolerant pigeonpea and chickpea varieties for north-west India
- Development of machinery for simultaneous harvesting and thrashing of pulse and oilseed crops
- Coldwave/frost tolerant pulses: pigeonpea, moong, urad and oilseed crops
- Promotion of pulses seed and grain storage bins
- Integrated weed management technology



Point 9 : Biotechnology and Genetic Engineering Research in Agriculture

Biotechnology and genetic engineering research is likely to play a significant role in future food and nutritional security. However, it may not be considered only solution for increasing production and productivity. Major emphasis being on biotechnology in the recent past, discipline of conventional plant breeding did not get the desired emphasis. Several crop varieties developed through conventional breeding including simple selection methods remained in the field for decades and contributed significantly in achieving food and nutritional security in the past. Biotechnological research need to focus on solving those problems where solutions through conventional breeding remained unsuccessful. Some of the priority areas for this kind of research may include:

- Breaking yield barriers and enhancing genetic potential of wheat, rice, pulse and oilseed crops by atleast 20-30 per cent
- Bacterial blight in pomegranate
- Developing yellow, black, brown and Ug99 rust resistant wheat varieties
- Developing pod borer and yellow vein mosaic resistant pulse varieties
- Herbicide resistant rice, wheat, maize, pulse and oilseeds crop varieties
- Bacterial blight resistant rice varieties
- Improve nutrition traits like Fe, Zn, vitamins, Amino Acids to address hidden hunger in ladies, girls and children in villages
- Herbicide resistance management in weeds e.g. Phalaris minor in wheat

Point 10 : Agriculture Diversification

Diversification of agriculture in the First Green Revolution areas such as Punjab, Haryana and Western U.P. seems need of the hour. To promote diversification on ecological principles, will require making monetary equivalence (profit margin) between the replaced crop/commodity/ enterprise with the one planned to be introduced. Farmer is mainly concerned with the profit he gets from a particular crop or commodity. Crops like maize, soybean, pulses, oilseeds, fruits and vegetables have the potential to replace rice and wheat in this area. Upward push in



MSP and assured marketing in favour of proposed diversification crops will be a practical option to achieve this objective.

Point 11 : Agricultural Education

There is a strong need to improve educational standards in the schools, colleges and State Agricultural Universities (SAUs). Agricultural Scientists Recruitment Board (ASRB) recent data reveals that hardly 10 to 20 per cent of the total candidates who appeared for the National Eligibility Test (NET) were successful to be appointed as Assistant Professors in the Universities. Similarly, sizeable number of posts in Agricultural Research Service (ARS) advertised every year to fill up

entry level scientific positions remain vacant because of non-availability of meritorious candidates. Too much emphasis has been given in the recent past on the creation of new SAUs and Research Institutes. Most of the already established research organizations and institutes are suffering from infrastructure, finances and human resource. Better option may be to strengthen the already established agricultural universities and institutes rather than going for opening of new universities and institutes. Some of the SAUs may be upgraded to Central Agricultural Universities with a state of the art infrastructure and hu-

man resource comparable to some of the best Universities in the world like Stanford, Harvard, Oxford and Cambridge etc.

Point 12 : Central and State Subsidies

All central and state subsidies may be targeted to empower farmers to make them stand on their own feet through infrastructure development in rural areas to promote agribusiness, food processing, water management, soil health enhancement, seed production and processing, custom hiring, plant protection, dairy, poultry, fisheries and other enterprises.

The author is Chairman, Agricultural Scientists Recruitment Board, Ex-Agriculture Commissioner, Gol



PROF O.P. GILL

Innovation in Agriculture to Achieve Sustainable Growth

By 2050, the world's population will reach 9.1 billion, 34 percent higher than today, and India will be the most populous country (1.6 billion) on the earth. Urbanization will continue at an accelerated pace (2.4 per cent) and about 50 percent of the India's population will be urban as compared to present 29.5 percent. In order to feed this larger population, food production must increase by 48.5 percent. India ranks second worldwide in farm output but the economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. The contribution of this important sector to the national GDP is declining. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India.

Since Independence, India has witnessed significant increase in production of food grains (green revolution), oilseeds (yellow revolution), milk (white revolution), fish (blue evolution), and fruits & vegetables (golden revolution). All these became possible owing to the application of cutting edge technology of science coupled with the positive policy support, and hard work of Indian farmers.

India is the second largest producer of wheat

and rice and third largest producer of pulses, sugarcane, roots and tuber crops, vegetables, coconut, dry fruits, agriculture-based textile raw materials, inland fish and eggs. The country has produced 258 million tonnes (MT) of food grains during 2011-12 surpassing all earlier records. Record production has been achieved in the case of rice (104.3 MT), wheat (93.9 MT), cotton (35.2 million bales), and sugarcane (357.7 MT). The projected food demand in 2050 will be around 382 million tonnes to feed the projected population. Hence, in the next 35 years, production of food grains needs to be increased at the rate of 8 million tonnes annually.

Small and marginal farmers, who constitute 86 per cent of the holdings in India, is anticipated to be more than 95 per cent by 2050. The comprehensive initiatives taken during the last two decades have clearly revealed that increase of productivity up to 4 times in equivalent food grain terms is achievable with logical use of available technologies in system mode. Still a need for integration of other enterprises is felt to make use of available resources and convert them into a possible means of profitability.

Therefore, the future of India and Indian agriculture on the world market will largely depend on its ability to cope with these



challenges, which can be addressed simply by incorporating innovations in agriculture.

In addition to the emergence of new research topics on innovations that should be addressed in the future, there are new research techniques and paradigms of innovation system that seems very promising for the future. Therefore, this article is focused on the additional insights and type of interventions that can be derived from innovation systems perspectives in agriculture that can influence generation of technology and its use for economic development.

Need for a synergy and new innovation model

There is a general consensus that for bringing a breakthrough in agricultural productivity, there is need for incorporating advances of science and technology in agriculture and up-scaling the gained advantage to larger area. There is a need for a favourable innovation paradigm in India which implies a change of the mind-set at all levels. Innovations in agriculture can be boosted in particular through:

- Facilitating exchanges between all actors,
- Sharing traditional and scientific knowledge,
- Relying on a bottom-up approach and strengthening networking,
- Engaging in developing practical solutions,
- Identifying and developing lighthouse projects,
- Mobilising innovation brokering
- Developing social and institutional innovation.

The orientation of the agricultural research and extension reach beyond the “linear innovation model” of speeding up transfer from laboratory



to practice must focus on “interactive innovation model” with thrust on forming partnerships, using bottom-up approaches and linking farmers, advisors, researchers, businesses, and other actors in operational groups that engage in practical projects.

Future needs & combined strategy

At present, agriculture is undergoing a technological revolution as evidenced by the introduction of nano-technology, biotechnology, good agricultural practices (GAP), eco-sensitive agriculture practices etc. However, we are also witnessing related processes of industrialization, product differentiation, and increased vertical integration in agriculture. Simultaneously, these changes raise new issues and introduce new challenges which need continuous focus on innovations in following thrust areas of agriculture.

Climate resilient agriculture

India may face a major threat, and require serious adaptive capacity to combat climate change. While considerable progress has been made

in developing strategies for ‘climate proofing’ agriculture in India, there is a need for more anticipatory research on analysis of weather extremes, and their impacts on agricultural production; development of agronomic practices for climate change scenarios; and integrated study of climate change impacts on dynamics of pests and diseases, cropping patterns, and livestock and fishery. In addition, resource mobilization, promoting insurance and agri-business are other major strategies to protect against risk of production loss due to calamities caused by climate change. Greater and imaginative governmental intervention would also need an efficient and professional administration that is tuned to the emerging but uncertain crises caused by global warming and climate change.

Nano-technology

A number of emerging forms of nanotechnology could provide significant benefits in various sectors, including food, water and agriculture. The current applications in the food and agricultural sectors are relatively few, because the science is still newly emergent. However, the number of

nanotechnology-derived products and applications in these sectors has been increasing steadily in recent years, and they are predicted to grow in the future. New and emerging applications such as water purification systems, rapid detection systems for pathogens and chemical contaminants, and nano-enabled renewable energy technology applied along the food chain may contribute to addressing some of the challenges pertaining to sustainable agricultural development, as well as the food safety and food security issues that many countries are facing today – particularly developing countries.

Bio-technology

Biotechnology has emerged as a new field in agriculture. However, 1996 was the breakthrough year for agricultural biotechnology as millions of hectares were planted with pest-resistant varieties of cotton and soybeans in the world. In 2014, the first year of successful commercialization of four genetically modified varieties of insect resistant Bt brinjal helped to save pesticides and increased the yield. This has created a success story in Bangladesh. In India also following facts need to be considered for successful acceptance and adoption of a biotech crop.

- Development and adoption of appropriate GM technologies would need a Mission Mode approach for which a strong public research system needs to be strengthened. Along with public sector, the private sector investments on GM technologies have to be enhanced for which an enabling environment is a must.
- There is urgency now for the prioritization of crops in order to effectively use GM technologies for improving specific traits.
- The bio-safety regulatory system though well-defined and in place, needs to be made more efficient and fool proof so as to facilitate effective and safe application of biotechnology.

Precision farming

Indiscriminate use of pesticides, irrigation and imbalanced fertilization has threatened sustainability. On the other hand, issues like declining use efficiency of inputs and dwindling output-input ratio have rendered crop production less remunerative. Precision Farming identifies the critical factors where yield is limited by controllable factors, and determines intrinsic spatial variability. It is essentially more precise form of farm management in using resources like water, fertilizers, pesticides and other

inputs. In this, the variations occurring in crop or soil properties within a field by applying input are noted, mapped and then management actions are taken as a consequence of continued assessment of the spatial variability within that field at the spot where it is required. The concept of precision farming may be appropriate to solve these problems, though it looks unsuitable to Indian conditions; but it is not impossible to adopt. However, following issues need to be considered for up-scaling of precision technologies.

- One challenge in improving precision technology will be to develop the software and management tools that will take advantage of new information. That will present a significant challenge to researchers in farm management. Other issues involve the development of institutions that take advantage of network externalities associated with knowledge, and that accumulate and distribute information that is pertinent to farm management. The pricing of knowledge will also become a major issue of research within the context of precision farming.
- Another important issue associated with precision farming is the potential for improving en-



vironmental quality. The adoption of precision farming may be induced by environmental regulation. The link between environmental regulation, research, development, and the adoption of new products needs to become clearer and provide insight to improve institutions and incentives.

Good agricultural practices (GAP)

The concept of GAP emerged recently as a result of the big concern about food safety and quality as well as the environmental sustainability of agriculture. Among contributing factors identified is the lack of GAP awareness at the level of both government officials and private operators, such as food producers and processors, as well as a lack of an active consumer's organization that could advocate improvement of food safety. Awareness and skills that address the needs of improving production practices that incorporate GAP and good manufacturing practices (GMP) are essential to help producers ensure the safety of their produce. In this regard there is a need for development of holistic procedures and innovative methods for improving operational aspects of GAPs.

Farm mechanization

The timeliness of operations has assumed greater significance in obtaining optimal yields from different crops, which has been possible by way of mechanization. Similarly, the quality and precision of the operations are equally significant for realizing higher yields. Higher productivity of land and labour is another factor, which clearly justifies farm mechani-



zation. Not only the output per hour is more, but the total labour requirement is also reduced. The use of farm mechanization enlarges the employment opportunities both on farm and non-farm sectors through increase in area under plough, multiple cropping, development of agro-industries and related services.

Organic farming

The soil has become addict and increasingly greater amount of chemical fertilizers are needed every year to maintain the soil fertility and food productivity at the same level. India needs to reevaluate proven, ancient ways of harmoniously maintaining soil fertility. This will require embark-

ing on a 'Second Green Revolution' and this time through organic farming practices; a shift to organic farming driven sustainable agriculture would require immense patience on the part of farmers during the transition period till the productivity is restored to original level. Promotion of supplementary sources of organic nutrient management, knowledge of non-chemical methods of pest and disease management, and assured price of organic foods after adding environmental costs are the various factors which will decide horizontal and vertical disseminations of organic farming in India.

Resource conservation technologies

Over the last few decades, the growth in agricultural production has come mainly from yield increase and to a lesser extent from area expansion. Now the agricultural land available per capita is expected to decline, while revolutionary technologies for significantly higher production potential do not seem to be in sight. Targeting of the resource conserving technologies offers newer opportunities for better livelihood of the resource poor small and marginal farmers. The major areas of research





under this theme cover water conservation, planting techniques such as raised bed and bed furrow planting; orchard floor management, mitigation of desertification and case studies on resource economics.

Post-harvest losses and value addition

India has to focus on secondary agriculture, which will generate additional value to the farm produce as well as income and employment for farmers especially for women and youth. Secondary agriculture is basically processing of products of primary agriculture. Value addition to agriculture produce can easily be promoted and established at village level which will prepare products of local importance for sale in the local markets. It can increase farm income up to 40 per cent and will create additional job opportunities and will also improve nutritional status of the people. It is imperative to enhance storage capacity up to 150 million tonnes in the country. In lieu to sustain food security, the focus should be on:

- Establishment and operation of agro-processing centers in the production catchments to minimize losses and transform the

raw food materials into palatable and nutritive edible products at an affordable price by all.

- Making better use of crop residues, processing by-products and wastes in eco-friendly and economically rewarding mode.
- Meeting hygiene and quality standard specified for domestic and export markets for fresh and processed products.

Information & communication technology

The role of information technology to develop agricultural research, education and extension to improve quality of life in rural area is well established. IT can help an average Indian farmer to get relevant information regarding agro-inputs, crop production technologies, agro processing, market support, agro-finance and management of farm agri-business. The agricultural extension mechanism is becoming dependent on IT to provide appropriate and location specific technologies for the farmers to furnish timely and proficient advice to the farmers. IT can be the best means not only to develop agricultural extension but also to expand agriculture research and education system. For

agricultural extension management, role of IT can be encouraged for future resource documentation, as methods of extension and linkage between research and extension.

What should be done?

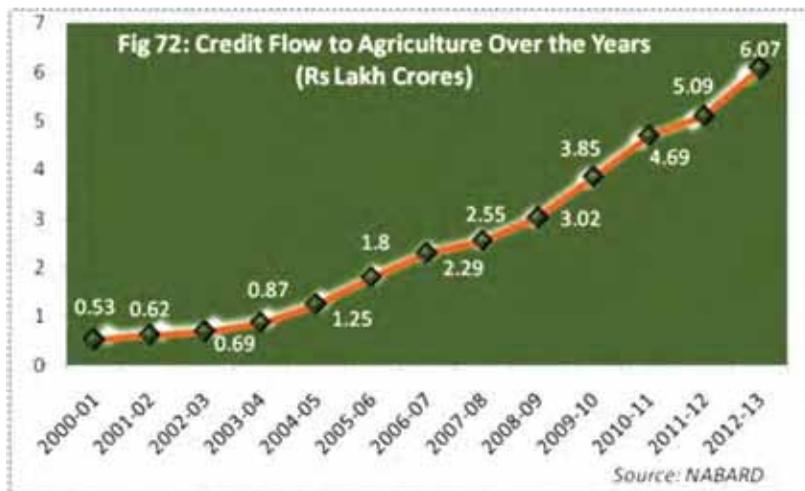
The conventional agriculture has been successful in increasing productivity, but this has been at a significant environmental cost that has not been sufficiently recognised. In the light of expected climate change in combination with the pressures on natural and other resources, the need of the hour is to rethink the way we produce, process, retail and purchase food. In order to make progress along a sustainable development path more research into alternative models that address the double challenge of food and environmental security will be vital.

Innovative research is essential to meet the challenge of growing more food for a growing world population on limited land, with less energy and other scarce inputs, while at the same time improving soil fertility and ecosystems resilience capacity as well as exploring all possibilities for mitigating climate change effects. The development of the "omic" sciences, nano-technology, robotics and other technologies forms an important part of meeting the challenge. There is a need for a paradigm shift in agricultural research. It needs to change its focus from production to productivity, from productivity to value addition, from uni-disciplinary approach to interdisciplinary approach, from a single commodity to a cropping/farming system and from reactive to proactive approaches.

The author is Vice-Chancellor, MPUAT, Udaipur (Rajasthan)

Farm Credit

Flow of credit to agriculture sector has increased many fold over the last decade or more. When we consider the period over the last thirteen years, from 2000-01 to 2012-13, we can observe more than 10 fold increase from 0.53 lakh crores to 6.07 crores. As a matter of policy, agriculture credit has emerged as an effective and important strategy for accelerating investments in agriculture (Fig 72). However, though the net credit flow has increased over the years, unfortunately long term credit in agriculture or investment credit has showed a declining trend over the years. As seen in Fig 73, share of long term credit or in other words the “term loans” meant to foster meaningful investments in the agriculture sector as a percentage of the overall ground level credit flow reduced from 40 per cent in 2006-07 to 22 per cent in 2012-13. Majority of the credit flow was in the form of crop loans and this share has kept on shown increase on an overall

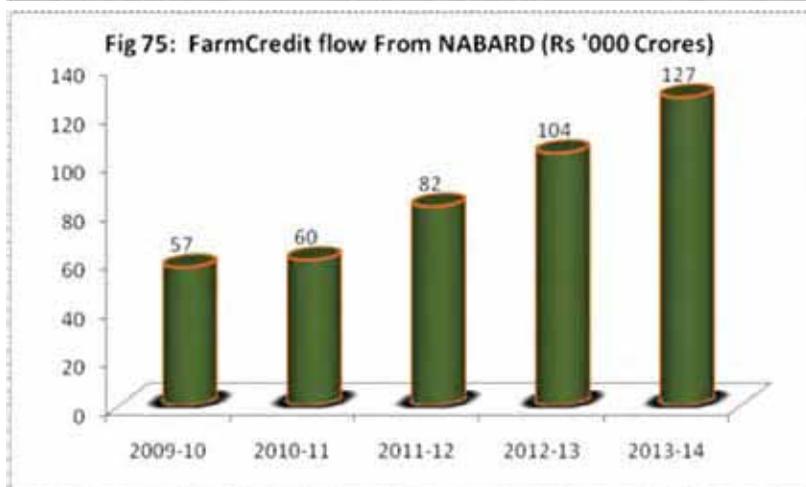
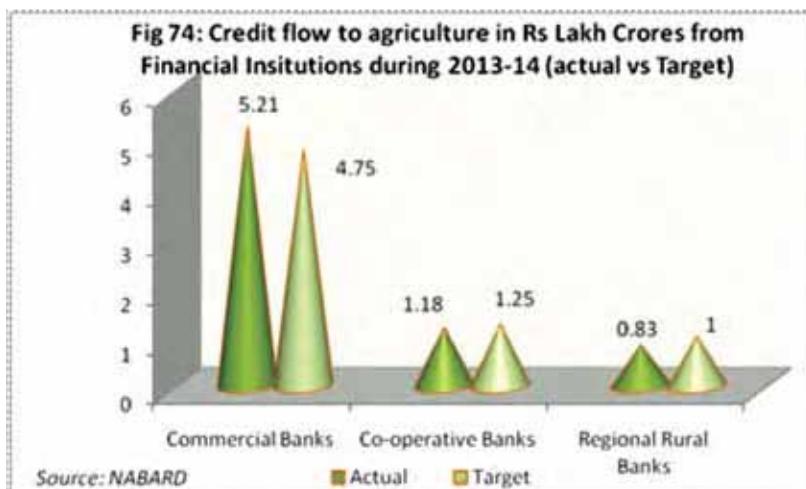
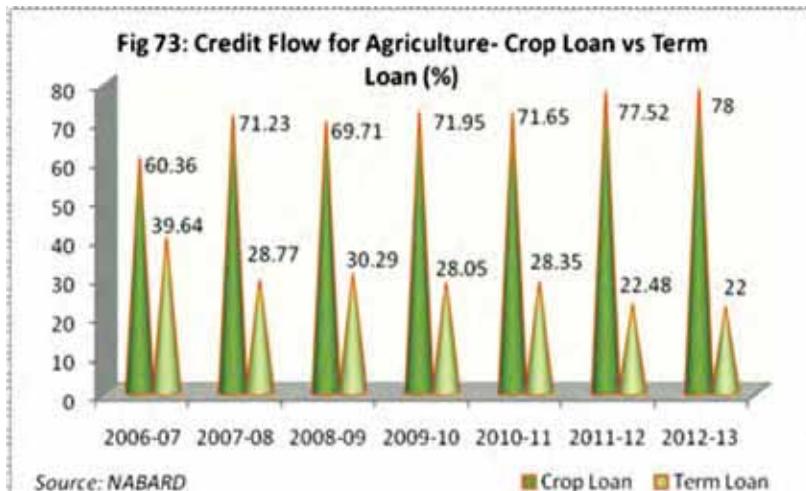


basis, which is ideally not desirable. As an important economic growth indicator for any sector including agriculture, investment credit is the major driver of private sector capital formation in agriculture. Continuous decline in its share in the agriculture sector of the country is a matter of concern about the agricultural production and productivity, and its subsequent con-

tribution to capital formation of the country.

Banking system in India in 2013-14 performed good and as a whole could surpass the target limit of farm credit disbursement. The target of for total farm credit flow was Rs 7 lakh crore to agriculture sector for 2013-14 and the banking system has disbursed more than Rs7.23 crore according to the provisional figures as on 31 March 2014. This was 103 per cent more than the target. However, when studied individually with respect to different categories of plants, commercial banks performed the best and exceeded its target while the co-operative and the Regional Rural Banks (RRBs) missed their targets. Commercial Banks, Co-operative Banks and RRBs disbursed Rs 5.21 lakh crores, Rs 1.18 lakh crores and Rs 0.83 lakh crores against their respective targets of Rs 4.75 lakh crores, Rs 1.25 lakh crores and Rs 1.00 lakh crores respectively (Fig 74). Thus, achievements of Commercial Banks, Co-operative Banks and RRBs were 110 per cent, 95 per cent and 83 per cent, respectively of





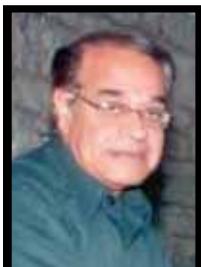
ARD believed in the core philosophy of three main platforms of ‘institutions’, ‘people’ and ‘State’ that ultimately three converge on people, and more importantly for a country like India, the people with small means. As shown in Fig 75, NABARD provided a total financial support of Rs 1,27,011 crore in 2013-14. This is a significant increase by 22% as compared to the previous year of Rs 1,03,923 crore extended during 2012-13. Different forms of support by NABARD included

- refinance to Rural Financial Institutions (RFIs) for extending short term and long term investment credit
- direct lending to co-operatives
- support to State Governments under Rural Infrastructure Development Fund (RIDF)
- support to State owned institutions/corporations under NABARD Infrastructure Development Assistance (NIDA) and
- NABARD Warehousing Fund and development initiatives including natural resource management, micro finance, non farm sector, technology transfer, etc.

their targets.

In India, National Bank for Agriculture and Rural Development (NABARD) is the torch bearer of farm

credit. As a financial institution with a focus on development, NABARD actively engages in financial operations and development initiatives. NAB-



Y.C. NANDA

SOME ISSUES IN AGRICULTURAL CREDIT

Credit needs of small and marginal farmers are not only growing but also getting diversified, due to increased commercialization and modernization of Indian agriculture. Small and marginal farmers are no longer subsistence farmers of a few decades back when the use of purchased inputs and hence need for credit was not a very substantive issue. Small/marginal farmers used their own seeds, labor and mostly organic fertilizers and were satisfied with whatever they were able to grow. If the nature was kind, the crop was good and the farmers were happy as food was available. If the nature was unkind, then the poor crop was attributed to the act of god and had to be accepted. The situation has changed a lot as commercialization of agriculture is getting widespread, the access to credit, its timeliness, adequacy, affordability and convenience is becoming important for the small and marginal farmers too. Due to non-availability of credit, the resource less farmers are often driven to money lenders, traders etc where the terms of credit are more often ex-

ploiting. We are already witness to the problems caused by constraints in credit delivery. It is not uncommon to see resource-less farmers buying spurious seeds from fly by night operators and getting insecticides/pesticides orders which the trader want to sell rather than what the farmers require for their farm and this has lead to disastrous consequences. On a macro level, this is a paradoxical situation. The institutional credit for agriculture has been increasing rapidly and has shown over 14 per cent growth per annum on a decadal basis. In absolute terms, the total credits flow for agriculture during 2012-13 was Rs. 607375 crore against a target of Rs. 575000 crore. The increase over the previous year i.e., 2011-12 and 2012-13, agency wise credit flow is shown below.

Thus between 2002-03 and 2012-13 the ground level agriculture credit flow increased from Rs. 69560 crore to Rs. 6,07,375 crore i.e. nearly by eight times, which in itself is remarkable. However, there are certain features which need to be taken note of these are discussed in the following paragraphs.



Decline In Share Of Cooperative Banks In The Ground Level Credit Flow

The cooperatives which were nearly the source of institutional credit till the sixties have a share of less than 20 per cent now, this has serious implications because they have been the most significant providers of credit to small and marginal farmers. According to agricultural statistics at a glance, 2009 published by the Ministry of Agriculture, GOI in the year 2001-02, only 14 per cent of the holdings of less than one hectare received institutional credit on all India bases and 75.3 per cent had received credit from the cooperatives banking system. It also means that less than 3.5 per cent of marginal holding (less than one Ha) in size had received credits from commercial banks, RRBs etc. Similarly, in the holding size between one hectare and two hectare, only 20 per cent received from the cooperatives and the remaining from all other banks. Analysis showed that only 2.6 per cent of the holding between one hectare and two hectare had received credit from the commercial banks alone.

The cooperative banking system, which is structurally more suitable for farmers particularly the small and marginal farmers, has suffered a lot due to governance deficit and also the policies adopted by RBI/NABARD. They cannot be blamed for the policy aberrations as the agricultural development had been the priority of the government and

Regional Imbalance in Credit Disbursement and Gross Cropped Area during 10th And 12th Five Year Plan

Region	Gross cropped area % share	10th plan period % credit share	11th plan % credit share
Northern	20.11	28.69	27.44
North eastern	2.83	0.38	0.44
Eastern	14.65	6.67	7.27
Central	27.26	15.10	13.20
Western	16.47	14.17	14.10
Southern	18.68	34.99	37.55
Total	100	100	100

keeping in view the inadequacies of the banking architecture, the state/RBI/NABARD had to rely heavily on the cooperatives for meeting the credit need of the sector, sometimes ignoring the long-term sustainability issues of the cooperatives credit structure itself.

Shift Towards Large Loans By Commercial Banks

Based on the data available in the basic statistical returns published in various issues by the RBI, it is observed that between 1990 and 2010, the share of credit limits of less than Rs 2 lakh in the total agricultural loans outstanding of

the commercial banks declined from 82.6 per cent to 44.3 per cent and the share of credits limits exceed by Rs 10 lakhs increased from 13.1 per cent to 33.1 per cent. This is a clear trend in favor of credits depending but against credit widening which by passed small /marginal farmers.

Increase In The Share Of Urban Branches In The Agricultural Loans Outstanding Of The Commercial Banks

Between 1990 and 2011 the share of agricultural loans outstanding in the case of urban branches of banks increased from a level of 14.9 per cent to 33.1 per cent. Even in the case of direct agricultural loans outstanding in case of urban branches of banks increased from a level of 14.9 per cent to 33.1 per cent, even the share of urban branches increased from 11.2 per cent in 1990 to 25.5 per cent in 2011.

The details above also create some doubts about the quality of reporting based on which the credit flow data is made available. Large agricultural lending by urban branches and loans above Rs 10 lakh may not be entirely for agricultural purposes. The quality of data needs to be looked at closely for a more realistic/accurate data relating to agricultural credit in the country.



Agency Wise Ground level Credit Flow for Agriculture (Rs in Crores)

Agency	2002-03	2008-09	2011-12	2012-13
Co-operatives	23,716	45,966	87,963	1,11,203
Regional Rural Banks	6070	26,765	54,450	63,681
Commercial Banks	39,774	2,28,951	3,68,616	4,32,491
Total	69,560	3,01,682	5,11,029	6,07,375

Indebtedness of Farmer Household

Sno	Source of Borrowing	% Farmers Household Indebtedness
1	Banks	22.7
2	Co-operative Societies	21.7
3	Government	2.5
4	Professional Money lenders	24.1
5	Relatives and friends	15.0
6	Traders	10.0
7	others	4.2
	Total	100

Regional Imbalance

There are wide disparities in the disbursement of agricultural credit in different regions. Though this could be partly attributed to difference in credit requirements, absorption capacity of borrowers in different regions, the disparity appear too large to the explained above. The table below shows the regional imbalance in credit disbursement and gross crop area during 10th and 11th five year plan period.

It would be seen that the north-Eastern, eastern and the central region together had 44.74per cent of the gross cropped area of the country but received only 22.15per cent of the total credit during the 10th plan period and declined to 20.91per cent of the total credit during the 11th five year plan period.

The Problem of Access to Institutional Credit :

Access to institutional credit is an important issue and the problem is more acute for small/marginal farmers and also farmers in non-irrigated areas. According to the NSS report no 498- situation assessment survey of the farmers –indebtedness of farmers'household-NSS 59th round

2005, the professional moneylenders had the highest percentage of farmers' households indebted to them. The position is shown in table below:-

It is very disturbing that even after 45 years of nationalization of private sector banks; the outreach of the banks was lower than that of

the money lenders in the case of farmers' household. The findings of the rural finance access survey done by the World Bank and NCAER in Andhra Pradesh and Uttar Pradesh in 2003 indicate that only 19per cent in U.P had access to formal credit while 56per cent and 51per cent of AP and UP were dependent on private source for credit. The above survey also revealed that in A.P only 11.8per cent of the marginal farmers and 13.5per cent in UP had access to formal credit sources. The above survey also revealed that the quality of credit provided by the banks was also poor. On average, loan approval in rural areas took 33 weeks in the case of commercial banks, 28.5 weeks in the case of RRBs and 24 weeks in the case of cooperatives. The survey also pointed out that in 26.8per cent cases bribe was demanded in the case of commercial banks for loan approval. This percentage in the case of RRBs and the cooperatives was 21 and 9.7 respectively. The borrower also pointed out about inadequate amount of loan sanction which partly defeated the purpose of loan itself.

The extremely low coverage of small/marginal farmers and the poor quality of credit from the formal credit

institutions is a serious issue both from the borrowers and lenders view point as also for equity consideration and the overall agricultural development in the country. It is pity that as on 31st march 2010, 15 out of 27 public sector banks had failed to meet the credit targets of the 10per cent of the net bank credit to weaker section which includes lending to small/marginal farmers. Not only the target of loans to weaker section was not met, the direct agriculture loan target under priority sector at 13.5per cent of net loan outstanding was also not met by 25 out of 27 public sector banks. The non achievement of these targets by public sector banks causes some doubt about the seriousness on the part of these banks in achieving the priority sector targets as the informal sector appears to be quite active in meeting the credit needs of farmer.

It is encouraging to note that the RBI has finally realized that a change in banking architecture is needed and is moving ahead in the matter of allowing a new set of banks i.e. small banks, payment banks etc. to fill in the void. The government's move in furthering financial inclusion and incentives for setting up of producer's company and other institutional structure for bringing the small/marginal farmers together are excellent development and one wishes for a brighter future for the distressed farmers of India. It is also hoped that attempts would continue to be made with all seriousness to improve the cooperative credit system which structurally appears to be more appropriate for the rural areas.

*The author is Former Chairman,
NABARD*