AGRICULTURE TODAY
The National Agriculture Magazine

AGRICULTURE YEAR BOOK 2016

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Editorial Note

Dear Readers,

Aligned with our idea of bringing out the best of the agriculture sector, we introduce you to the ninth edition of the Agriculture Today Year Book. The edition is the fruitful culmination of the efforts of a spirited team and most importantly, the faith of the readers who have lent their absolute support which till date has remained our strongest ally. Agriculture Today has remained in the Indian scene for close to two decades now, since its launch in 1998, and stood the test of time due to the constant encouragement and faith reposed on us by our loyal readers. The magazine, over the years, has become the platform to discuss and debate topics of agricultural relevance.

Agriculture Today Year Book of 2016 features articles penned down by some of the most illustrious personalities of Indian and global agriculture. These articles are snippets of knowledge extracted from different planes of the world agriculture, discussing the most pressing and critical challenges encountered in today's agriculture. They also bring forth innovations and initiatives from around the world to get inspired and replicated elsewhere. The year book 2016, has also 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 2016 without which the publication would have remained a mere vision. Their timely and valuable contributions were critical 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. Our best efforts have gone into the creation of the Year Book. At the same time, we also believe that there is always room for improvement. 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 9th Agriculture Leadership Summit 2016 and Dr. MJ Khan, Chairman, Indian Council of Food and Agriculture for their valuable guidance. I am also thankful to my colleagues specifically Mr. Pinaki Ranjan Dey, Ms. Fariha Ahmed, Ms. Sonam Singh and Mr. Abdul Rehman for their untiring efforts in compiling and editing the Agriculture Year Book 2016.

Anjana Nair

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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, 80% of Basmati export is done by AIREA members.

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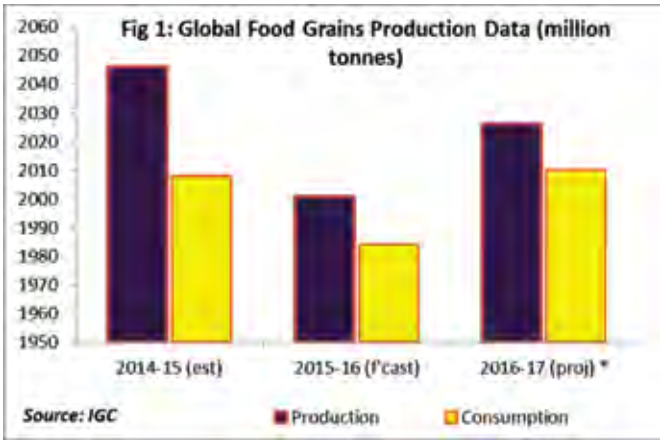
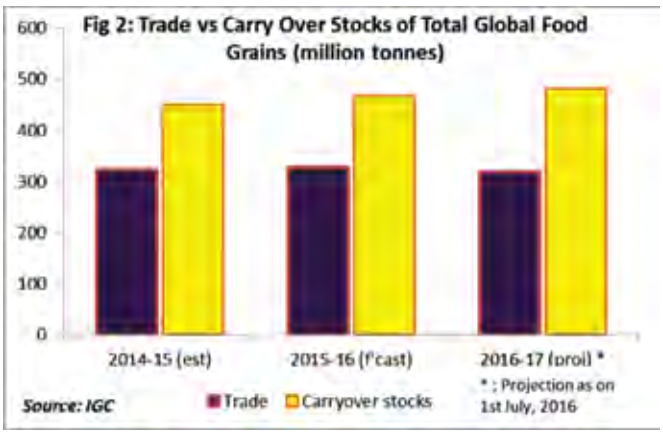
AGRICULTURE

INTERNATIONAL SCENARIO

Global Agricultural Production

The total production of foodgrains globally is projected to be 2026 million tonnes in 2016-17. This is a marginal increase of about 1.2% from the 2001 million tonnes of 2015-16 but a drop of about 1% when compared to 2046 million tonnes of 2014-15 (Fig 1). On the other hand, the global consumption of food grains in 2016-17 is projected to increase when compared to the global consumption in 2015-16. In 2015-16, the global foodgrains consumption was 1984 million tonnes which was a decrease of about 1% from the consumption figures of 2014-15 which was 2008 million tonnes. According to forecast from the International Grains Council, in 2016-17, the total consumption of foodgrains is going to be about 2010 million tonnes.





The total amount of grains traded globally has shown a fluctuating trend in the period of three years from 2014-15 to 2016-17 (Fig 2). A total of 322 million tonnes of food grains were traded in 2014-15. This increased marginally to 3229 million tonnes in the following year of 2015-16. However, in 2016-17, the total amount of foodgrains to be traded globally is projected to decrease by a marginal amount to 319 million tonnes. The amount of carryover stocks have increased consistently in the three years period from 2014-15 to 2016-17. From a carryover stock of 450 million metric tonnes in 2014-15, the carryover stock increased by almost 4% to 467 million metric tonnes in the following year of 2015-16. The carryover stock in 2016-17 is projected to be around 482 million metric tonnes, marking an increase of 3.1%. Adequate rains in recent months across regions like the European countries, the CIS and North America have improved the production prospects of Wheat and Barley. Heavy supplies coupled with attractive prices raise is forecasted to be a driver for greater consumption of Wheat and Barley as feeds, but the demand for maize in the livestock sector is projected to be cut by a more or less an equivalent amount.

Although there is a promise of greater yields of Wheat and Barley from regions like Europe, the CIS and North American countries, overall world Wheat and Barley harvests are still expected to be smaller year-on-year.

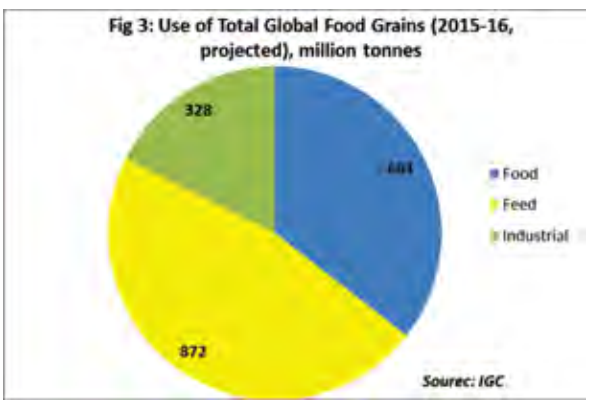
The use of total global food grains as food was 661 million tonnes in 2015-16. This is about 33.3% of the total food grains consumption during the same year and 33% of the total food grains production in the same year. The major portion of the global foodgrains was utilized as animal and poultry feed. In 2015-16, as much as 872 million tonnes of food grains were used in this sector. This is almost 44% of the total consumption of foodgrains and also 43.5% of the total global production during the same year. Consumption of foodgrains for industrial use was 328 million tonnes in 2015-16 which accounts to 16.5% of the total consumption and 16.4% of the total production of food grains globally in the year 2015-16 (Fig 3).

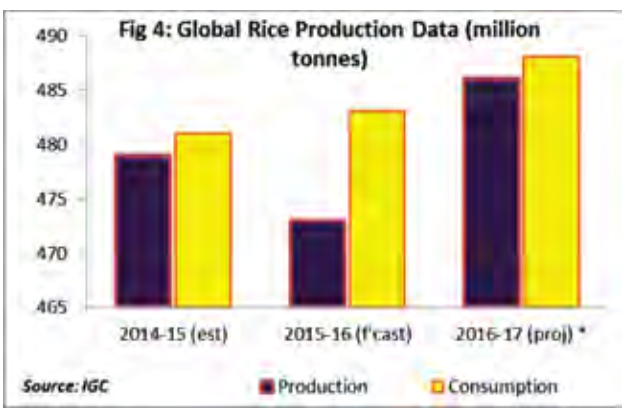
The production of Rice globally exhibited a fluctuating trend in the past few years. In 2014-15, the global production of Rice was 479 million tonnes. This decreased to 473 million tonnes in the following year of 2015-16, registering a year on year decline of 1.2% (Fig 4). The 2016-17 global rice projection is seen at a new peak driven mainly by improved crops in Asia and particularly in India. In 2016-17, the

Table 1: FAO Price Indices of Rice for Recent Years (With 2002-2004=100)

Year		Varieties				All Varieties
		Indica				
		Superior Quality	Lower Quality	Japonica	Aromatic	
2012		225	241	235	222	231
2013		219	226	230	268	233
2014		207	201	266	255	235
2015	July	182	185	265	175	211
	August	179	182	267	175	210
	September	176	176	266	168	206
	October	179	175	251	154	199
	November	180	178	244	146	196
	December	180	181	242	152	197
2016	January	179	181	240	149	196
	February	180	181	243	148	197
	March	180	184	242	142	196
	April	181	187	236	145	195
	May	191	195	230	151	199
	June	191	198	223	159	198

Global Rice production is projected to increase to 486 million tonnes. This is an increase of 2.6% when compared to the previous year of 2015-16 and 1.4% increase when compared to 2014-15. Unlike fluctuating production during the period of three years from 2014-15 to 2016-17, the consumption of Rice is however maintaining an increasing trend. In 2014-15, the total global consumption of this grain was 481 million tonnes which increased marginally to 483 million tonnes in 2015-16. The total consumption of Rice in the current year of 2016-17

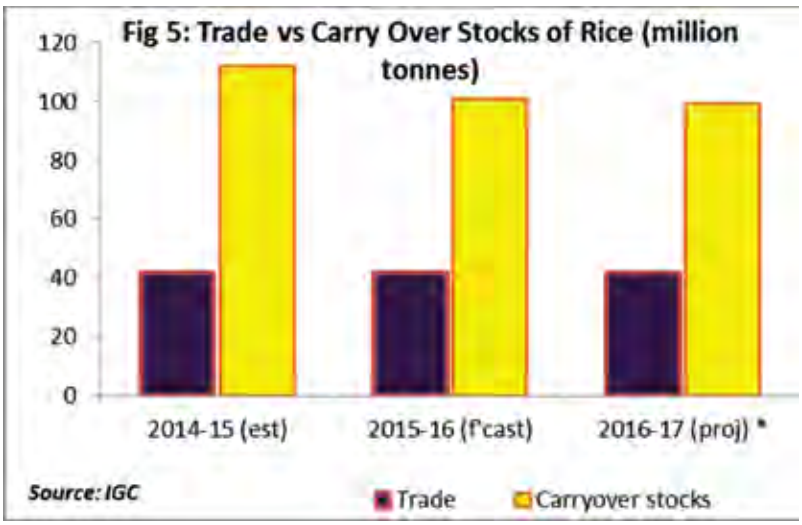




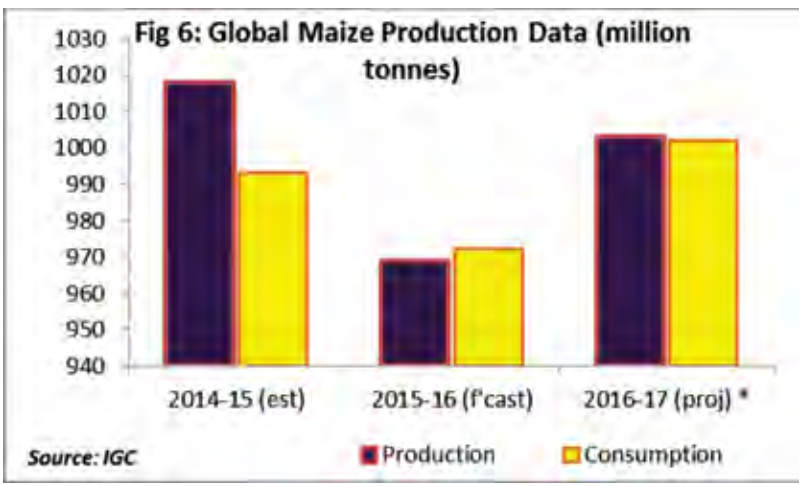
is projected at 488 million tonnes. Agriculture Today Year Book also studied the FAO Rice Market Monitor to understand the very latest trend in terms of production of Rice globally. Based on current weather and planting indications as latest as July 2016, according to the FAO market indicator, forecast of World Paddy production in 2016 is 746.8 million tonnes. This is an increase of 1.3 million tonnes as compared to the previous year. When translated in terms of milled basis, this is equivalent to 496.0 million tonnes. The bullish forecast is mainly driven by good production prospects during the current year in countries like India, the Lao People's Democratic Republic, Pakistan and the United States. The outlook was also upgraded for Egypt, the United Republic of Tanzania and Colombia. However, for countries like Bangladesh, Brazil, China, Nicaragua and Sri Lanka, the outlook was downgraded a little during July 2016.

We also took a look at the price indices of Rice in some of the recent years and recent months as calculated by FAO with prices of 2002-2004 as 100. FAO calculated the price indices based on 16 export quotations. For defining superior and lower quality standards, it has considered superior quality as those which contain less than 20% of broken kernels and otherwise higher or equal to 20% as lower quality rice.

Figure 5 provides an overview of the trade versus carryover stocks of Rice in the recent three years period of time. The global trade of Rice has remained at a constant level of 42 million tonnes from 2014-15. This year too it is projected to be at the same level. However, the global carryover stocks of Rice is decreasing at a marginal rate. In 2014-15, the global carryover stock was 112 million tonnes which decreased in both the following



years of 2015-16 and 2016-17 to 101 million tonnes and 99 million tonnes respectively. According to analysis by FAO, draw downs are expected to be most pronounced in the major Rice exporters like India and Thailand. This would be mainly because of the sustained efforts by the Governments of these countries to consistently reduce mammoth government reserves. Out of the five major exporters, only the United States is anticipated to face a build-up. This shall consequently lead to a situation where stock-to-disappearance ratio of the major exporting group of five countries falling to its lowest level since 2007-08. This is estimated to be around 15% decrease.



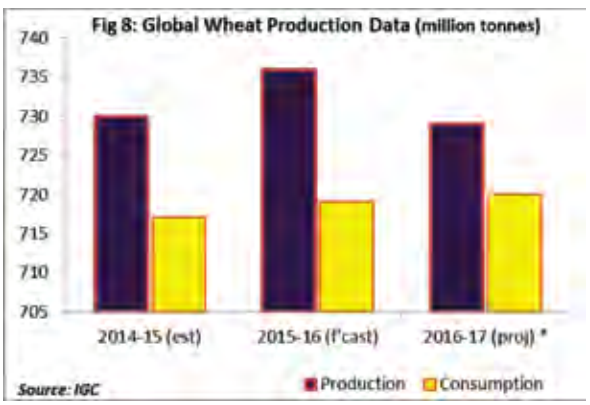
One of the most important food grains is Maize and globally, the production of Maize has witnessed a fluctuating trend in the recent years. The global Maize production witnessed a substantial decline by 5% in 2015-16 as compared to 2014-15. The global production decreased from 1018 million tonnes in 2014-15 to 969 million tonnes in 2015-16. The production is however projected to increase to 1003 million tonnes in the current 2016-17 (Fig 6). In this way, Maize production is projected to post a formidable recovery from low global production during the recent years. Despite the fact that the projected production figures during the current years are still lower than that of 2014-15, prospects for Maize production continue to improve. However, it is anticipated that because of the wet finish to the growing season in several countries, average quality might sustain a negative impact.

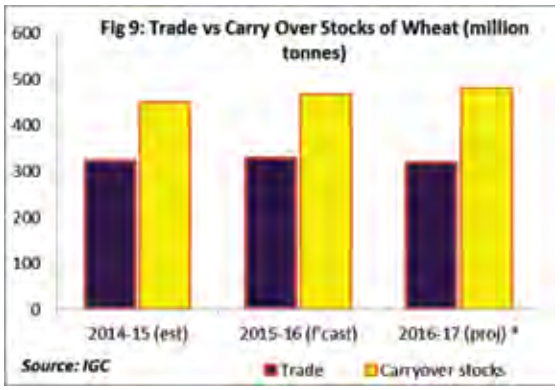
The global consumption figures of Wheat similarly reveal a fluctuating trend in the recent years. The consumption of Wheat in 2014-15 was 993 million tonnes which dropped to 972 million tonnes in the following years (2015-16). However, the current year (2016-17) projection of global Wheat consumption is higher at 1002 million tonnes.

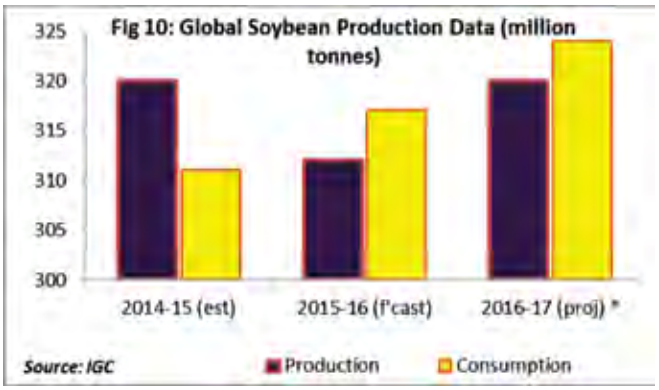
The global trade of Maize as well as the carryover stocks have remained more or less consistent in the recent

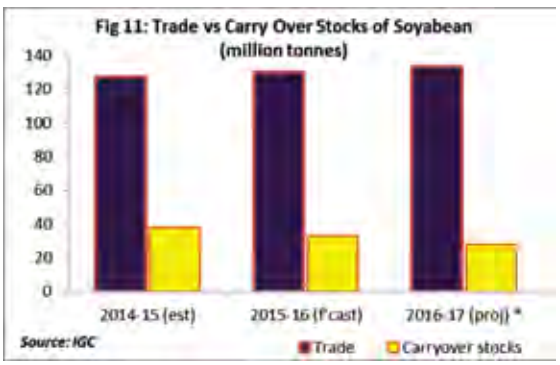
years. In 2014-15, the trade was 125 million tonnes globally which increased to 130 million tonnes the following year (2015-16). The global trade during the current year of 2016-17 however has been forecasted on a marginally lower side at 128 million tonnes (Fig 7). The decrease is mostly as a result of a deteriorated outlook for Brazil and China. In Brazil, dry weather impaired prospects for the second Maize crop. Expectations for Maize output in China were similarly downscaled because of the reason that plantings contracted following reduced government support.

Global Wheat markets are projected to be adequately supplied in the current year of 2016-17 despite a forecast of decline in global production. Total Wheat output in 2016-17 is projected at about 729 million tonnes (Fig 8). This signifies a decrease of 1%, or 7 million tonnes, from the 2015-16 production of 736 million tonnes. Experts tracking the global market attribute the decline in the current year production mostly to the expected lower year-on-year outputs in the EU to the tune of 6.5 million tonnes, decrease forecast in the Wheat production in Morocco by 5 million tonnes, in Ukraine by 4.5 million tonnes, and in the United States by 1.4 million tonnes. An improvement









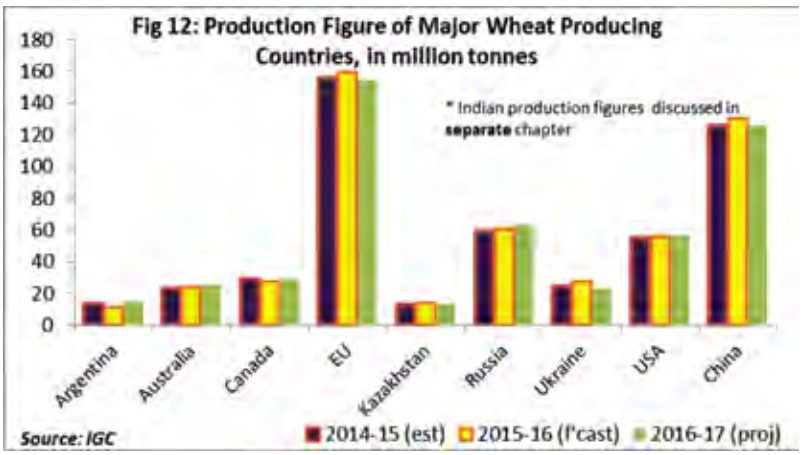
in yields is mainly behind the expected production rise, despite some dryness in countries like Pakistan, where dry weather spells affected rainfed crops, lowering the 2016 wheat forecast from earlier expectations.

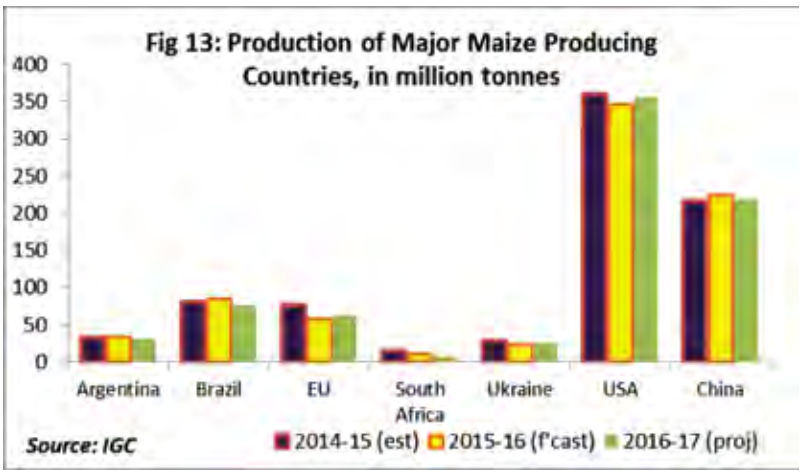
The total global consumption of Wheat shows a relatively consistent trend in the period from 2014-15 to 2016-17. Total Wheat consumption in 2016-17 is projected to be about 720 million tonnes, which is a marginal increase from 719 million tonnes in the previous year of 2015-16. However, this consumption of Wheat in 2015-16 globally was a marginal increase from 717 million tonnes in 2014-15.

Based on the latest production prospects for 2016 and the projected consumption in 2016-17, world Wheat carryover stocks by the close of crop seasons in 2017 are projected to increase for the third consecutive year, reaching 482 million tonnes, which is almost 3.2% percent than the level of carryover stocks in the previous year of 2015-16 at 467 million tonnes. In 2014-15, the stocks were 450 million tonnes. The global Wheat trade however witnessed quite a bit of fluctuations in the recent times. In 2014-15, the total global trade was 322 million tonnes which increased by about 2% in the following year of 2015-16 at 329 million tonnes. However, in the current year global wheat trade is projected at a lower level at 319 million tonnes. This decline is projected from the anticipated decline in purchases by several countries in Asia and South America during 2016-17. This decline may result in reduced export from countries like reduced sales by the EU, the Russian Federation and Ukraine. However, shipments from countries like Argentina, Australia, Canada and the United States are expected to remain unaffected and rather may increase.

When talking about global Oilseed production, the forecast for this year (2016-17) is higher for Soybeans. A seemingly larger Soybean crop projection for the United States and Canada is set to offset a minor reduction in production in Ukraine. According to projections, the global Soybean production in the current year of 2016-17 is 320 million tonnes, an increase of 8 million tonnes from the previous year in 2015-16. The global production figures in 2014-15 were also 320 million tonnes like the projections of this year. In 2015-16, the global Soybean production took a beating following heavy El Nino-related losses in South America (Fig 10).

On the global consumption front in Soybeans, 2016-17 is projected to witness an increase in the consumption of soybean as compared to the previous year. The global consumption is projected to increase to 324 million tonnes from 317 million tonnes of the previous year. In 2014-15, the total global Soybean consumption was 311 million tonnes. It has been observed that the share of Soymeal in total inventories is steadily increasing over the years. This is mainly due to ample supplies and competitive prices that are boosting Soybean meal transactions worldwide.



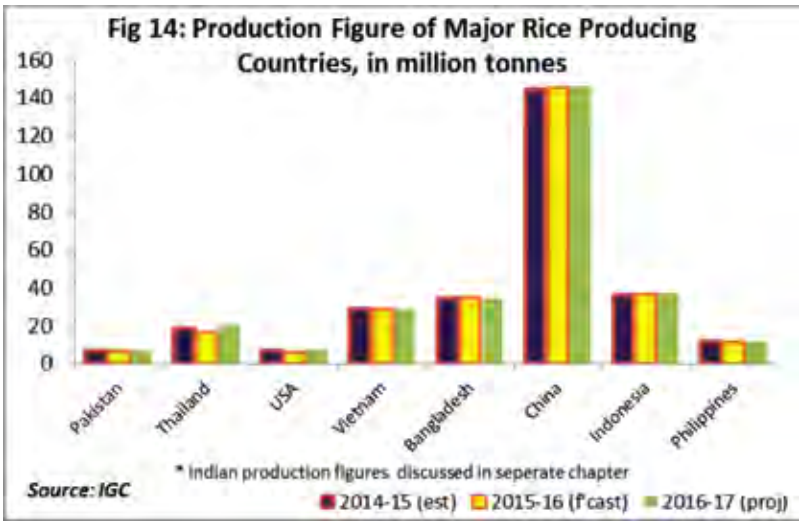


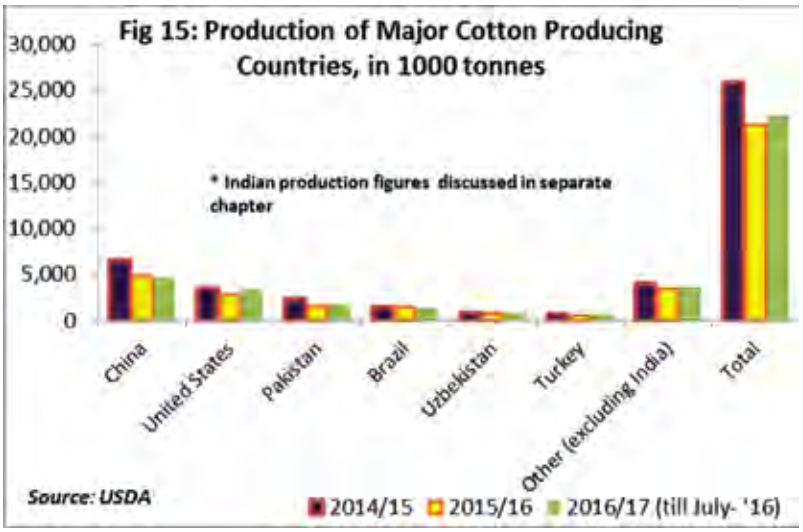
Globally, 133 million tonnes of Soybeans are projected to be traded in 2016-17. This marks a marginal increase from 130 million tonnes in the previous year of 2015-16. In 2014-15, the total amount of Soybeans traded globally was 127 million tonnes (Fig 11). However, prospects for 2016-17 are highly tentative given that fieldwork in South America for Soybeans will not begin until September and ultimate production will have a significant bearing on the trade. Underpinned by demand for Soybean products, trade has been projected on a higher trajectory by the continued growth in China's protein meal requirements. The export prices of soybeans are also expected to increase this year.

The global carryover stocks of Soybeans are however dwindling consistently in the recent years. From a level of 38 million tonnes in 2014-15, the global stock of soybeans have dropped to 28 million tonnes as projected this year in 2016-17. This is a significant decrease of 26%. In 2015-16, the global stock was 33 million tonnes. During the recent years, countries like Argentina, Australia, Brazil, Canada, China, India and the EU have downsized their stocks in order to offest poor domestic supplies and also in some cases to support higher exports. The biggest drawdown was in Argentina, where high reserves were scaled down to sustain the expansion in exports. In China, the government, after discontinuing public soybean procurement, intensified its efforts to dismantle state stockpiles.

As seen in Fig 12, as a country, China leads the global Wheat production. In 2014-15, the total Wheat production in China was 126.2 millon tonnes which increased to 130.2 million tonnes in the following year of 2015-16. However, this year in 2016-17, the production is set to decline marginally with the projected production at 126 million tonnes. As a region, the European Union produced 156.1 million tonnes of Wheat in 2014-15 which increased to almost 160 million tonnes in 2015-16. However, the production in EU is projected to marginally decrease to 154.6 million tonnes in 2016-17. India is alo a signifacant Wheat producer globally and currently is the second highest producer as a country behind China (production data of India has been discussed separately in the subsequent chapter). Among the other major producers of Wheat, Russia produced 59 million tonnes in 2014-15 which increased to 61 million tonnes in 2015-16. This year, the projected production of Wheat is 63 million tonnes.

Figure 13 depicts the production scenario of major Maize producing countries in the world. USA and China stand out apart from the other major Maize producing countries. In 2014-15, USA produced a total of 361.1 million tonnes of Maize, whereas for China, the production was 215.6 million tonnes. While the production in the subsequent year in 2015-16 dropped in USA, China recorded an increased production of Maize in the same year. In 2015-16, the total production of Maize in USA was 345.5 million tonnes and that in China was 224.6 million tonnes. However, this year, the reverse trend is projected to occur where USA is projected to witness increased Maize production whereas in China, the production is projected for a marginal decline. In 2016-17, the total Maize production in USA is projected



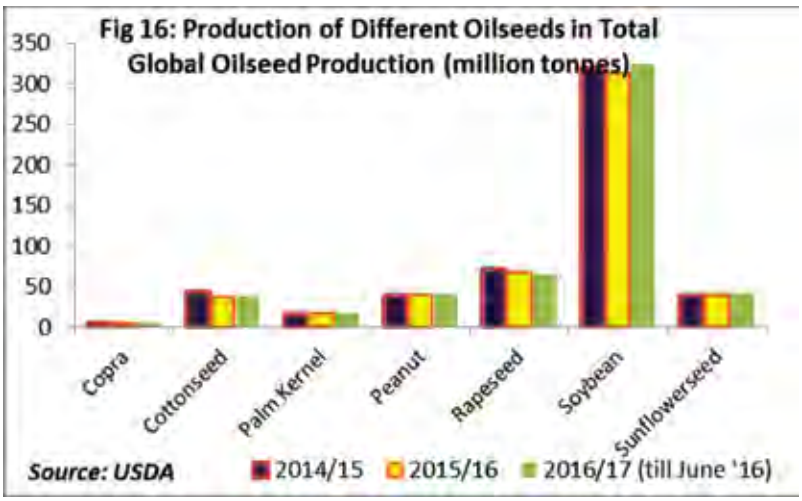


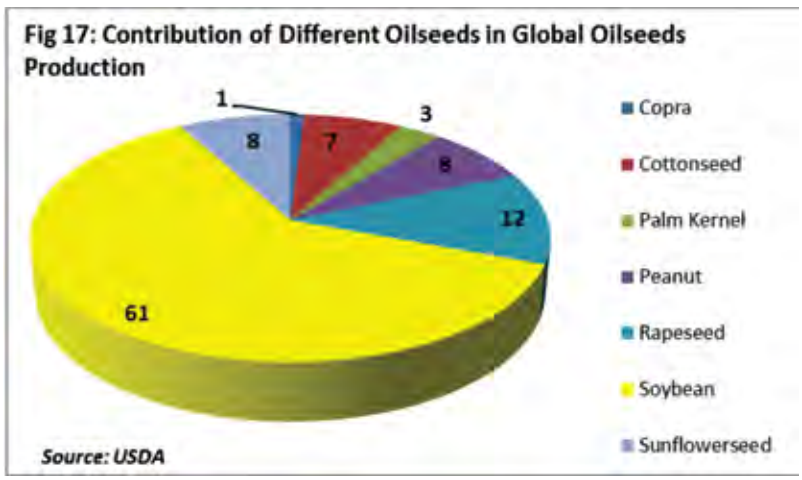
at 355.3 million tonnes and in China, 219 million tonnes of production. As a country, Brazil is another significant producer of Maize. The production in 2015-16 was almost 85 million tonnes which was an increase from about 80 million tonnes in 2014-15. In 2016-17, Brazil is projected to witness a marginal decline in Maize production owing to a slight decrease in cultivated area. It is noteworthy that the European Union in the recent years has been witnessing fluctuating Maize production. In 2014-15, the total Maize production was 76.2 million tonnes which declined sharply to 58.2 million tonnes in the year 2015-16, marking a significant 24% decline. According to this year's projections, Maize production in the EU is expected to regain marginally and increase to 63 million tonnes.

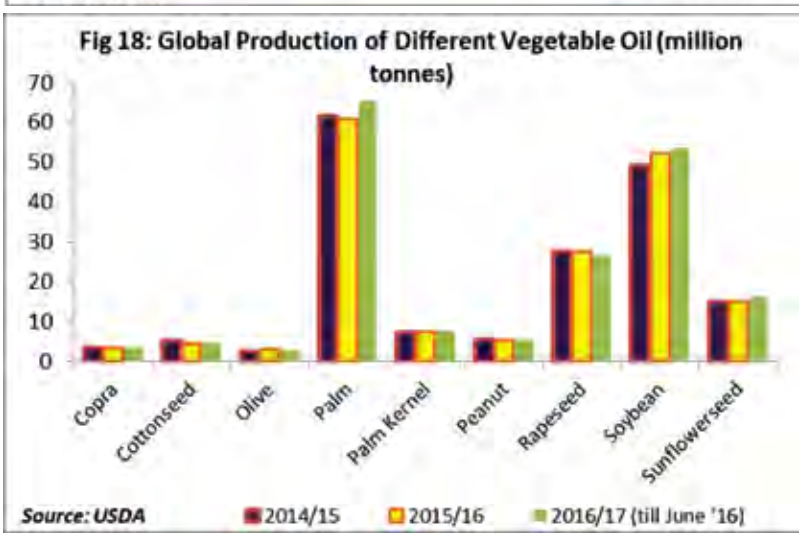
China is the global leader in Rice production and in 2016-17, the total production of Rice in China is projected at 146.3 million tonnes (Fig 14). This is a marginal increase from 145.7 million tonnes in 2015-16. China had produced 144.6 million tonnes of Rice in the previous year of 2014-15. This indicates that the production of Rice in China has remained consistent in the recent years. India is the second largest producer of Rice globally and the production figures are discussed in details in the subsequent chapters. Bangladesh and Indonesia have emerged as the other major Rice producers globally. In 2014-15, Bangladesh and Indonesia produced 34.5 and 36.3 million tonnes of Rice respectively. Both the countries maintained the same level of production in the following year of 2015-16. In the current period of 2016-17, while Bangladesh is again projected to maintain the same production of 34.5 million tonnes, production is marginally going to increase in Indonesia in 2016-17 to 37.5 million tonnes. Vietnam is another major Rice producing country that has been consistently producing around 29 million tonnes of Rice in the recent years.

The global Cotton production scenario of different countries is depicted in Fig 15. For 2016-17, world production and beginning stocks are forecasted to decline. This is mainly due to the predicted lower production in India and China. This lower production is unable to offset the forecasted higher production in the United States and Australia. Consumption is forecast to be higher due to a large increase in China being only partially offset by declines in India and Pakistan. Indian production which is one of the highest in recent times in the world has been discussed separately in another chapter.

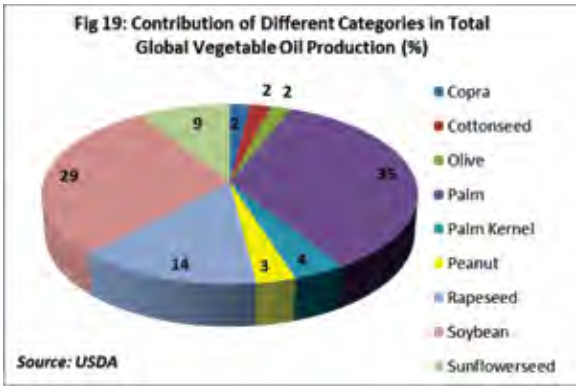
The projected production of Cotton in 2016-17 is 4681 thousand tonnes which is a minor decline from 4899 thousand tonnes in the previous year of 2015-16. USA had experienced a significant decline in production in 2015-16 compared to 2014-15. From a total Cotton production of 3553 thousand tonnes in 2014-15, USA recorded a significant decline of 25% production in 2015-16 at 2806 thousand tonnes. 2015-16 had witnessed a sharp decline on the overall global Cotton production scenario as compared to the previous year of 2014-15. The global production of Cotton decreased to 21.3 million tonnes in 2015-16 from about 26 thousand tonnes in 2014-15. This was a decrease of about 18% in overall production. The projected production of Cotton globally in 2016-17 is marginally higher at 22.3 million tonnes. Other than USA, countries like Pakistan and Turkey are expected to drive the increase this year. Cotton production in Pakistan is projected at 1742 thousand tonnes while in Turkey, the total cotton production is projected to reach 653 thousand tonnes, an increase from 577 thousand tonnes in the previous year.

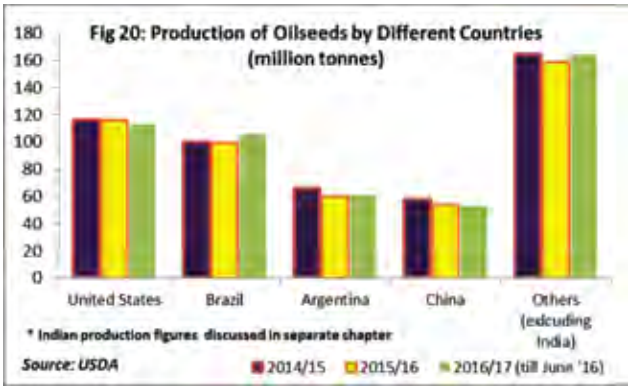


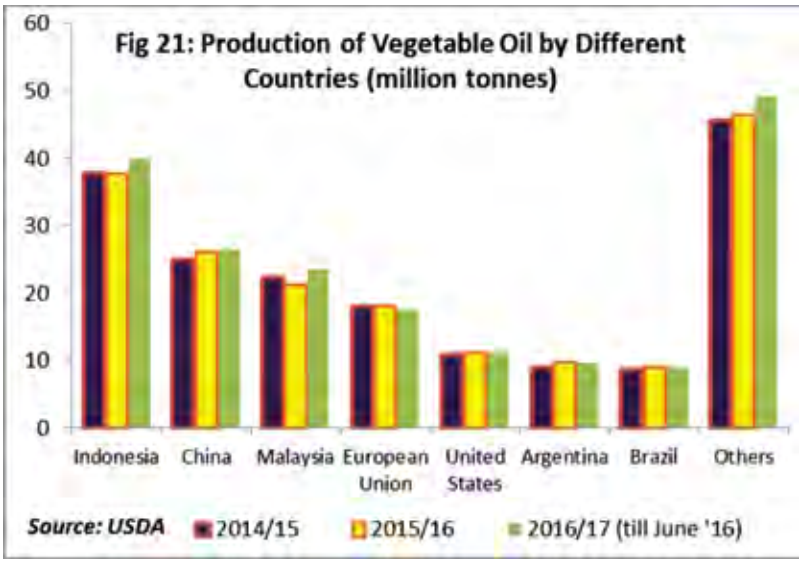




Soybean leads the pack when it comes to the global oilseeds production scenario. This year, larger soybean crop projections for the United States and Canada are expected to partially offset a projected reduction in production for Ukraine. As seen in Fig 16, other than Soybeans, the other major Oilseed crops are Cottonseed, Rapeseed and Peanut. Production of Cottonseed has been declining in the recent years from 2014-15 till the current 2016-17 cropping year. The production declined from 44.33 million tonnes in 2014-15 to 36 million tonnes in 2015-16. However, in 2016-17, the production of Cottonseed is projected to increase to 39 million tonnes. The global production of Peanut has remained constant in the last two years at 40 million tonnes and even this year, the projection remains the same. Production of Sunflower seeds is projected to increase in 2016-17. After maintaining equal productions in both 2014-15 and 2015-16, at 39 million tonnes, the production of sunflower seeds is projected to increase to 42 million tonnes in 2016-







17. Global Sunflower seed production is expected to increase riding on larger projections for the European Union and Moldova. Copra and Palm kernel are the other notable Oilseeds in the global production scenario. In 2016-17, there is a reduced Rapeseed production forecast in the European Union. However, this is going to be offset by production gains in countries like Canada and Russia.

Fig 17 depicts the percentage share of different types of Oilseeds in the total production of Oilseeds globally. Soybeans constitute an overwhelming 61% share of the global Oilseeds. Rapeseeds constitute 12% of the total production followed by Peanut and Sunflower seeds each at 8%. Cottonseed, Palm kernel and Copra constitute respectively 7%, 3% and 1% of the total global production. In fact in the global scenario, Oilseeds are also studied in three major groups. They are: Oilseeds (consisting of Copra, Cottonseed, Palm kernel, Peanut, Rapeseed, Soybean and Sunflower seed), Meal (consisting of Copra, Cottonseed, Fish, Palm kernel, Peanut, Rapeseed, Soybean and Sunflower seed) and finally Oil (Coconut, Cottonseed, Olive, Palm, Palm kernel, Peanut, Rapeseed, Soybean and Sunflower seed).

It is interesting to note that though the contribution of Soybeans constitutes an overwhelming 61% of the total Oilseeds production in the world, it is not the largest contributor in the global Vegetable Oil production. The leading contributor to the total Vegetable Oil production in the world is Palm. In 2014-15, the total Palm Oil produced in the world was 62 million tonnes which marginally decreased to 61 million tonnes in 2015-16. It's projected production in 2016-17 is 65 million tonnes (Fig 18). Total production of Soybean Oil in 2014-15 was 49 million tonnes. It increased to 52 million tonnes in 2015-16 and this year, the total Soybean Oil is projected to be around 54 million tonnes. Production of Rapeseed Oil in 2014-15 was 28 million tonnes and it decreased marginally to 27 million tonnes in 2015-16. The projected rapeseed oil production in 2016-17 is 26 million tonnes. When studied in terms of percentage contribution as depicted in Fig 19, is seen that Soybean Oil constitutes 29% of the global Vegetable Oil production. The largest share of Palm oil as already discussed contitutes 35% of the total production. Rapeseed and Sunflower oils constitute respectively 14% and 9% of the total Vegetable Oil production across the world.

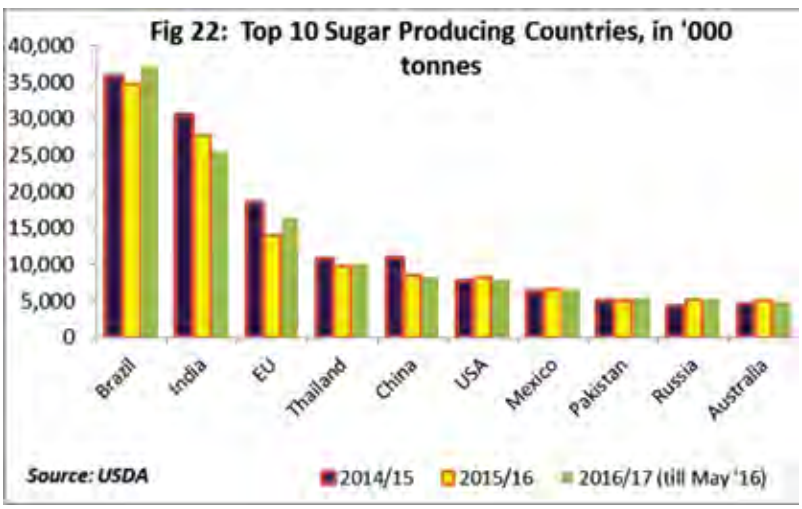
The global Oilseeds production is led by the USA followed by Brazil, Argentina and China. India ranks among the top five countries. Oilseeds production figures of India is discussed separately in the subsequent chapter. In 2014-15, USA produced 116 million tonnes of oilseeds which remained the

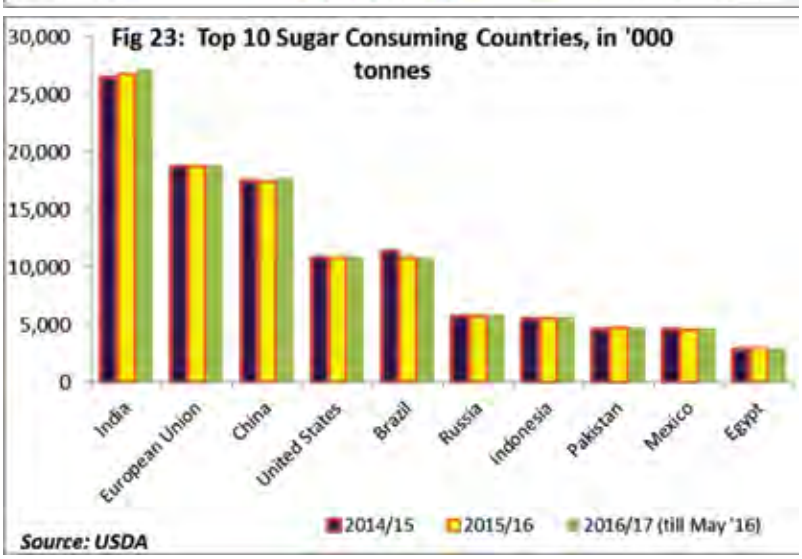
same in the following year of 2015-16 (Fig 20). This year, the production of Oilseeds in USA is projected to decline marginally to 113 million tonnes owing to a marginal decrease in area under cultivation. In the global Oilseeds production scenario, Brazil follows closely after USA and in 2014-15, the total production of Oilseeds by Brazil was 100 million tonnes which decreased by 1 tonne in 2015-16. This year, Brazil is projected to produce 106 million tonnes of Oilseeds. Argentina is maintaining a production of around 60 million tonnes, while China is projected to produce 53 million tonnes in 2016-17.

Indonesia leads the world in Vegetable Oil production (Fig 22). After maintaining a production of 38 million tonnes each year in 2014-15 and 2015-16, the projected Vegetable Oil production by Indonesia in 2016-17 is pegged at 40 million tonnes. China is the second largest producer of Vegetable Oil and in 2016-17 too, it is expected to maintain a production of 26 million tonnes like it did in 2015-16 (Fig 21). Malaysia is the third largest Vegetable Oil producer in the world. In 2014-15 and 2015-16, Malaysia has produced around 21 million tonnes of Vegetable Oil and according to projections for 2016-17, the country is expected to increase its production to 24 million tonnes. European Union, USA, Argentina and Brazil are the other important countries in terms of Vegetable Oil production.

Fig 22 depicts the top 10 Sugar producing countries in the world. Brazil, the highest Sugar producing country in the world is projected to produce 37 million tonnes of sugar in 2016-17. This marks an increase from the previous year's production of 34.6 million tonnes in 2015-16. In 2014-15 Brazil had produced a higher quantity of Sugar as compared to 2015-16, when the production was recorded at about 35 million tonnes. India though is the second largest producer of Sugar in the world, its production has been decreasing in the recent years. In 2014-15, India produced a total quantity of 30.4 million tonnes of Sugar which decreased in the following year to 27.7 million tonnes (2015-16). The projected production figures this year in 2016-17 is even lower at 25.5 million tonnes. Sugar production in the European Union witnessed a major decline in 2015-16 when compared to the previous year of 2014-15. From 18.4 million tonnes in 2014-15, the production of Sugar dropped by 24% to 14 million tonnes in 2015-16. According to the projections for 2016-17, the production of Sugar in the EU region is going to increase marginally to 16.5 million tonnes.

Along with being the second largest producer of Sugar as discussed in Fig 22, India is also the largest consumer of sugar in the world (Fig 23). Consumption of Sugar has been increasing consistently over the years in India with the consumption for 2016-17 projected at 27.2 million tonnes. The consumption in the previous two years were 26.8 million tonnes and 26.5 million tonnes respectively in 2015-16 and 2014-15. Sugar consumption of the European Union has remained constant at 18.8 million tonnes in current year. ■





Howarth Bouis
Director,
HarvestPlus,
2016 World Food Prize
Winner

A Pivotal Moment for Biofortification

This year's World Food Prize pays tribute to biofortification, an intervention that strengthens efforts to address one of the world's most insidious and pervasive public health challenges—hidden hunger. That is good news for the majority of the two billion people globally who suffer from hidden hunger, and likewise for those fighting to end the epidemic.

Hidden hunger is the lack of essential vitamins and minerals (micronutrients) necessary for a healthy and productive life. According to the World Health Organization, Zinc, Iron and Vitamin A are among the micronutrients most lacking in diets globally. The deficiency in these particular micronutrients can lead to blindness, stunting, mental retardation, learning disabilities, low work capacity, and even premature death. Women and young children are the hardest hit due to their higher requirements for reproduction and growth, respectively. More than half of women and three-quarters of children aged under five in India, for example, are estimated to be Iron deficient. The burden of hidden hunger extends to economies. India alone loses over $12 billion in GDP annually to Vitamin and Mineral deficiencies.

The majority of populations most affected by hidden hunger reside in the developing world where regular access to important and effective interventions such as supplementation and fortification is constrained by cost and infrastructure challenges. Those populations are also, unfortunately, unable to diversify their daily diet and, therefore, their micronutrient intake rely largely on macronutrient- and/or energy-rich but micronutrient-deficient staple food crops—Rice, Maize, Cassava, Beans, etc.—for sustenance. In India, for instance, only about one in 10 children regularly consume Iron-rich food, while the proportion of children under two years of age who regularly consume Vitamin A-rich foods is less than half.

It is difficult to imagine a reversal in the global incidence and impact of hidden hunger without innovative new approaches to complement conventional nutrition interventions. Biofortification is not the silver bullet, but it can significantly ex-

pand the reach of nutrition to populations in need. Its underlying premise is that since millions of people eat staple food crops daily, improving the nutritional quality of these crops will lead to better nutritional and health outcomes. By breeding and disseminating staple food crops rich in Vitamins and Minerals, which are just as high-yielding and profitable as non-biofortified varieties, biofortification can substantially increase the intake of micronutrients among households growing and consuming these improved crops.

Biofortification has distinct advantages. It is sustainable; farmers and consumers who adopt biofortified crops can grow and eat these crops over and over, benefitting from the extra Vitamins and Minerals for free. It is a food based approach that lets the plant do the work. Biofortification is cost effective. After the initial outlay of funds, the recurrent costs are minimal, and each dollar invested reaps $17 dollars' worth of benefits.

More importantly, biofortification is effective. Recently published studies show that crops biofortified with Iron, such as pearl millet in India and beans in Rwanda, can reverse iron deficiency. Sweet potato biofortified with Vitamin A reduced the incidence and duration of diarrhea among children in Mozambique. The evidence on the nutritional and health impact of biofortified crops continues to grow as the crops gain momentum around the world.

To date, biofortified crops have been released in 30 countries, including India, and are under testing in an additional 25. HarvestPlus and its partners are developing and delivering these crops as public

goods. At least four million households in Asia, Africa, and Latin America have already been reached with these nutritious crops. Scaling up delivery to reach a billion people with biofortified foods by 2030 is a key objective of HarvestPlus.

By shining the spotlight on biofortification, the World Food Prize has brought greater visibility and momentum to the strategy, and it can be the springboard for its scale up and impact globally. India, a country that is no stranger to agricultural innovations, will also play a major role in scaling up biofortification. The country has already adopted several biofortified crops such as Iron Pearl Millet, Zinc Rice, and Zinc Wheat, with more varietieson the way. In 2018, New Delhi will host the Third Global Conference on Biofortification, which will explore strategies and partnerships to broaden delivery and adoption of the nutritious foods. This is a pivotal moment for biofortification and the millions of households around the world who stand to benefit from its success. ■

Ambassador Daniel Carmon
Ambassador of Israel to India
and
Non-Resident Ambassador to
Sri Lanka

Agricultural Cooperation - Main pillars of the relations between India and Israel

If you had told the world nearly 70 years ago that Israel, the new little country comprised of 70% desert, would become an agricultural powerhouse with water surplus – the world would never have believed you. But the vision that the first Prime Minister of Israel, David Ben-Gurion, had of Israel making the desert bloom has indeed come to pass. Shortly following its independence, as early as 1952, and under the leadership of its first Prime Minister David Ben-Gurion, Israel sought to share its knowledge and experience with the nations of the world understanding that it is as essential for the State of Israel as it was for the aided nations. After decades of water shortage, through innovation and research, Israel has found ways to use the limited resources in its possession to not only feed its population but to export its produce and know-how to the entire world.

In a way, Israel's small scale and plethora of challenges has made it an ideal Beta test for the world. Israel has dealt with desert terrain, mountainous terrain, Mediterranean weather, water shortage, drought, scarcity of natural resources, just to name a few challenges. In the face of this adversity, Israel used its human resources, its bright minds and research capacity to do the unimaginable. Not only has Israel succeeded in growing high quality produce in the dessert, but it has also found ways to use salt water instead of fresh water to grow better crops, it has reversed its water shortage to water surplus by proper water management and recycling, it has discovered how to make more with less and effectively served as a lab experiment providing agricultural solutions for the entire world.

These advances were not made by the individual Israeli farmer. The government of

Israel has invested heavily in an infrastructure, an ecosystem of sorts, including the Israeli Ministry of Agriculture, academia, the agricultural industry and entrepreneurs. Working together, the Israeli ecosystem has revolutionized the way we think about agriculture; instead of being dictated by the conditions on the ground, it has created the conditions to allow it to grow anything from olives watered by salt water to the first, and sweetest, cherry tomatoes.

Israel has transformed from a developing country to one with a strong economy, a high-tech hub and a greenhouse of innovation. The knowledge that Israel has accumulated in overcoming its own challenges is something Israel wishes to share with the world – especially countries which are undergoing some of the challenges Israel faced in the past. This will is embodied in MASHAV which is the Hebrew acronym for Israel's Agency for International Development Cooperation. MASHAV launched in late 1957 with the aim of sharing with the rest of the developing world the know-how and technologies which provided the basis for Israel's own rapid development. Since its establishment, MASHAV has helped people from 132 countries around the world in the field of agriculture as well as education, water management, sustainability and women empowerment.

Considering the similarities in history, culture and values between India and Israel, it is no wonder that India is one of the most important allies with which Israel has decided to cooperate and continue its agricultural development. While India and Israel are very different geographically (and certainly in terms of size) there is much common ground between the two countries in agriculture. The years of growing relations between India and Israel based on building block after building block of confidence building measures have brought the two countries to a level of cooperation which answers the needs of both countries. The supply and demand between the two economies in terms of agriculture - be it produce or technology - compliments the strengths on either side and contributes to the development of our respective markets.

The importance Israel attributes to agricultural cooperation in India is evident in the appointment of a special diplomat at the Israeli Embassy in New Delhi charged with deepening this cooperation. The Indian and Israeli Governments, both acutely aware of the importance of agriculture, have also held regular visits of Ministers of Agriculture in recent years. In recent years, two Israeli Ministers of Agriculture visited India in January of 2015 and again in April of 2016, showing the importance Israel attributes to agricultural cooperation with India. Indian Chief Ministers, State Ministers of Agriculture and other policy makers have also visited Israel to see first-hand the technologies Israel offers.

It is important to note that for Israel India is not only the federal government. While the relations between the two countries on the federal level are strong, in agriculture it is the relations with the states which prove to be the most productive and beneficial to the Indian farmer. The sheer size of India as well as its diverse topography breeds different

challenges in different states. Finding the right technology and the right solutions for these obstacles requires the help of the local government which is better suited to provide precise information and set more precise goals for the cooperation between India and Israel.

The model of cooperation that India and Israel have built is called the Indo-Israeli Agricultural Project (IIAP), and it is based on an approach of working both top down and bottom up. The Indian Federal Government provides umbrella support while the state governments are those who decide exactly what is needed in their part of the country. Prime Minister Modi's goal to double the farmers' income, to diversify the Indian food basket and to increase India's export capacities are all goals which Israel has managed to accomplish and is now interested in developing in India. The application of these goals rests on the individual state needs and those of the farmers as well, which is why Israel is guided by its Indian partners on which technologies and knowledge are needed.

The Indian farmer is at the center of this approach. In the past, the focus of governments in the field of agriculture surrounded food security, but we have come to think far beyond that. Today we focus on higher nutrition value, crop diversity, increased productivity and resource efficiency. All of these together contribute to the farmer's ability not only to grow more produce than he did before, but also get higher revenue for a better quality product. In today's global economy, and in the large Indian market alone, the farmer must be able to grow produce with a long shelf life so as to sell it at the right time in the right market. This is why one of the newest fields in which Israel has shared its expertise in is Post Harvest Methods. This knowledge enables the Indian economy to grow in its export capacities, enriching Israel with Indian fruit in return.

The technology Israel has created and offers India is imparted via Centers of Excellence. There are currently 15 fully active centers in 9 states, with ongoing preparations to expand in the coming years. These Indian run centers demonstrate new varieties, advanced cultivation and water management.

My request to be posted as the Ambassador of Israel in India was inspired by the work I saw when I served as Director of MASHAV in the Ministry of Foreign Affairs. The work I oversaw all around the world showed me that international development is the future of international relations. This was something I had already come to understand during my years as the Deputy Chief of Mission at the Israeli Mission to the United Nations, where I was exposed to the value of international cooperation in the world as a modern day political tool. The power of connecting people to people by solving shared problems and overcoming hardships together is what brings countries together in our modern world.

I was particularly stricken by the unlimited potential of international development between India and Israel. Our shared values shared goals and shared interests and our willingness to learn from each other is the reason agricultural cooperation has so easily become one of the main pillars of the relations between our two countries. The Indian and Israeli governments, the Israeli experts, the Indian farmers and I personally, value this cooperation and will continue to promote it. I have no doubt in my mind that the work India and Israel are doing in agriculture will benefit us all: India, Israel and the entire world. ■

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Shifting Gear in the Indo-Israeli Agricultural Project

Dan Alluf,
Counsellor for
International Development
Cooperation (MASHAV)
Science & Agriculture,
Israel Embassy in India

Indo-Israeli Agricultural Project, a Growing Partnership

In 2006 India and Israel chose to embark on a special journey together in the field of agriculture when a bilateral agreement between the Indian and Israeli Ministers of Agriculture was signed. This partnership between India and Israel has been very successful and continues to be successful today as it has evolved into the Indo-Israeli Agricultural Project (IIAP). The Indo-Israeli Agricultural Project is implemented via the establishment of Centers of Excellence (CoE), in which Israeli technologies and know-how are disseminated.

This project is led by the Mission for Integrated Development of Horticulture (MIDH) along with the partnering states on the project. On the Israeli side, this project is led by the Embassy of Israel in India and Mashav: the Israeli Agency for International Development Cooperation which has been sharing Israel's agricultural experience and know-how with the world since 1958. This unique and strong partnership provides professional guidance during the planning and the executing phase.

The Indo-Israeli Agricultural Values and Model

The Indo-Israeli Agricultural Project aims to benefit the farmer by bettering farmer's value-chain, introducing crop diversity, increasing productivity and optimizing resources use efficiency.

Through the Indo-Israeli Agricultural Project, we have set three main goals to develop and deliver added value to the farmer. The first is demonstrating applied research;we bring knowledge and technology which has proven experience and tailor it to local conditions.Thus the farmer can make immediate use of these technologies in an easy and efficient manner.

One example of such technology is drip

Israeli expert ChaimEfrat, guiding an Indian farmer on Date cultivation Bhuj Gujarat

Pic 2; Intensive mango cultivation of ridges with Drip Irrigation, plastic mulch and high density spacing, IIAP CoE mango

irrigation. This is a major focus of our Centers of Excellence; we share Israeli knowledge, experience and technology of drip irrigation in all key crops. Israel provides guidance regarding which irrigation systems are to be installed and how to perform water management. Irrigation workshops are conducted in the Centers of Excellence through which Israeli experts train Indo-Israeli Agricultural Project Officers in irrigation methods and techniques. Using a hands-on approach, the irrigation workshops conduct root exposure to better see the correlation between water, soil and plant.

Pic 3: Irrigation workshopfor IIAP project officer's

The second goal pertains to the transfer of knowledge, in a Train the Trainer (TTT) method acknowledging the Indian trainer as a linking element between applied research and farmers. "Training the Trainer" means identifying and training qualified local experts who can lead the project forward and spread the new found knowledge in their region. This is implemented by way of Israeli experts training the local Indian teams within the Center of Excellence.

The purpose of this important link is double: first, to disseminate the knowledge and second, to make sure that the new technologies are assimilated and implemented by the farmers in the field.

A good example of Train the Trainer activity is the workshop held in Talala Gujarat in July 2016, at the Mango IIAP Center of Excellence. Mango is a leading cluster within the Indo Israel Agricultural Project with a total of 7 Centers of Excellence across India. In Gujarat, we conducted a workshop on two core topics: Nursery management and canopy management in a large scale demonstration led by two Israeli experts in the field of nursery management and mango cultivation. The local team was then able to pass on the information to the mango farmers in the area.

The last goal of the Indo-Israeli Agricultural Project is sustainability. The Indo-Israeli Agricultural Project aims to develop into a self-sufficient

Israeli expert training Indian IIAP officers on vegetables nursery management, IIAP CoE for vegetables, Karnal, Haryana

platform withrespect to human resources, accumulated knowledge, capacity building and operating capabilities. The Centers of Excellence act as a meeting point and working environment for academia, government and farmers to cooperate and reach fruitful achievements.

The Current Status of the Indo-Israeli Agricultural Project

The Indo-Israeli Agricultural Project is currentlyoperating in nine states across India with 26 Centers of Excellence, out of which 15 are fully active. The additional states which have been invited to join the Indo Israel Agricultural Project under the 3rd phase of the Indo-Israeli Agricultural Project are Madhya Pradesh, Andhra Pradesh, Telangana, Goa, West Bengal and Mizoram. Mizoram has been chosen to act as a regional Center of Excellence for the north Eastern states.

Shifting Gear in the Indo-Israeli Agricultural Project

As the Indo-Israeli Agricultural Project moves ahead toward its 3rd phase we aim to achieve new horizons through the expansion of the value chain implemented in our centers. One of our main points of interest is Post-Harvest Management (PHM). It is important to understand that Post-Harvest Management is comprised of a few sub-segments including sorting, grading, packaging, cold chain and storage. Unique solutions should be tailored for each key crop. Currently, together with the Indian stakeholders, we have started a joint process whose outcome will aim to benefit the farmer by providing tools which will extend crop shelf time and quality.This will enable the farmer to

IIAP work shop for mango canopy management, IIAP mango cluster workshop in Talala Gujarat

Farmers training in IIAP CoEfor Floriculture,Tali, Tamil-Nadu

9 states part of phase 1 & 2
*Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Karnataka, Tamil-Nadu, and hopefully in the future also Bihar, Uttar Pradesh

7 states to partner in 3rdphase

market the crop for a longer period of time at a premium price, hopefully increasing his income.

Water recycling for agricultural use is another strategic area of cooperation.Today more than 80% of agricultural irrigation in Israel is in fact recycled urban water which is treated and distributed to the fields by drip irrigation. This is something we wish to demonstrate within the Indo-Israeli Agricultural Project too, and we are currently in the initial stages of a fact finding process to establish such a solution.

During the past two years as MASHAV Counsellor I have seen the project grow, strengthen and bear fruit. I believe that the secret of our success lays in the fact that the project is based on a true Indo-Israeli partnership which is comprised of professionalism, trust and a shared goal of benefiting the farmer. Looking to the future, I wish to see the impact of our activity resonate and reach more farmers. ■

Jaime González G.
Agricultural
Counsellor of Chile,
Embassy of Chile in India

HIGH PHYTOSANITARY STANDARDS: KEEPING CHILE FRUIT FLY FREE

A much feared pest

Fruit flies are among the most destructive insect pests, soon after hatching, the larvae start feeding on the pulp of many deciduous, tropical, subtropical fruits and some vegetables, hastening rot and turning them unmarketable.

Scientists call them Teprhitidae and many species in this family are reputed to be serious pests. In spite of the havoc they may raise in crops, fruit flies are harmless to humans in a direct way. Nevertheless, the pesticide load that chemical control programs require to get rid of them may affect the innocuousness and quality of the fruit. That's why in an indirect way and from the food safety perspective, being fruit fly free leads to healthier and tastier fruits.

Nowadays the world has turned global and fruit flies go by jet, taking advantage of the modern transportation means to spread and invade new areas. They can travel concealed within the baggage of an unsuspecting tourist or be a part of smuggled shipment.

Fruit Fly free, why is this important for Chile?

The export of fresh fruits is an important part of the Chilean economy. Being able to grow them in fruit fly free areas is deemed of strategic importance. There are countless advantages, like direct market access without expensive and damaging quarantine treatments; higher yields; no necessity of pest control programs etc.Also, and very important for a reliable fresh produce supplier: less pesticides means healthier fruits.

Taking the above into account, during the 1960's, Chile did a visionary and ambitious wager: to eradicate isolated populations and become a fruit fly free country. Then, after the eradication of the last spot up in the North, in 1995, the country consolidated the fruit fly free condition countrywide.

Today, Chile keeps this status and has international recognition as per the international guidelines and regulations. Though expensive, the economic analyses of the export figures versus associated costs,proved this decision to be highly cost-effective.

Ceratitiscapitata; male adult. Credit: Ricardo Rodríguez

Chile's Fruit Fly Program at a glance

Preventative by nature, the objective of Chile's fruit fly program is to maintain the whole country as fruit fly free. Operated year round, it focuses on three levels, strategically devised and coordinated to act synergically.

Pre-border: Historically, Chile has worked together with its neighbors, aiming to be mutually beneficial and played an active role in the eradication of the medfly *(Ceratitiscapitata)* in southern Peru and Southwest Argentina.

By working in close collaboration with the technical teams of the said countries, the program was enriched and just to mention a few, the main benefits ensued from the exchange of experiences, a bigger source of inputs and data for more accurate analysis, cost reduction due to scale economy of resources, and so forth.

At the border: Anyone entering Chile may have seen the big efforts put in this stage to prevent unauthorized fruits to enter the

Fresh fruits from Chile. Credit: Ricardo Rodríguez

country. X-ray machines, specially trained dogs,and lots of PR to create awareness are only a few of the tools used at this point. Certainly, fines may also be there, when dealing with the ones who would like to challenge and outwit the system.

Due to its particular geography, Chile is naturally well protected to prevent the spontaneous entry of pests and has been called as sort of sanitary island. Therefore, passive spread through infested fruit movement is the only way for a fruit fly to enter. This explains why lots of efforts and resources are allocated in this stage.

Within Chile: In the Chilean territory, the fruit fly program focuses on prevention and the main components are:

- **SURVEILLANCE:** The key point is to early detect any fly that has managed to sneak in. For this purpose a specially tailored trap network operates year round, traps are baited with specific lures and regularly inspected. With around 15,500 traps placed out there, the intricate course of the trap lines may look like a spaghetti bowl, but modern geopositioning technology helps trappers and supervisors to operate it in a very efficient manner.Here, male and female biased traps co-exist in perfect harmony, densities and locations are strategically determined to maximize the likelihood of detection. Since trap inspection can be routine-work, leading to potential miss of attention, supervisors have several tricks like "spiking traps", just to have the trappers always alert. Because of the strategic importance of early detection, surveillance is the main component of the post-border activities of the fruit fly program.

- **SIT: BIOTECHNOLOGY, SEX, NAUGHTY FLIES:** The Sterile Insect technique (SIT) is all about offering female flies with millions of mating possibilities but the trick is that all of them have been sterilized, thwarting reproduction i.e. after mating, no fertile eggs are laid. In an infested area, the objective of SIT is to outnumber wild males, but in Chile, it is used for prevention. To achieve such numbers, millions of fruit flies are reared, genetically sexed, sterilized and released every week. Chile has its own rearing facility and operates under a cooperation agreement with IAEA (International Atomic Energy Agency).

This tool is used as a complement to the general program in the higher risk areas, like the extreme north of Chile, it receives the name of Preventative Release Program (PRP). Because of the advanced technology required, SIT is applied in coordination Specialized International Organisations (like the IAEA) and in close collaboration with similar programs undertaken in other countries.

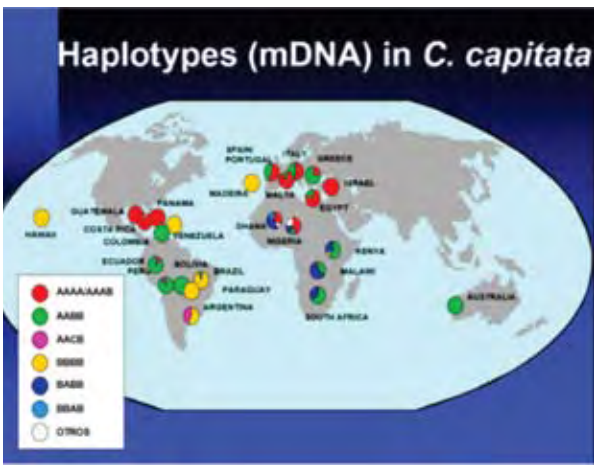
Chile's bilateral teams for fruit fly prevention, Left (Chile-Peru) and Right (Chile -Argentina). Credit: Ricardo Rodríguez

- **HAPLOTYPES: SCIENCE**

Pictures of flies after releasing and sterile male rearing centre. Credit: Ricardo Rodríguez

PROVIDES ANSWERS: Being able to determine the likely source of potential fruit fly entries is a valuable tool to help in the strategic analysis and to identify critical points to be strengthened. Molecular biotechnology provides the tools to track back a specimen to its source population and similarly to the genetic fingerprinting, mDNA is analysed and the resulting haplotype can be compared with the existing database, generating strategic information for decision makers.

Response Plan: Despite all the prevention efforts, some uninvited flies manage to sneak into Chile from time to time. Therefore, it is important to know beforehand how to respond in a consistent manner. In Chile, the responsible Organization to run the complete fruit fly program, including the Response Plan is the Agricultural and Livestock Service (SAG).One single specimen caught in any of the traps triggers immediately a chain of pre-determined actions, such as enhancing the surveillance by placing a huge amount of new traps and conducting an intensive specifically directed fruit sampling. If a second specimen is found, an eradication campaign is declared and additionally to the enhanced surveillance, control measures are applied to all the developmental stages, including bait spray (for adults), fruit stripping (for eggs and larvae), soil drenching (for pupae) and so forth. Quarantine measures are also implemented and remain in force for three theoretical generations of the pest, computed by a day-degree model, to simulate the actual development that the insect would have in nature.



Fruit flies are important pests and for a fruit exporting country like Chile, its natural condition as a fruit fly free country is an important advantage and therefore, the country's strategic decision is to protect this condition.

Conducting a preventative program like the one for fruit flies may be expensive and resource consuming but undoubtedly it is something worth all efforts.

Chile works actively within and beyond its borders to remain fruit fly free, overcoming the odds given by the current global world and aiming to keep this important advantage long standing.

Leading such an important program creates legitimate feelings of pride and responsibility; this is reflected in the words of the Program Head, Mr Ricardo Rodríguez: "The year 2016 is a special year for the fruit fly program of Chile. It completes 50 years since the detection of the first entry of Mediterranean fruit fly in the city of Santiago and it has been eradicated successfully every time whenever an accidental entry has occurred. We are proud to work with such a great team of professionals and technicians who have managed to maintain the status as "country free of fruit flies" for more than 50 years, being recognized for the same throughout the world".

Last, but not least, I would like to express my gratitude to all the staff of the fruit fly program in Chile, for the enlightening experience of getting to know this robust and extraordinary program. ■

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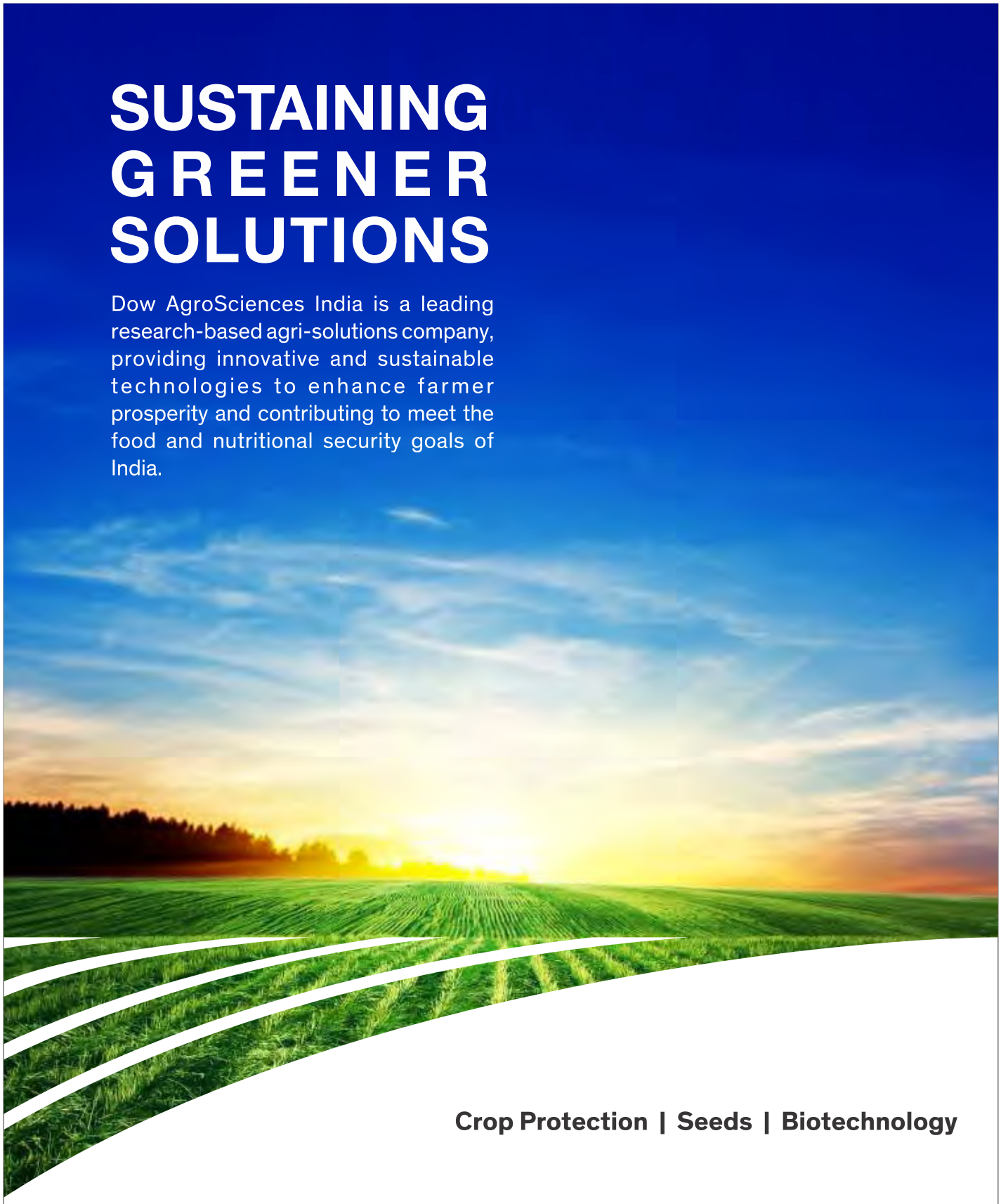

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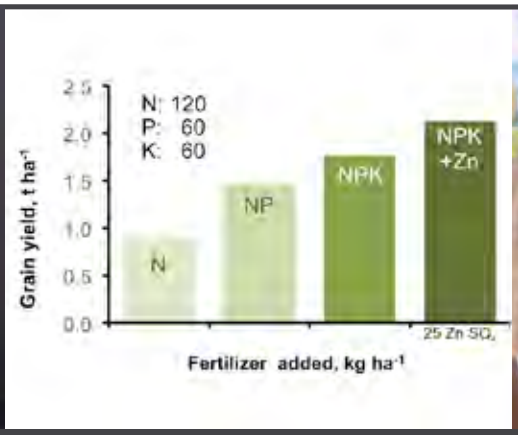

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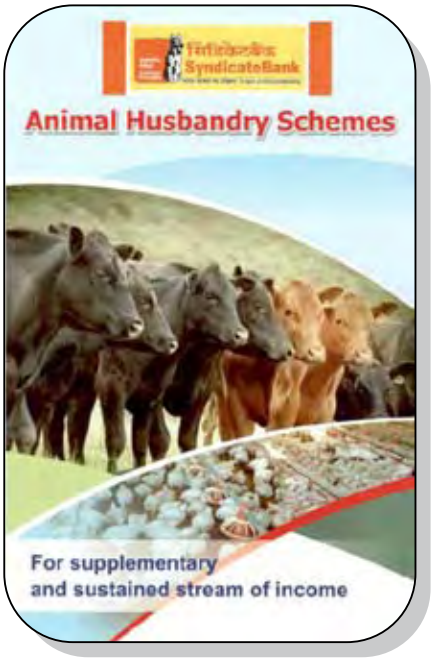
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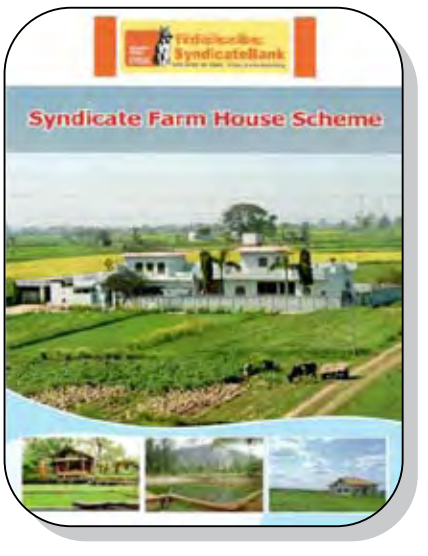
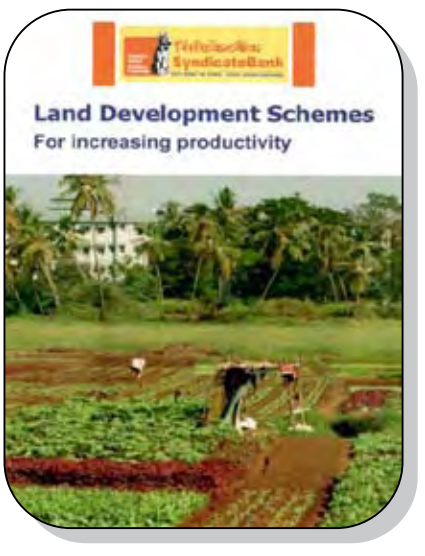

Syndicate Farm House Scheme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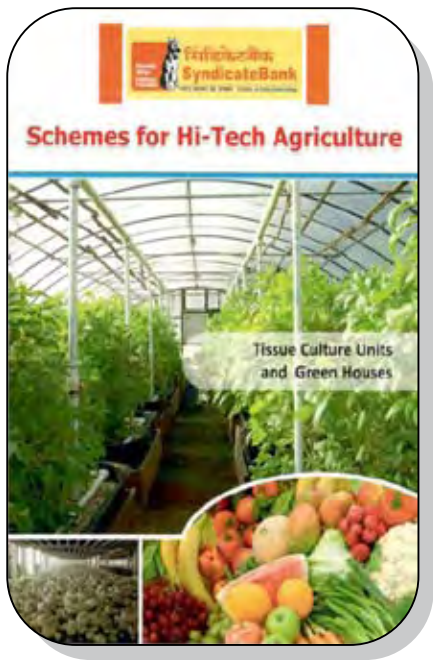
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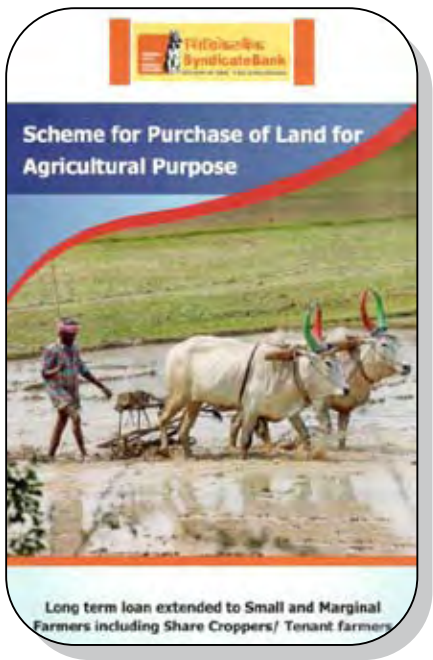
Scheme for Purchase of Land for
Agricultural Purpose
Long term loan extended to Small and Marginal
Farmers including Share Croppers/ Tenant farmers

FOOD SECURITY

ISSUES AND STRATEGIES

PROF. M.S. SWAMINATHAN

Towards Sustainable Agriculture

From 2016, the UN Millennium Development Goals have evolved into UN Sustainable Development Goals. Some of the important requirements for sustainable agriculture is the Evergreen Revolution which translates as resulting in higher productivity in perpetuity without ecological harm, and in this paper, I would like to highlight a few important issues relating to malnutrition, and access to balanced diets.

A] Designing Soil Health Cards for Pulses Revolution

Our PM has announced that Soil Health Cards will be provided to every farmer within three years. This will be helpful to ensure sustainable advances in farm production and productivity. The Soil Health Card will become even more useful to farmers if the card is tailored to the needs of a specific cropping system. For example, we are short of pulses like pigeon pea, chickpea, moong, urad, lentil, etc. and the price of pulses has gone up by over 60% during the last year. As a consequence, protein hunger will increase. 2016 has been declared as the

International Year of Pulses. Although, most of the pulses are native to India, they are grown without irrigation and under low soil fertility conditions. This is why the average yields of most pulse crops are less than one tonne per hectare. On the other hand, crops like *arhar* (pigeon pea) which are grown in Australia from seeds obtained from India yield over 4 tonnes per hectare. The import of pulses is increasing and now exceeds 3.6 million tonnes.

Pulse crops require more phosphorous in the soil. Therefore the Soil Health Cards given to those cultivating pulses should be designed to address the specific nutritional needs of these crops. The soil health monitoring and advisory service which I have been recommending could be equipped to render specific advice to pulse crop cultivators on the nutrients needed, based on soil testing. In other words there has to be cropping or farming system based Soil Health Cards which could help the farmer to enhance the productivity of the conserved cropping/ farming system. From now onwards we should also provide soil health cards for enhanced pulse production. We can then accelerate progress in bridging the demand and supply gap in the case of pulses and make the International Pulses Year purposeful.

B] Agricultural pathway of overcoming malnutrition

Unfortunately the latest estimate on World Hunger released by FAO shows that India has the highest number of undernourished people in any single country (194.6 million). One in every four hungry persons in the world is an Indian. Hence we should recall on this day the following words of Mahatma Gandhi:

"There are people in the world so hungry, that
God cannot appear to them except in the form of bread"

To eliminate hunger, we should pay concurrent attention to overcoming undernutrition caused by inadequate purchasing power, protein hunger due to insufficient intake of pulses and other protein rich foods, and hidden hunger caused by micronutrient deficiencies. In addition, we should pay attention to clean drinking water and sanitation, in order to ensure absorption of food in the body.

A recent article in Down to Earth (1-15 March 2016) has described the serious malnutrition prevailing in several parts of Maharashtra, particularly Amaravati district. The author Shri Jitendra has quoted the work of Satav, who said "Our study shows a tribal family consumes less than 50 g of vegetables per day, when an individual needs around 200 g of vegetables". This emphasises the urgency of mainstreaming nutrition in farming systems by a procedure which I have termed Farming System for Nutrition (FSN). We need to introduce the FSN approach to solve the malnutrition problem through locally grown biofortified plants. FSN has three components; first, introduce crops which can address the malnutrition problem prevailing in an area. Second, establish a Genetic Garden of Biofortified Plants which will introduce the local community to agricultural remedies for the nutritional maladies of the area. Finally, train at least one woman and one male member of each Panchayat as Community Hunger Fighters who are knowledgeable of the malnutrition problem and of local farm level solutions. This will be the most economical and speedy method of achieving a malnutrition free Amaravati as well as other districts with a high malnutrition burden.

I would suggest, we should plan to establish Nutrition Gardens of Biofortified Crops which will supply the needed micro nutrients like iron, iodine, zinc, vitamin A, etc. At the same time, we must launch programmes for creating a cadre of community hunger fighters in every Panchayat, who are well versed with the nutritional problems of the area and with methods of solving them. Above all, every farm should become a 'nutri-farm' combining the dimension of nutritional security with food security.

The UP government deserves our gratitude for initiating the Hausla Nutrition Scheme to make pregnant women and children healthy. I hope similar programmes will be initiated in other states as well. To achieve malnutrition free India, we require concurrent attention and action in the following areas: Undernutrition, protein hunger, hidden hunger caused by micronutrient deficiencies, food quality and safety and attention to non-food factors like clean drinking water and sanitation. The Hausla Nutrition Scheme gives attention to only one component of this integrated package. I hope in the interest of getting full benefit from the investment, the Hausla Nutrition Scheme, should include the other components. We need a peri-urban horticulture mission which will help to stabilise the prices of food items like onion, tomato and other vegetable crops. There is considerable possibility of harnessing peri-urban land for stabilising the prices of essential commodities.

We face three major challenges on the food security front. First, there is extensive poverty induced undernutrition. This can be overcome by implementing the provisions of the Food Security Act 2013. Second, there is widespread prevalence of protein hunger largely caused by the inadequate consumption of pulses. Finally, hidden hunger prevails due to the deficiency of micronutrients like iron, iodine, zinc, vitamin A, vitamin B12 etc. in the diet. High priority should go to promoting balanced diets through attention to all these three forms of hunger. Food safety and drinking water security are equally important.

C] Towards a Pulses Revolution Symphony

A study by Assocham Chamber has indicated that India may have to import 10 million tonnes of Pulses to achieve a balance between demand and supply. This reminds me of the situation in 1966 when we had to import 10 million tonnes of wheat largely under the PL480 programme of USA. Internationally, we were then described as a "ship to mouth nation". We were determined to change this situation and before the end of the 60s, the country witnessed the Wheat Revolution and the more general Green Revolution. Such a change in our food situation came about through a combination of scientific skill, political will and farmers' toil.

The same symphony approach could bring about similar results in the case of pulses. As mentioned earlier, the average yields can be easily doubled with technologies on the shelf for our entire major pulse crops namely, Chickpea, Pigeonpea, Lentils, Urad and Moong bean. National demonstrations have shown that there is a large gap between potential and actual yields. An urgent task is the launching of a "Bridge the Yield Gap Movement". This will require attention in improving soil health enhancement, seed conservation and supply, appropriate mechanisation, improved post-harvest technology, community management of plant health and disease control, and appropriate import-export policies. Nutrients and crop saving irrigation from *Jal Kunds* etc., will play a significant role.There are also opportunities for expanding the area under pulses in rice fallows and through inter- and multiple cropping.

MSSRF has initiated a programme of promoting the concept of Pulse Panchayats where all the farmers in the Panchayat cooperate in areas like rain water harvesting and efficient use, crop health management and safe storage and value addition to primary products. The first such Panchayat is in the Edaiyappatti village of Tamil Nadu. I hope such Panchayats would be a trailblazer in the origin and growth of pulse revolution symphonies, just as Seed Villages and National Demonstration did in the case of wheat fifty years ago.

D] MSP for Pulses

I am happy that the procurement prices for major pulses like *arhar, moong, urad, lentil* and other crops have been increased by over 6% by the Government of India. This will provide incentive to farmers for increasing the area under pulses which are climate smart and nutrition rich crops. At the moment, we are importing about 4 million tonnes of pulses annually, largely from countries like Canada, Russia, Australia, Myanmar, Tanzania, Mozambique and Malawi. India's entry into the global pulses market enhances price volatility.

Another aspect of the decision for providing higher MSP for pulses is arrangement for procurement. In crops like wheat and rice, procurement by FCI or State Food Corporations or Rice Mills is done. Unfortunately, similar arrangements do not exist in the case of pulses which are mainly grown in dry farming areas. Therefore, we should give concurrent attention to pricing and procurement so that farmers are able to obtain a remunerative and assured price for these protein rich crops which can make an immediate contribution to overcoming the widely prevalent protein hunger.

E] The Pulses paradox

India is the leading producer and consumer of pulses. But for the nutritious pulse crops, protein hunger would have been more widespread in our country. Unfortunately, the per capita consumption is going down because of a gap between supply and demand. Recently, the FAO office in Bangkok convened a meeting on improving the production and productivity of pulses. The following nine point strategy suggested by me

was adopted for action.

- Introduction of short duration high yielding varieties
- Improved varieties with drought tolerance
- New niches, eg. chickpea in rice fallows
- Pigeon pea in rice-wheat cropping systems
- Seed systems and Pulses Seed Villages
- Input supply, micronutrients and fertilizer
- Water Harvesting and Crop life saving irrigation
- Mechanisation both at the production and post-harvest phases
- Remunerative Support Price and assured marketing
- Organisation of Pulses Panchayats

MSSRF is assisting the Government of India in putting up a Rice Bio Park at Nay Pyi Taw, Myanmar. This is for value addition to the entire biomass. During next year, we should establish similar Pulses Biopark where we can demonstrate how numerous market driven by-products can be prepared from the plant biomass. This will also help to improve the income of farmers cultivating pulses who normally live and work in dry farming areas dependent mostly on rainfall. As a part of its support to pulse production, Government of India should also support the establishment of a chain of pulses bioparks. Pulses contribute not only to human health but also to soil health through improving the physics, chemistry and microbiology of the soil. Time is therefore opportune for concerted efforts to bridge the prevailing gap between potential and actual yields in Pulses.

F] Monsoon management : maximising the benefits of rainfall

Apparently, the acreage under pulses has increased and it is good news that pulses like *arhar*, *urad* and *moong* have been sown over

8.24 million hectares. This is 21 per cent higher than previous season. Scientific monsoon management involves maximising the benefits of normal/good rainfall and minimising the adverse impact of monsoon deficit. So far, conditions have been good for pulses and oilseeds which represent high value but low water requiring crops. It is now important for farmers to harvest the rainwater and store it in a *Jal Kund* for a crop life saving irrigation, when needed. Usually the crop may face moisture stress in late August – early September and harvested rainwater will be extremely useful at that time. Also, plant pesticides like neem powder may also be kept ready to control pests including the pod borer. Such anticipatory action will be an insurance against severe loss of yield if late monsoon rains fail and pest damage increases.

G] Social Protection against hunger

India occupies a low position in relation to the elimination of widespread hunger. We however know that undernutrition has multiple adverse impacts on human development and economic growth. Therefore, it is good news that the Union Food Minister has asked all States and Union Territories to implement the National Food Security Act by 31 March 2016. Tamil Nadu already operates a universal PDS and is hence ahead of other states in the matter of extending social protection to the hungry. The effective implementation of the provisions of the National Food Security Act will help to eliminate calorie deprivation in nearly two thirds of the population. It is now important to integrate this programme with attacking protein hunger through pulses and hidden hunger through biofortified crops and fortified salt. If all this is done, India's position in the Global Hunger Index will show a marked improvement and the goal of providing every child, woman and man an opportunity for a productive and healthy life, can be realised.

H] Ensuring price stability and safety of Food

There is now widespread concern on the prevailing high rate of food inflation. Inflation in vegetable prices is particularly high, rising to 12.9% in May from 2.2% in April. Obviously this will further aggravate the problem of malnutrition, highlighted recently by the Global Nutrition Report. This year's price rise is not new, such a situation occurs now and then. Therefore a permanent solution to food inflation should be found.

Urbanisation in India is growing and the problem of food inflation largely rises from the demand-supply gaps in urban areas. One way of stabilising the prices of vegetables and fruits in urban areas is to promote peri-urban horticulture by providing the necessary technical and marketing support. Decentralised production, as for example in Israel, could be supported by cooperative marketing. Urban and peri-urban 'horticulture revolution' could pave the way for more stable prices to the consumer. At the same time, we should ensure that the quality of the food remains high and free of pesticide residues and other unsafe chemicals. Thus we can ensure stability of supply coupled with high quality and safe food, while contributing to price stability. ■

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India's Food Security
Yesterday, Today and Tomorrow

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Considering these facts on ground let us be clear that there is no hope that food inflation will come down in coming years, unless we have some serious rethinking about our lifestyle and consumption habits. The biggest challenge for the policy makers and for governance is going to be, how to improve our productivity to ensure food security for masses in the coming years.

How much food will India need in coming days?

In a country where per capita income is lower than world average, and where 30% of population lives below poverty line, food inflation is and will always remain a biggest political issue in every election. The management of food inflation will be the corner stone of good governance claims by any ruling party.

Agriculture reforms will take time because no government have the capability to take on vested interest. They are not keen to look at productivity as criteria for policy reforms.

On one side, it is State subject and its local politics, and on the other technology penetration in agriculture will take its own time due to various inefficiencies created under the name of socio-economic, agro-climatic and political reasons.

If we want economic success in India, agriculture sector needs due attention. Long term consistent policy to ensure suitable food security is vital. The National Food Security Plan will act as a blue print for all and will also encourage private investment. This document should include needs for food, feed, fiber and fuel and also agriculture based inputs for other industrial sectors. This will give clear direction to all stakeholders at least for next 10 years, which can be evaluated on yearly basis.

Projected Population of India in 2025

According to the Report of the Technical Group on Population Projections constituted by the National Commission on Population, Government of India, the population of India is expected to increase to 1400 million by 2025 at the rate of 1.2 percent annually. As a consequence, the density of population will increase from 313 to 426 persons

per square kilometer.

Projected Per-capita Income of India in 2025

According to the Chairman of Prime Minister's Economic Advisory Council (PMEAC),it has been estimated that if we grow at 9 per cent per annum, India's per capita GDP will increase from the current level of $ 1,600 to $ 8,000-10,000 by 2025. It looks more on optimistic side, with this growth; India will become part of the middle income group of countries when it achieves $ 8000-$ 10,000 per capita income.

Food requirement for India by 2025

According to an FAO study, food energy requirements for South Asian population will be about 2700 Calories / capita / day in the year 2025.

In India, the food grain availability is at present around 525 gms per capita per day whereas the corresponding figures in China & USA are 980 gms and 2850 gms respectively. Due to improvement in per capita income, if per capita consumption is 650 gms, the food grain requirement will be about 390 MT of food grain by 2025.

In case of Pulses, according to WHO requirements, India will need about 35 million tonnes of pulses by 2025.

In terms of edible oil demand, it is estimated that it will be about 17 kg per capita per year. It means India will need about 23.8 million tonnes of edible oils by 2025.

Shrinking and fragmenting landmass for food production

Indian agriculture is dominated by small farmers, having small landholdings for cultivation. The average size of the landholding was 2.30 ha in 1970-71, which declined to 1.32 ha in 2000-01. The absolute number of operational holdings increased from about 70 million to 121 million. If this trend continues, the average size of holding in India would be mere 0.68 ha in 2020, and would be further reduced to a low of 0.32 ha in 2030.

On the other hand, by 2025, per capita agricultural land available will be just 0.1 ha per capita. In other words, it is just 100 feet x 100 feet plot per person to meet the daily needs of food, fuel, fodder and fiber round the year. With increasing population this area will further shrink.

At the same time, available estimates with agriculture ministry 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, huge quantities of nutrients are lost during crop production cycle.

Annually, India is losing nearly 0.8 million tonnes of Nitrogen, 1.8 million tonnes of Phosphorus and 26.3 million tonnes of Potassium—deteriorating quality and health of soil is something to be checked. Problems are further aggravated by imbalanced application of nutrients (especially Nitrogen, Phosphorus and Potash), and excessive mining of Micronutrients, leading to deficiency of Macro- and Micronutrients in the soils.

Estimated food requirements of India by 2030 are given in the table below:

Demand projections by author based on various recommended parameters

(in million tons)

Category	In 2015 (Estimated.)	By 2030 (Projected)	Required Growth in production per year (in Million tonnes)
Pulses	17.2	40.0	1.52
Coarse Cereals	41.7	102.0	4.02
Wheat	88.9	95.0	0.41
Rice	104.8	156.0	3.41
Oilseeds	26.7	70.0	2.89
Milk	146.3	182.0	2.38
Fish	10.1	16.0	0.39
Egg	39.2	57.0	1.19
Meat	6.0	15.0	0.60
Fruits	86.0	110.0	1.60
Vegetables	167.0	180.0	0.87
Tea	0.9	1.1	0.01
Sugar	25.0	33.0	0.53
Total food Demand	759.8	1057.1	19.82

Please note: Demand for many other items which make part of food system is yet to be estimated.

Water Requirement and shrinking availability:

According to Ministry of Agriculture, by 2025, India will have about 1700 m^3 of water per person and 84% of this water will be used for irrigation purpose. This is at stress level.

At Independence, population was less than 400 million and per capita water availability over 5000 cubic meter per year (m^3/yr).

Water is another vital ingredient to ensure food security of the country. At the time of Independence, population was less than 40 crore and per capita water availability was over 5,500 cubic meters per year. In the year 2007, India's population has gone up to about 95 crore and per capita water availability had fallen to about 2,200 cubic meters per year. With the population crossing1 billion mark, water availability had fallen to about 2000m^3/yr per capita. By the year 2025 per capita availability is projected at only 1500 m^3/yr or 30% of availability levels at Independence. By 2025, the water requirement for irrigation will be 790 billion cubic meter.

This per capita water availability will further fall to about 1500 cubic meter per year by the year 2025 due to increasing population. It means about 4000 liters of water per day per person is needed to meet all our requirements for food, feed, cleaning, industrial and non-industrial activities like recreation, etc. Animals also need water to survive which we have not factored in.

At the same time, economic growth and individual wealth are shifting diets from predominantly starch-based to meat and dairy, which require more water. Producing 1 kg rice, for example, requires about 3,500 L water, 1 kg meat some 15,000 L, and a cup of coffee about 140 L. This dietary shift is the greatest to impact water consumption over the past 30 years, and is likely to continue well into the middle of the twenty-first century.

This is a very complex and serious problem. Food security of India needs serious attention.

India will emerge as major net importer of food products

in coming years

According to authors estimate, with the best of the efforts and resources India will be not be able to produce major essential commodities to meet the growing demand mainly in the area of edible oils and pulses for human consumption and protein meals and fodder for livestock.

Challenges before India in meeting food production targets

In order to meet the demand for food and other agriculture products, according to author's estimate, by 2030, India will need double the land mass to produce food and other agriculture items if productivity remains at the same level. The alternate option before us is to double the yield per unit area to meet the growing demand. There are many supply side challenges which will need out of box thinking because existing way of working is not delivering desired results.

Implications on Indian Economy and on foreign exchange reserves:

Considering the above facts, India will have to import commodities like edible oils and pulses from the world market. I am also not ruling out the possibility of wheat and sugar imports in coming years.

The average estimated import of edible oil will be about 15 million tonnes and pulses about 6 to 8 million tonnes. The estimated value of these two products will be about USD 20 to 25 billion annually in coming years. It means India will invest about USD 25 billion of foreign exchange to buy these two basic commodities from the world market in coming years.

This means India should consider all options how to increase the supply of these commodities from domestic sources. At the same time, India should also think how to develop a strong sourcing base which can ensure supplies at an affordable price, so that food inflation can remain under control.

How to meet the challenges of food security in coming days?

If we can control the population growth, this will be the most important option before us as a nation. In the absence of this option, we have think of a workable compromise.

The most important approach which we have to adopt is documenting the natural resources like soil, water, seeds and related technologies.

The two most limiting resources for food security will be land and water. There must be national policy to manage both these resources with the help of modern technologies like remote sensing, digital recording of soil health and water table measurement on real time basis. This must be shared with public on real time basis to sensitize the masses about the changing ground reality.

Research has to work on new seed varieties which can produce the food, fiber and feed in less water and can withstand climate shocks. This means we have to think of all options and no ideological preference will help in this crisis.

Policy planners should also explore how to conserve the soil and water. Every Panchayat and Municipalities must have a ground water recharge plan and it should be monitored as public assets and must be audited on monthly basis. Open and transparent system will create public awareness and encourage public participation in preserving water and soil health.

Modern technologies like water recycling plants, desalination plants on coastal areas, sewage treatment plants should be included as part of infrastructure to ensure maximum use of water.

Many critics may protest the use of technology. I propose that anyone opposing the technological intervention must provide a better National food security plan with resources required and their sources before rejecting the existing proposal.

There is no alternate to food security and there is no food security without soil quality and water availability. If these two aspects are not taken on priority, this will also lead to social and political unrest in various parts of the country.

Without social and political stability other economic activities and investment will suffer badly. This will also reflect on the quality of governance and its leadership.

In the new millennium, India needs sensible and accountable National Food Security Plan before we think of any other meaningful economic development plan. With every passing day, we are losing time and pushing ourselves to a point of no-return.

High time to think out of box about what is the way forward. ■

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Indian Farming
The Way Forward

Agricultural activity is one of the oldest facets of our civilization and is reported dating back even to Indus Valley Civilization and is still growing, modernizing and gaining importance socially, economically and politically. The activity in agriculture encompasses not only raising of food or commercial crops but also includes a variety of allied activities like horticulture, sericulture, social forestry, dairy, fishery, animal husbandry, etc.

If one has to sincerely understand the importance of agriculture in the Indian context, one should not miss the facts and figures surrounding the activity. Food, the one and the foremost of three basic essentials of human needs is provided by the farming activity and no nation can ill afford to depend on other countries for its food requirements continuously. Our country which immediately after Independence depended on food imports under PL 480, successfully warded off import requirements in mid 70's thanks to the fighting spirit exhibited by the farm community under Green Revolution and is presently self sufficient with food grains production touching a high of 252 million tonnes in 2015-16. It is an acknowledged fact that 66% of our massive 1.33 billion population is sheltered in rural areas. The rural economy is the single largest category of employers that provides direct and indirect employment to 50% of our work force. It is worth noting that Agricultural exports at USD 39 Billion constitute roughly about 10% of country's merchandise exports. This sector's contribution to country's GDP though has been falling on the back of progressive growth in industry and service sectors, it is still quite encouraging at 15%.

Despite all these favorable and attractive statistics, it is quite sad that the farming community at large still remains poverty stricken and farmers' suicide continues to persist at an estimated yearly average of 1.4 to 1.8 per 100,000 of total population. In this article, I have tried to compile and analyze the major reasons for the inadequate and unfortunate happenings in rural India and what best could be achieved to alleviate the rural miseries.

Farm Credit

The farming community, majority of which, holds lands measuring less than 2 hectares don't have the required means to invest in pre and post harvest operations. Availing short term crop loans is the only available option for such marginal and small farmers. Commercial Banks,

Cooperative banks and Regional Rural Banks extend such short term agricultural loans to these farmers having relieved them from the clutches of money lenders to a large extent. In order to ensure flow of more institutional credit to agriculture and allied sectors, Banks have been mandated to lend a minimum of 18% of their total loans to this sector with sub target of 8% for lending to small and marginal farmers. Any shortfall in the lending targets of scheduled commercial banks should be deposited with Rural Infrastructure Development Fund established with NABARD and other funds established with NABARD and other similar development institutions like NHB, SIDBI and MUDRA.

Considering the necessity to make farming a viable activity, the Government has ensured the availability of farm loans cheap at 4% to small and marginal farmers through interest subsidy of 2% to Banks and interest subvention of 3% to farmers provided the interest charged by banks do not exceed 9%. In order to ease the procedure for availing of loans by farmers, a rolling credit facility under Kisan Credit Cards has been actively pursued by Banks. The Gold Loans extended by banks to agriculturalists help meet the deficit arising from the insufficiency in the scale of finance prescribed by NABARD for bank lending.

In order to cover the entire rural population under development finances, a comprehensive plan of financial inclusion has been initiated whereby cluster of villages have

been allotted to various banks based on their branch network to create a banking environment among rural people enabling them to save, avail credit and involve in all channels of banking including technology based electronic banking. A new scheme named Deendayal Antyodaya Yojana - National Rural Livelihoods Mission (DAY-NRLM) has been launched wef Apri 01, 2013 to enlarge the scope and concept of Self Help Groups(SHG) particularly of women in rural areas. DAY-NRLM would work towards achieving universal financial inclusion, to promote financial literacy and to coordinate with the financial sector and encourage use of Information, Communication & Technology (ICT) based financial technologies, business correspondents and community facilitators like 'Bank Mitras'. The licensing of Small Finance Banks that fortifies the functions of already existing Micro Finance Institutions (MFI) will serve meeting rural banking needs. Hence it could be well observed that the entire gamut of financial requirements of farmers and rural people are fully addressed through institutional mechanism.

Land holdings

One of the reasons very often talked about for the poor performance in the Agricultural sector is the small size of cultivable land holdings. The Economic Survey 2005 reported that about 90% of the land is cultivated by landless tenants and farmers holding lands of size less than 2 hectares. The small size of lands really makes it an unviable unit from the productivity and economic perspectives as the farmers have not been able to fully benefit from farm mechanization. While on the one hand the cost of operations including the price of seeds, fertilizers and pesticides are rising

and farmers are not compensated by the minimum support price fixed by the Government, they are not able to deploy latest production and harvesting techniques, on the other to reduce cost and increase productivity. The subsidies provided by the Government to compensate the higher cost of inputs do not fully meet their requirements. Our country is fast embracing urbanization and large scale shift of rural workforce to urban areas has resulted in higher farm labor cost. As the seasonal nature of agricultural operations does not provide job and income throughout the year, the Government has provided livelihood venues under MGNREGA scheme guaranteeing job for rural families for a minimum period of 100 days in a year. As the size of family increases, the farming community depending on the income from the same small land holding finds it difficult to meet the cost of living and this problem cannot be solved unless some members in every rural household take up alternative employment.

Infrastructural Bottlenecks

One of the major problems associated with our agriculture is high dependence on monsoon. In the last two years, our country received deficient rainfall resulting in lower production of agricultural commodities leading to higher prices. The demand for manufactured goods including automobiles and white goods was low due to poor rural incomes. This year the monsoon has been favorable and higher than long term average levels and the expectations of economic revival is high on the cards. When the entire economy looks to rural prosperity for growth, the alternatives available to monsoon failures is largely nonexistent. Irrigation facilities to ensure sufficiency of water during periods of monsoon failures should be accorded highest priority. No doubt the Government allots funds and keeps rising the same in the budgets year after year, but the very fact that farming is constrained in a year of deficient rains reflects the insufficiency of allocated funds. When the monsoon rain is not uniform across all regions in the country, the distribution of surplus water to scarce areas needs proper attention and intervention including formation of national water grids. As monsoon is nature's gift and we cannot have control over the same, it is advisable that farmers look to changes in crops that consume less water as also shift to water efficient drip irrigation measures to mitigate production losses. Since all the alternative channels to natural rain water involves huge capital investment, farmers either solely or in cooperatives cannot be expected to meet with such requirement even by availing investment credits from Banks. It is high time Central and State Governments provide sufficient allocations in the budgets including external funding so that our farming operations are not affected by quantum of monsoons every year. Other needed infrastructure includes proper connectivity and transportation facilities for movement of goods particularly perishables. Lack of proper storage facilities also adds to farmers' difficulties particularly when the harvest is bountiful. Governments are addressing the problem by increasing the level of procurement to

save the farmers from distress sales. Financing of Cold storage facilities by banks have been accorded priority sector status to improve bank lending to augment storage facilities.

Other Impediments

There is a host of other bottlenecks faced by the farmers that remain partly or insufficiently addressed.

While the farmers most of whom are either marginal or small farmers, need finance for farm operations from organized institutions like banks, not any year passes when their incomes and consequently repayments are not affected either due to excessive or deficient rainfall. Crop insurance to fully protect them against vagaries of nature at affordable premia is vastly called for. The Pradhan Mantri Fasal Bima Yojana (Prime Minister's Crop Insurance Scheme) launched in February 2016 envisages a uniform premium of only 2 per cent to be paid by farmers for Kharif crops, and 1.5 per cent for Rabi crops. The premium for annual commercial and horticultural crops will be 5 per cent. Crop failures or excessive production has affected the repayment capacity of farmers forcing some to commit suicide. The Central Government announced farm debt waiver/relief in 2008 and some State Governments too promised/ implemented partial waiver to protect farmers from default label in periods of extreme difficulties.

The second or third generation farmers lack the experience/expertise which their grandfathers possessed in assessing suitability of crops, soil conservation, crop yields, etc. It is highly necessary they turned to agricultural studies and equip themselves adequately.

As the population swells and the number of members increases, it would not be possible to provide all of them even for their minimum living requirement based on the income generated from the same old small piece of land. Hence it is very much required of them that some members turn to alternative employment. The Government is addressing this problem through their education policies supported by educational loans from Banks.

The farm productivity in our country is lower when compared to advanced economies and even some emerging markets like Brazil. Despite lower land holding in China by 97% of rural household as compared to 90% in our country, their total factor productivity is 3 times that of ours. The reasons cited for our lower productivity include dependence on rains, lack of farm mechanization, insufficient storage facilities, higher wastage, lack of knowledge on better yielding seeds, inadequate use of appropriate fertilizers, etc. While some of the problems are structural, the Government has been trying to correct imbalances within the available resources.

The space occupied by rural economy in Indian context needs little emphasis. As per Central Statistics Office's estimates, agriculture and allied sectors constitute 15% of Gross Value Added in 2015-16, though falling over years on the back of higher growth recorded by manufacturing and service sectors. Two thirds of the country's population lives in rural India and 58% of rural households depend on agriculture for their livelihood. The fall in monsoon over the last two years has vastly affected consumption led growth emanating from rural India leading to stagnant GDP numbers. Despite occupying center stage of Indian Economy, the agricultural productivity remains lower and farmers continue to be in distress and poor, driving few of them to commit suicides. While Central and State Governments have been allocating increased quantum of funds to improve Agricultural output and farm incomes, the results do not corroborate the efforts. Leaving the activity to market demands, eliminating all controls, suppressions and subsidies and finally protecting all the deserved through a well defined Direct Benefits Transfer scheme could emerge as the best solution. ■

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Soil, Food Security and Human Health

"Upon this handful of soil our survival depends. Husband it and it will grow food, our fuel, and ourshelter and surround us with beauty. Abuse it and the soil will collapse and die, taking humanity with it" (Vedas, Sanskrit Scripture, 1500 BC).

According to FAO, food security is the state when 'all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life'. Soil is at the core of food production, markedly affecting its availability and quality. It also directly influences accessibility and social preferences for certain foods. Soils also influence human contact with various chemicals. However, it may also expose human, to various pathogens, if not managed properly. Therefore, it is important to understand the soils and manage them in a way to harness maximum benefit on sustainable basis.

ROLE OF SOIL IN FOOD SECURITY AND HUMAN HEALTH

Nutrients may be transferred from soils to plants to people, or from soils to plants to animals to people, or even directly from soils to people. Hence, the nutritional value of many foods is markedly affected by the soil. Crops require 18 essential elements and deficiency in any one restricts plant growth and reduces crop yields. Out of the 29 elements considered essential for human life, 13 are essential plant nutrients obtained from the soil and another five are elements obtained from the soil that are needed by some, but not all, plants. Therefore, soils that provide a healthy, nutrient-rich growth medium for plants will result in plant tissues that contain many of the elements required for human life. Soil fertility determines the quantity and quality of food that can be grown on a given area of land, and its productivity determines our health indirectly. The inherent properties of different types of soil have marked effects on crop productivity, and that some soil types are inherently more fertile and productive than others. A good fertile soil ensures optimum nutrient availability, stable porous structure, large available water content and microbial and faunal communities that facilitate root and shoot growth. Fertility can, however, be improved by management practices that maintain soil structure and through additions of manures and fertilizers.

The nutrient status of the soil also impacts the nutrient composition of meat, milk, and other animal products produced for human consumption since, the feed for the animals is grown in the soil. Just as with plants, the nutritional content of these animal products in turn influences the general health of the people who consume them.

Soil is a living body and contains millions of soil microorganisms per gram of soil. Many of these microorganisms are the source of

antibiotics. Selman Waksman and his team at Rutgers University in the 1940s were the first to isolate antibiotics (actinomycin, neomycin and streptomycin) from soil actinomycetes, a group of soil microorganisms for which he received a Nobel Prize for Physiology or Medicine in 1952, the only soil scientist to date to have received this award. More than 50% of current antibiotics come from the genus Streptomyces, the largest group of Actinobacteria. Soil fungi. The successful immuno suppressant cyclosporine is derived from the fungus *Tolypocladium inflatum*. Penicillin (isolated by Sir Alexander Fleming in 1929) is also formed from a soil-borne fungus. Recent research has focused on rhizosphere bacteria and endophytic microbes as new sources of antibiotics or other compounds to aid human health. Also, a majority of cancer drugs have been developed from natural products in soil.

The soil clays, which are the smallest soil particles having size less than 0.002 mm, have a long history of medicinal use because of their capacity for adsorption and surface charge. Kaolin and attapulgite soil clays have long been used in diarrhoea medicines. Kaolin is also used in ointments as an emollient. In Burundi, France clay minerals have been used to treat Buruli ulcers (caused by *Mycobacteriumulcerans*) in children successfully without any need for surgical intervention. Soil

clays can also positively influence human health by acting as a filter to remove hazardous materials and pathogens.

The deliberate ingestion of soil – Geophagy, is practiced by many animals and humans. While geophagy is not common in the urban developed world, there are still many societies elsewhere where geophagy is common. There are a number of potential benefits to geophagy. The most frequently cited benefit is using the soil as a source of mineral nutrients, particularly Ca and Fe. Soil has also been used as a food supplement during times of famine. Soils can be mixed with plants that would otherwise be toxic, making them edible. Soil has been widely consumed as a medicine. Medical uses of ingested soil materials include treatment of some types of poisoning and the treatment of gastro-intestinal disorders such as stomach aches, acid indigestion, nausea, and diarrhoea. Geophagy, however, is not recommended as there are a number of negative effects as well. Ingestion of high cation exchange capacity clays such as smectites can cause deficiency symptoms of nutrients such as Fe, Zn, and K. Geophagy is also associated with Pb-toxicity and infection by a number of parasitic soil organisms. Toxic substances such as pesticides may also be found in soil. Liver disorders may be associated with soil bacteria and fungi ingested through geophagy. Involuntary ingestion of soil also occurs in all societies. Foods often contain soil particles on them, especially foods that have been dried outdoors. Another route of involuntary ingestion

involves dust particles in the air that are inhaled. Children are particularly prone to ingesting soil on their hands when they put their hands into their mouths. There are some potential benefits to the involuntary ingestion of soil, such as the intake of Fe-rich dust on foods, but most studies have focused on the potentially negative impacts of soil ingestion and they are similar as in geophagy.

PROBLEMS ASSOCIATED WITH INFERTILE AND POORLY MANAGED SOILS

Infertile and poorly managed soils will not be able to sustain the high levels of crop production. A nutrient deficient soil will yield nutrient deficient plants which will adversely affect animal and human health. Figure 1 shows the number of nutrients that are increasingly becoming deficient in Indian soils. The figure shows that in the year 1950, only one element N was deficient. However, nine elements became deficient, at least in some soils of the country, in the year 2010. Many more elements may become deficient if the same trend of over exploitation of soil fertility continues. Also, some elements may become potentially toxic.

There are several adverse health effects that can arise from nutrient deficiencies in soils. Iron deficiency is probably the most common example and may affect as many as 5 billion people, with about 2 billion considered anaemic. Low iron in soils is may be a problem in arid regions. Another soil-related sickness is iodine (I) deficiency, which leads to goitre, severe cognitive and neuromotor deficiencies, and other neuropsychological disorders. The World Health Organization estimates that about one billion people are at risk for iodine deficiency disorders, and has made the elimination of iodine deficiency disorders a priority.

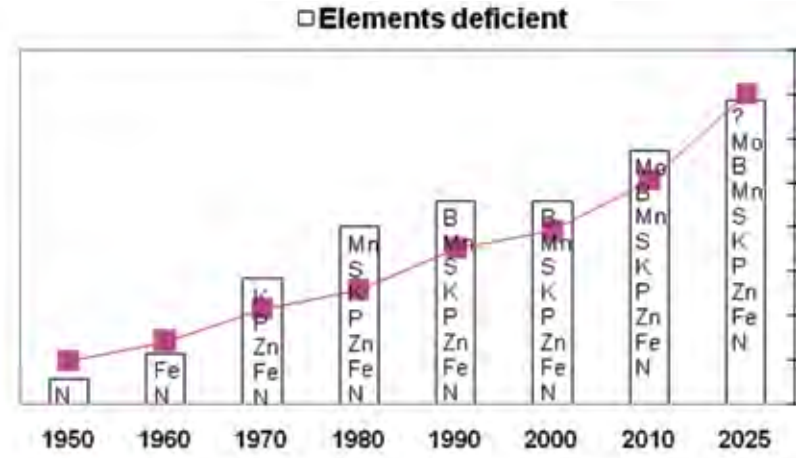

Fig. 1. Emerging deficiencies of plant nutrients in relation to increased food grain production

Zinc deficiency causes stunted growth and hypogonadism. Some foods such as whole grains can be rich in Zn, but low in bio-available Zn which can then lead to Zn shortage in the human organism. Zinc deficient soils are widespread and include about half the world's soils. Calcareous soils and leached, acidic soils are more likely to be Zn deficient. Copper deficiency has been shown to cause heart disease and has been observed in acidic Histosols, acidic sandy soils, and some alkaline sandy soils.

Mineral deficiencies occur worldwide, but some elements occur in potentially toxic concentrations that diminish crop yields. Potentially toxic elements may be taken up by plants and animals and accumulate in the food chain with detrimental consequences for human health. On acid soils, which occupies about 40% of the world's agricultural land, toxic concentrations of Manganese (Mn) and Aluminium (Al) limit crop production, whereas on sodic and saline soils (5–15% of agricultural land) too much Sodium, Boron and Chloride frequently reduce crop production. Toxic concentrations of Mn and Fe can occur in waterlogged or flooded soil. Excessive concentrations of Nickel (Ni), Cobalt (Co), Chromium (Cr) and Selenium (Se) can limit plant growth on soil derived from certain geological formations, such as serpentine, and toxic concentrations of Arsenic (As), Cadmium (Cd), Copper (Cu), Mercury (Hg), Lead (Pb) and Zinc (Zn) have accumulated in agricultural soil in some areas as a result of the mining and manufacturing industries.

MEASURES TO IMPROVE SOIL FERTILITY

The use of crop rotations, crop residues, animal and green manures

and other organic wastes can improve soil fertility and mitigate soil degradation. Farming systems that use integrated management with rotation and organic and mineral fertilizers can maintain both human and soil health.

Several elements normally required in small amounts for human health can become toxic when present in high amounts, such as As, Cd, Fe, Zn, Cu, Cr, and others. Therefore, it is important not to over-correct soil nutrient deficiencies. The nutrients may be applied after testing of soils. Now, in addition to traditional laboratories for soil testing, there are some mini-labs, one such lab developed by ICAR-IISS, Mrida parikshak can estimate the available forms of soil nutrients and prescribe fertilizer nutrients rates to different crops based on estimated soil test values.

Soil erosion and salinization diminish food security. Degradation also adds to the poverty of farmers in developing nations because they lack the resources to remedy the losses, which leads to greater food insecurity and under-nutrition. Modern research focused on the links between erosion and food security clearly demonstrates that soil erosion threatens to undermine global food security and thus human health. Afforestation is, therefore, imperative to bring sustainable soil health and food security.

Interactions between soil and water can lead to exposures including toxic levels of hazardous materials and pathogens in the local water supply. A famous example of hazardous materials introduced to groundwater from soil is arsenic in Bangladesh, a problem encountered when Bangladesh switched from

surface sources of drinking water to groundwater to avoid human exposure to enteric pathogens. There is need to test the water before its use not only for drinking purposes but also as irrigation water.

Mrida parikshak for assessment of soil health and fertilizer advisory

Maintaining soil health shall depend on the basic premise that the amount of nutrients removed through crop removal should be replenished in the soil. Thus, efficient recycling of nutrients by supplementing the fertilizer nutrients with the nutrients from available organic residues, manures and composts should be an integral part of the nutrient management strategy so as to contain nutrient mining.

Resource conserving technologies, such as conservation agriculture, soil conservation measures and use of crop residues, organic manures and biofertilizers need to be promoted so as to integrate with the nutrient management schedules at the farmers' field.

Soil organic matter is a key indicator of soil health and thus necessary investment need to be made and programs need to be launched to promote generation of organic residues and green biomass *in situ*.

As routine laboratory analysis for the key soil quality indicators is very expensive and time consuming, it is desirable to identify few suitable indicators which can give a fairly good idea about the soil health.

Improving network of soil testing and soil testing need to be made comprehensive so as to analyse overall soil health rather than few soil parameters. Future research needs to focus on developing comprehensive soil testing involving key physical, chemical and biological soil properties.

Assessment of soil health for the major crop producing regions of the country need to be taken up urgently, which shall provide the baseline or the first estimate. Periodic assessment of soil health shall provide information about the improvement or decline in the soil health and thus shall assist the policy planners for developing optimum land management plans, so as to sustain agriculture productivity. ■

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Agriculture Development: Essential for Food Security and Inclusive Growth

Agriculture plays a vital role in India's economy. Over 58 per cent of the rural households depend on agriculture as their principal means of livelihood. India, having a vast population has a huge responsibility of feeding the nation. Also, being a major agricultural food producer and a contributor to the global market, India holds a responsible position towards the future of agricultural scenario globally.

The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India. Agriculture is key for the food security of the country, however, in the coming 5-10 years one has to have the right enablers and facilitators like farm mechanization, progressive & consistent agricultural policies, sustainability, free international trade flows, to make farming remunerative and drive inclusive economic growth.

Food security, as defined by FAO, will be accomplished when "all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Food security is a matter of concern for India as well as for most of the emerging economies where the population is growing faster but the resources are limited. In food security, one has to address both calories security (carbohydrates) and nutritional security. Carbohydrate is essential and are fundamental for the developing population, whereas, having right amount of nutrients in the food is important for the overall physical and mental development of the person. With higher GDP growth, increase in income and migration from rural to urban areas the need to have more nutritious and sustainable food emerges. India can address these issues with the help of growing science and technology, improved food safety standards and appropriate execution of government policies.

Sustainability comprises of four key elements namely land, labour, farmers' livelihood and agricultural practices. Climate change is also going to play an important role and impact our ability to deliver nourishment into the world for the developing populace. How we are going to address these elements? For us farmers' livelihood ought to be the focus

area and in line with PM Modi's vision of doubling the farmers' income by 2022 as it would keep farming remunerative. The success story of green revolution encompasses around flood irrigation where the farmer continued growing the crop with abundance of available natural resources. Today the scenario is different; the contemporary success story depends upon usage of modern technologies. Technology enabled solutions will help us in increasing productivity from the same piece of land without impacting the climate (more we produce more we emit the greenhouse gases), exploiting natural resources, deforestation, decreasing wastage, improved storage etc. As a country, we have to embrace parcel series of advance solutions like hybrid crops, bio-technology etc into our practices to compete with and serve the global and domestic markets.

Free International Trade Flows

while we are endeavoring to increase the productivity,free trade flows has an important role to play where the surpluses can be transferred to the places of deficit.Our focus should be on increasing productivity of agri commodities where we have a comparative advantage, meanwhile, we should leverage international trade flows to import commodities where we are structurally deficit like - edible oils from Indonesia and Malaysia and Pulses from Africa, Myanmar and Canada – or export surpluses like Wheat and Rice.

Progressive & consistent agricultural policies are vital to address various challenges of the agriculture. The Indian farmers are glad to see various reforms and policy announcements that have happened in the last 24 months such as -JAM (Jan Dhan, Aadhar & Mobile), per crop more grain, to double farmer income, crop insurance, crop loan scheme etc. Through these instruments, any type of benefit, welfare program that the government wants to run either at the backend or at the frontend is able to reach the targeted beneficiary. Agriculture, is a dual subject and close coordination between the Centre and State governments is important to make any policy successful. It is important that the states implements and enforces the policies that are announced by the Central government.

The future of our agriculture and country's food security depends on keeping a right balance between calorie & nutritional security, incorporating sustainability, practicing free international trade flows and implementing progressive & consistent policies and the latter - implementing policies is the key.

In the last 20-30 years, our research institutes, scientists, governments, farmers and industry all have contributed towards the development of agriculture and we have reaped the benefits of their efforts. Now with agriculture being in its next phase of advancement we again need to come together and collectively work towards the next agriculture revolution.

The last two years have been a wakeup call for all of us: back to back droughts; India being a temporary surplus exporter has now become an importer of Cotton, Pulses, Wheat, Corn, Vegetable Oils etc.

However, the good news is that we have plenty of scope for building new technology and innovative products and solutions that adapts to the changes in climate, technology, natural resources and growing population to serve the current and future needs and demands of the nation. ■

Dr. Rakesh Gupta
(General Manager)
Punjab National Bank

Farming Scenario in India
Issues & Challenges

India accounts for 2.4% of the world's geographical area and 4% of its water resources, but has to support 17% of the world's human population and 15% of the livestock. Agriculture, the backbone of Indian economy, not only contributes to the overall economic growth of the country but also determines the standard of living and socio economic status for more than 50% of the Indian population.

The Agriculture sector, which sustains more than half the country, is no longer the first preference of rural households in India. It is heading towards a huge never ending debt crisis. The plight of India's farmers has only become grimmer in the past decade. The lot of the embattled Indian farmer only keeps on getting worse with the passage of time. Farmers' distress is particularly acute at present since 18 of the 29 states are facing drought in one part or the other for the second year in a row. Through analysis of the data on agricultural households and farmers' debts trend, an attempt has been made to point out urgent needs of agriculture.

Problems faced by Indian farmers are:

Farms are fragmented and economically unviable: Even as India celebrates the golden jubilee of the Green Revolution, NSSO (Jan-Dec, 2013, 70th Round) has come out with the data indicating that nearly 70 percent of farmers subsist on economically unviable farm holdings of less than a hectare in size.

Quality Seeds:The High Yielding Varieties seeds as well as the Genetically Modified (GM) seeds which promise higher yields force the farmers to buy seeds for every crop. False claims made by seed companies regarding yield and productivity are the loopholes in this context. Improved and Government approved high quality seeds are not within the easy access of majority of small and marginal farmers. Also, the seed replacement rate is very less. Average yields of almost all the crops grown in India are among the lowest in the world.

Access to credit: Nearly 40% of all loans came from informal sources with 26% advanced by moneylenders. Marginal land holding households suffer the most with only 15% of their credit from institutional sources such as the government, cooperatives and banks, for households in the highest land owner class (with land more than 10 hectares) the ratio is 79%. As per NSSO Survey (Jan-Dec,2013), only 45% of small & marginal farmers have access to Institutional Credit. The small and marginal farmers practice farming which is different from that of big land holders. They try to keep investment low and for this they do not access institutions for loans but are still dependent on non-institutional sources like money lenders.

According to recent ***NSSO survey*** (Jan-Dec, 2013, 70th Round), Rural India had an estimated 90.2 million agricultural households i.e. about 57.8% of the total estimated rural households in the country. In India, approximately 52% of agricultural households are indebted, with levels of indebtedness varying from *93%* in Andhra Pradesh and 82.5% in Tamil Nadu to 37% in Chhattisgarh and 17.5% in Assam. The average amount of outstanding loan was highest for Kerala (Rs.2, 13,600) followed by Andhra Pradesh (Rs.1, 23,400) and Punjab (Rs.1, 19,500).

Irrigation: Only one-third of the cropped area is under irrigation. In India, out of net sown area of 140 million hectares, just 65 million hectares area is net irrigated. This means 54% of the cultivated land in India is monsoon dependent i.e. rainfed.

Agricultural Marketing: India is one country with 29 States, 2477 principal regulated Markets and 4840 sub markets under APMC Act. But there is huge disparity in taxes and fees charged in different states which goes upto 19% in some states which ultimately put, the burden on farmer's pocket?

Inadequate storage facilities: The post-harvest losses are valued at around Rs. 44000 crores annually, out of this Fruits and Vegetables account for the largest portion. Around 18% of the annual production of Fruits and Vegetables, is pegged at around Rs. 13300 crore, is wasted annually due to shortage of cold chain and high quality cold storage facilities.

Illiteracy among farmers: Education in terms of knowledge of new farming techniques, new developments government schemes and financial literacy empowers them to take better decisions.

Alternate source of farm income: Indian farmers stick to monotonous cropping patterns due to insufficient knowledge and thus become highly dependent on agricultural production, and very less on other agriculture allied activities which is also increases the risk of failure**.**

Government schemes for the solutions of problems being faced by farmers

- **Sub-Mission on Agriculture Mechanization is welcome step:** Promotion and Strengthening of Agricultural Mechanization through Training, Testing and Demonstration, Establishing Farm Machinery Banks for Custom Hiring is encouraged under this scheme**.** Allocation of USD223 million has been made for the establishment of Farm

Machinery Banks and distribution of farm machinery and tools to farmer s in various states

- **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY):** Plans to provide irrigation to every village and has an outlay of Rs 50,000 crore spread over 5 years with the objective of "HAR KHET KO PAANI" that provides end – to – end solutions in irrigation supply chain and focuses on creating sources of assured irrigation, per drop more crop, and harnessing rain water at micro - level through Jal – Sanchay and Jal–Sinchan.

- **Pradhan Mantri Fasal Bima Yojana:** Despite implementing several crop insurance schemes, farmers are yet to get enough protection from risks in farming. The reason for thousands of farmers killing themselves every year is not just because of climatic factors; it is also due to the absence of protection from risks, in terms of crop insurance, which is not reaching them when they need it the most. Apart from yield loss, the new scheme will cover post-harvest losses also. It will also provide farm level assessment for localised calamities including hailstorms, unseasonal rains, landslides and inundation.

- **National Agriculture Marketing (NAM):** The current state-level APMC laws permit the first sale of crops — after harvesting by farmers — to take place only in regulated market yards or mandis. It, thus, restricts the farmer's universe of buyers to just the traders licensed to operate in the mandi under the concerned APMC's jurisdiction. Even traders have to procure separate licences to operate in different mandis within the same state. NAM would essentially be a common electronic platform allowing farmers to sell their crops to buyers anywhere in the country and vice versa.

- **Gramin Bhandaran Yojna:** Under this Gramin Bhandaran Yojana or Rural Godown Scheme,

government provides supports to an individual, a company, a farmer , local government, NGOs and various associations, if they build or renovate rural godowns.

- **Pradhan Mantri Jan Dhan Yojna:** Financial Inclusion is important as it provides an avenue to the poor for bringing their savings into the formal financial system, an avenue to remit money to their families in villages besides taking them out of the clutches of the usurious money lenders. 23.74 crore accounts have been opened so far with Rs. 41,664 crore deposits.

- **Soil Health Card Scheme:** Aims to make agriculture more productive, sustainable and climate resilient; to conserve natural resources; to adopt comprehensive soil health management practices; to optimize utilization of water resources. It also aims at promoting Integrated Nutrient Management (INM) through judicious use of chemical fertilisers including secondary and micro nutrients in conjunction with organic manures and bio-fertilisers for improving soil health and its productivity; strengthening of soil and fertiliser testing facilities to provide soil test based recommendations to farmers for improving soil fertility. Till 23 August 2016, 2,60,38,885 SHC have been distributed.

What more can be done to improve the farm economy?

- ***Agriculture Technology Training Institutes (ATTIs),*** could be set up in rural and semi-urban areas, offering certified courses covering modern agronomy, mechanized farming, soil, water and pest management, farm equipment operations, etc.

- ***Education to farmers regarding climate specific farming to enable better yield of crops, and avoid present scenario,*** where water intensive crops are being grown in drought prone areas, aggravating the situation.

- ***Lack of liberalized leasing laws,*** resulting in concealed/ informal tenancy restricting investment in land improvement and irrigation because of the inherent overhang of uncertainty. System needs to be streamlined.

- We need ***to reduce the power of cartels and middlemen*** who are controlling India's agriculture through the APMC act. This would enable more efficient trading and enable better price discovery (the whole purpose of markets) without adding too many layers of middlemen.

- ***Strategies to be formulated*** which encourage the farmers to diversify their crops and thereby reduce the risks, whether it is ***Surprise risk, Climate risk or Market risk.***

- ***Scaling up the Aggregation:*** Promotion of Farmers producers Organizations, Joint Liability Groups, strengthening of cooperatives at multi activity agents as they have proven platform to reduce the input cost, enhancing bargaining power of farmers and thereby ensuring better prices.

- ***Skilling for diversification of activities so the farmers can get the supplementary income through other enterprises not only from farm.*** Farmers are to be motivated for taking the different agri allied business also like poultry, fisheries, piggeries, silviculture, apiculture, etc.

We need to understand that agriculture is also a kind of business and deserves similar attention. The efforts should be towards "ease of farming" in terms of mechanization, infrastructure and technological advances for increasing farm income substantially. ■

Dr K M Bujarbaruah,
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University

Towards Tomorrow's Agriculture

Continuous provisioning of quality food to the burgeoning population especially on the face of multiple vulnerabilities confronting the sector today and the vulnerabilities likely to confront the sector tomorrow, has become an important issue of concern for India. This concern demands proper visioning of agricultural scenario in the country, preparing a road map to transform that vision into reality and strategise the walkable path to realise the vision. What should be then our vision?

Our Vision should be to see an India by 2030 that is capable of not only producing the required food for the nation but also be in a position to be a formidable force in the area of global agri-business supplying food to the less privileged nations. Vision is to have an India where the agricultural workers/stakeholders, down the production to consumption value chain, have an extra smile on their face for being in the trade because of realisation of remunerative returns from their sweats, an India where the agricultural work force declines from the present level of 50 per cent to 25 percent and yet produce close to 350 million tonnes of food grains, 200 million tonnes of milk, 80-100 billion eggs, 8-10 million tonnes of meat and 12 million tonnes of fish. The Vision is also to have an India where an Agriculture Cabinet at National and State level is constituted drawing the Ministries like Power, Water Resource, Roads, Finance, Animal Husbandry and Fisheries, Rural development in a convergent mode to take resource allocation etc. decisions across the table, avoiding the ministry-wise

drum beating actions so that optimal resources for research, extension and development activities could be earmarked. Last but not the least, the vision is to earn the coveted seat in the UN Security Council through the medium of agriculture by becoming a power house of global food supply and an effective country to achieve Sustainable Development Goals of the United Nations.

Having envisioned such a vision, the next important question is "How to Get There?" In order to have an appropriate answer to this question and to keep the image of agriculture flying high, let us examine this IMAGE in an abbreviated form.

I in IMAGE will mean Innovations i.e what innovative methods, methodologies, techniques and technologies we can lay our hands on in a perpetual manner, how can we promote innovative spirits in a team to innovate and bring in innovations to keep on injecting resource compromising and productivity increasing technologies to cope up with the challenges to the sector called agriculture.

M in IMAGE will mean Mastery development/skill development along the food production to consumption value chain. We will need perfectionists right from seed bed preparation to the effective use of ICT, space technology and gene technology in farming including mastery in post harvest handling, storage and marketing.

A in IMAGE will mean Availability of quality food in an affordable manner at all times which will lead to the concept of Abundance of food nationally. This can happen only when we achieve success in I and M of IMAGE, when we have enough support from the government

to re-articulate resource use efficiency, engineer and utilize novel technologies.

G in IMAGE is Gainful employment through lucrative and attractive agri-centric business. This business will include encashment of business opportunities in the field and off the field. Both the kinds of businesses need to complement and supplement each other for a win - win situation.

E in IMAGE means Evolving continuously or in other words ensuring sustainability - an issue where lot many institutions are researching today. How best we can keep our land, water, forest and biodiversity including the microbial biodiversity resources for our posterity while trying to meet the present day requirements of food.

There is no doubt that the future of our agriculture is going to be input driven, especially when all of us are experiencing near acute crisis in input front especially Water. One of the strategic options will be to establish a linkage between plenty water areas and scanty water areas by facilitating water highways in the line of national road highways. For this purpose, government will have to extend its prudent assistance first to widen the scope of water holding capacity in the major rivers where water is plenty, the river Brahmaputra in Assam for example, by de - silting themup to a depth of 10 - 12 feet in consultation with experts from institutions like IITs. De-silting of a river by the depth mentioned above shall harness much more quantity of water besides addressing the flood and erosion problems in water plenty areas.

When this is done, the captured water in these rivers could be channelized to water scanty areas not only to address water scarcity issue in those areas but also to pave the ways for inland water transport. Fund for such an important venture could be drawn by levying yet another tax as has been done for mission like swachh bharat. In addition to harnessing the highly precious water resource this way, demonstration of water saving technologies like producing rice crop through drip irrigation system on wider scale is necessary together with those already evolved technologies that scales up water productivity.

The second issue is that of land. A proper brainstorming for urban

horticulture is the need of the hour. The success recorded already in vertical farming on the walls, inside the green houses, on the roof tops, under multi-storied structures, in the homestead gardens as well as in the water bodies has opened up the possibility of this kind of intervention. The water highways, if established shall be an added opportunity for hydroponic horticulture without using soil thus avoiding soil borne pathogens as well as the requirement of surface soil. More researches shall be called for in the area of zero gravity horticulture. However, it will be difficult to shift crops like Coconut, Arecanut, Litchi etc., to urban areas. Vegetable and Flower farming shall have to be attempted on the body of these crops besides utilizing the interspaces with suitable allelopathic crops. It is perhaps important to share here that such an attempt has recently been made in Assam to produce leafy vegetables and orchids in Areca nut and other trees.

The third issue is that of producing more from less and lesser resources. Here exactly the adoption of the science of precision farming needs to be embraced in its true sense leveraging the benefit from the use of GPS and RS technologies in computer mounted tractors, dividing the crop production plots into groups and sub-groups depending on the soil nutrient contents, water retention capacities of the plots and sub-plots and precisely deciding on the fertilizer and pesticide need per plot avoiding over and under use of these inputs in the entire crop land, thus saving both in the financial and labour fronts.

Labour front - we have already experienced acute labour shortage problem in agriculture as a result of many of the agricultural work force opting out for other alternatives. Future agriculture will have to be oriented towards a machine friendly mode particularly in the small holder fields. Handy and affordable farm implements and machineries will be needed to counter the labour problem as well as to bring down the percentage of people dependent on agriculture from the present level of around 48 percent to a level of around 20 percent. Machines and implements together with other technological packages will have to support this 20 percent people to produce around 350 million tonnes of food grains by 2030. Therefore, in addition to the present attempt of developing suitable farm implements for medium and large category farmers, simultaneous innovative methods will have to be applied to develop such equipments for small holder producers. We have started working for application of robots in agriculture, particularly to assist in weeding and such similar activities. While this could be an alternative for large farm holdings, small holders probably will not be benefitted much. For them, we may perhaps think of engineering some sports kind of shoes with small nails through which weeding can be performed while walking in the crop fields in a manner the dogs scratches the

soil with their paws. Similarly, direct sowing methods, instead of the time consuming line sowing method in rice may have to be perfected. Assam Agricultural University is making this attempt in association with a local innovator, Sri Udhav Bharali who has been recognised by NASA and many such organisations for his inventions like pomegranate de-seeder etc. First year trial has shown very promising results. These kinds of small but effective innovations will be needed to stay in the business of food production.

It has been envisioned that our microbial population will hold the key to the success of our agriculture tomorrow. A massive research effort on screening the soil, rumen, aquatic including marine microbes shall therefore be needed. As we are aware, some of our soils are acidic, some are alkaline. Under these environments, the microbes not only live but also multiply and maintain their colonies. Some works are already on in this direction but they need to be scaled up so that we get some of the hidden answers from them. Similarly we have a rich agricultural bio-diversity. A massive bio-prospecting research is necessary in a collaborative mode targeting the bio-diversity rich eastern and western Himalayas and also the Southern/Western Ghats. Wild sanctuaries like Kaziranga National Parks need to be targeted for such screening. If we find stress tolerant genes in some of our microbes and other bio-resources, we can enter in to gene based agricultural trade across the world and thus be benefitted in real sense from our bio-wealth.

Saving of our post harvest crops, even to a level of 50 percent, can feed quite a million number of hungry mouths. Several research works have been carried out in this front but without the desired success rate. Application of gene therapy appears to be the answer. A group of researchers across the four zones of the country needs to be identified to work in the area of gene silencing and other such areas to increase the shelf-life of the crops, while another group needs to work on value addition to the unsold crops and commodities. A massive government effort is necessary to stop wastage of food in marriages and parties imposing some fine, if necessary.

All these and many others can happen only when we have a competent group of researchers and food producers, food handlers, food transporters, extension agents and a vibrant market. For this, all agricultural universities and research institutions in the country will have to take the programs like "Educating the Educators", "Skilling the Skilled and also the Un-skilled", "A Shift in Field to Factory mode of Farming injecting the Agri-business Angle", "Making Agricultural Education, Research and Product handling Attractive and Remunerative" and the likes. In order to be an outstanding player in agriculture front, technology and package generation will have to match-up with their percolation to the grass root level farmers and other stakeholders which the present system of extension is apparently not catching-up with. It will therefore be essential that a completely independent extension institution is established in the pattern of RAW (Research and Analytical Wing) so that agricultural product marketing intelligence is gathered to guide the food producers as to what to produce, how much to produce, where and how to market etc. Such an institution should also work like the ISI to facilitate and find ways for entry route of food trade and business within the country as well as the globe.

Lastly, let us, the actors engaged in and responsible for guaranteeing food security come together under one umbrella to supplement and complement the efforts of one another in positioning the country as a global food hub by 2030 using the power of currently available technologies and the technologies expected to be evolved between 2016 and 2030. ■

Mr. Alok Sinha
Director General
ICFA

WANTED : A New Mind-set For INDIAN AGRICULTURE

A Glorious Green Revolution was initiated, half a century back, by then PM Lal Bahadur Shastri and then Food & Agriculture Minister C Subramaniam. In this revolutionary mission, they were very ably and crucially assisted by Dr MS Swaminathan who captained the ship of agricultural innovations to relentlessly leapfrog annual farm food output more than five times….from an annual figure of 50 million tonnes to more than 250 million tonnes.

From a foodgrains importer going around the world with the proverbial begging bowl, India became, surely and steadily, a huge exporter ! But we have peaked only to reach a plateau of agricultural productivity, unable to break the glass-ceiling of 300 million tonnes annually. And we have been trekking this plateau for last two decades, unable to reach let alone climb a new peak.

With abounding new agricultural techniques, and with an ever-expanding pool of internationally acclaimed agri-scientists and agri-technocrats, we are still groping to find the new peaks of agri performance and productivity. Why this nagging passivity ?

Perhaps, the reason lies in the mind-set ! When Lal Bahadur Shastri gave the stirring call of JAI JAWAN JAI KISAN, he exhorted all Indians into saluting and serving the hardworking and hapless farmer who is also the valiant soldier guarding our frontiers. Unfortunately, what happened thereafter was that the policy-maker

and opinion-maker (both largely urban based, with little rural roots) got obsessed with the solitary priority of how much food was available for the consumers. That by itself was all right. But what made for a twisted tale was that farm prices were to be always kept down to please the noisy urban consumer.

That is, while the concern was for enough food for the consumer, we threw out of the window the equally important concern for the interests of the agri-producer and his farm-income.

And therefore we saw successive governments stop exports of whatever agri commodity's price tended to go up beyond what was considered "normal" and "permissible". But this was done by artificially curbing farm prices to quieten and soothe ruffled urban anger. In effect, what was happening was that while income of every other profession (be it the lawyer or the doctor or the engineer or the management whiz-kid or even the industrial worker) was not being targeted as they were well-organised and even constituted vote-banks, the rural populace being largely unorganised and hence father-less was being targeted whenever rural incomes had a chance to make "opportunity" costs.

This negativity which hurt the rural populace for half-a-century has now a golden chance of being remedied by the Prime Minister's call to DOUBLE FARMERS' INCOME. Attention now would be on how to increase agri profits. That this new mind-set would automatically increase productivity is beyond dispute !

To give a telling example of how matters were ignored to the peril of the Indian farmer, much thinking went into the formation in 2007 of the National Rainfed Area Authority

(NRRA). Since two-thirds of our cultivated area is dependent on the rain Gods, it was correctly thought that assured and subsidized inputs (water, seeds, fertilizer, dry soil-technology etc) into the hitherto neglected two-thirds area of Indian agriculture would boost both agri productivity and rural incomes.

But the first decade of the 21st century introduced the heady thoughts of plus-seven per cent GDP. Liberalisation for the non-agri sectors were at its peak, the Annual Davos tamasha being the testament to our suspending concerns for the rural sector. This happened at a skewed cost, While GDP grew every year by more than 7 percent, agri GDP kept going down, finally going below the ONE per cent level by 2014 !

That is why the slogan of DOUBLING FARMERS' income by 2022, while a tall order by any means, has brought us back to our senses, to resume the thought process of how not only to arrest the continuing degeneration of Indian agriculture, but also how to make it the leading engine of economic growth. After all, two-thirds of Indians still live in the rural areas.

And the Indian Council of Food & Agriculture has not lagged behind. We held a Round Table (on 30 April 2016) with all stakeholders. Deliberations were presided over by Dr MS Swaminathan and co-chaired by Union Agriculture and Farmer Welfare Secretary Shri Shobhana Pattanayak. An Action Plan was drawn up and drafted, stressing on :

- Increasing incomes by improving productivity
- Water and Agri-Input policies
- Integrated Farming System
- Better market price realization
- Special Policy Measures

We are in the process of engaging the Union Ministry of Agriculture & Farmer Welfare on how to give shape to the Action Plan. Appropriately, along with the slogan of DOUBLING FARMERS' INCOME, the Ministry's historic name has been expanded with the crucial addition of FARMER WELFARE.

Hopefully, a new and positive mind-set for Indian Agriculture is evolving. And we are therefore, hopefully, on the cusp of the Second Green Revolution. ■

CARD

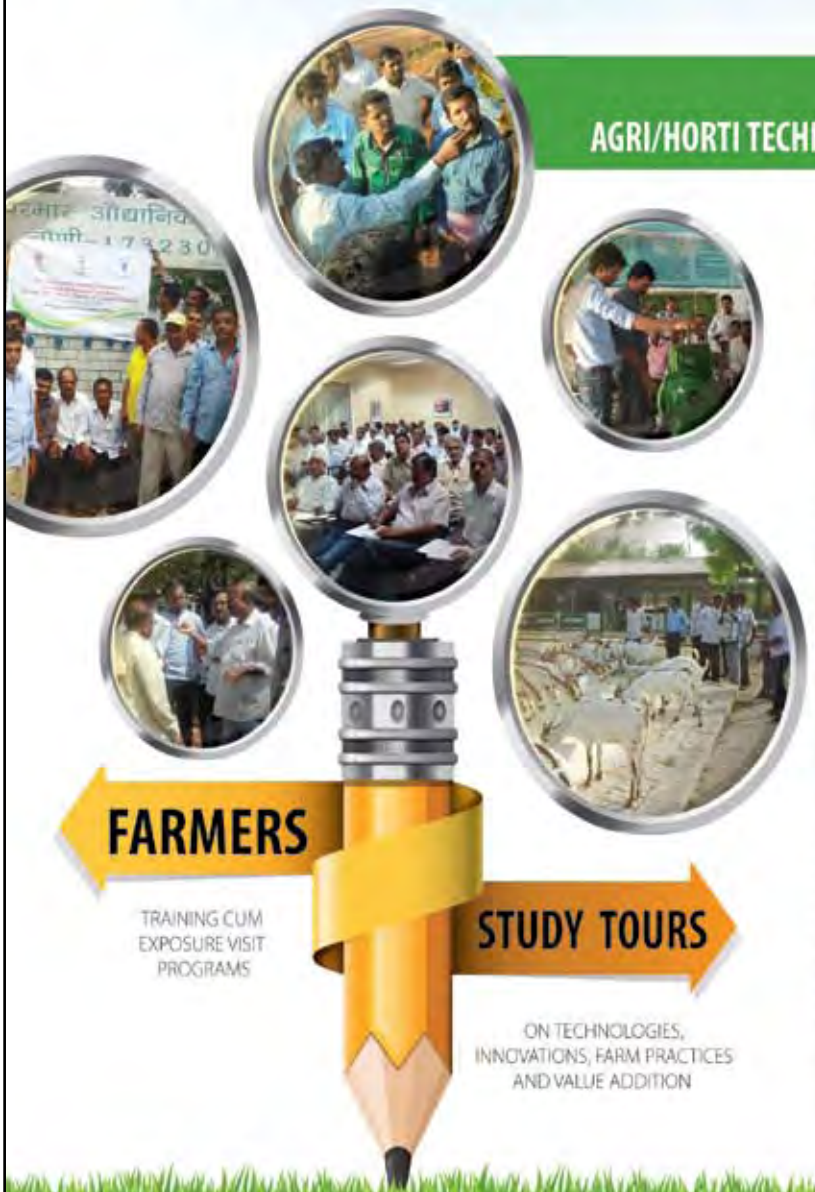
Centre for Agriculture and Rural Development

Farmers' Training cum Inter State Exposure Visit Programs

Under ATMA and MIDH, Government of India

Exposure and Training on Technologies, Innovations, Farm Practices and Value Addition

EXPLORING PLACES & TRAINING ON AGRI/HORTI TECHNOLOGIES, INNOVATIONS AND PRACTICES

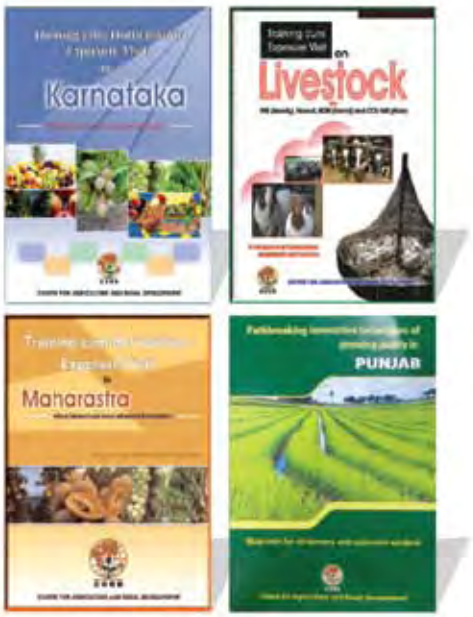


FARMERS

TRAINING CUM EXPOSURE VISIT PROGRAMS

STUDY TOURS

ON TECHNOLOGIES, INNOVATIONS, FARM PRACTICES AND VALUE ADDITION



FOR MORE DETAILS, PLEASE CONTACT

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खुशहाल किसान

खुशहाल छत्तीसगढ़

Credible Chhattisgarh
विश्वसनीय छत्तीसगढ़

श्री बृजमोहन अग्रवाल
कृषि मंत्री, छ.ग. शासन

- छत्तीसगढ़ राज्य को राष्ट्रीय स्तर पर बॉबल एवं दलहन के सर्वाधिक उत्पादन वृद्धि के लिये विगत 05 वर्षों में बार बार ''कृषि कर्मण पुरस्कार''।
- एग्रीकल्चर टुडे पत्रिका द्वारा वर्ष 2015 हेतु ''एग्रीकल्चर लीडरशीप एवार्ड''।
- विगत 11 वर्षों में कुल खाद्यान्न उत्पादन में 33 प्रतिशत की बढ़ोतरी।
- भारतीय कृषि अनुसंधान परिषद द्वारा कृषि विज्ञान केन्द्र, दंतेवाड़ा को सर्वोत्तम राष्ट्रीय कृषि विज्ञान केन्द्र वर्ष 2015-16 का पुरस्कार।
- फसल बीमा योजना के तहत बीमित कृषकों का कव्हरेज 32 से बढ़कर 37 प्रतिशत।
- राज्य के 04 जिलों तथा सभी जिलों में एक विकासखंड को पूर्ण जैविक बनाने का निर्णय।
- e-NAM के अंतर्गत प्रथम चरण में राज्य के 05 जिलों राजनांदगांव, कबीरधाम, रायपुर, बलौदाबाजार, धमतरी की एक-एक मंडी चयनित।
- मत्स्य उत्पादन तथा मत्स्य बीज उत्पादन में देश में छत्तीसगढ़ छठवें स्थान पर।
- विगत 11 वर्षों में मत्स्य उत्पादन 93 हजार मे.टन से बढ़कर 342.20 हजार मे.टन (268 % वृद्धि)।
- वर्ष 2003-04 की तुलना में वर्ष 2014-15 में फल के कुल रकबे में 1244 प्रतिशत एवं फलोत्पादन में 170 प्रतिशत एवं सब्जी के रकबे में 1414 प्रतिशत एवं उत्पादन में 213 प्रतिशत वृद्धि।

छत्तीसगढ़ शासन, कृषि एवं जैव प्रौद्योगिकी विभाग

NATIONAL INSTITUTE OF FOOD TECHNOLOGY ENTREPRENEURSHIP AND MANAGEMENT
Deemed to be University (De-novo Category) under Section 3 of the UGC Act, 1956 and
An Autonomous Institution under Ministry of Food Processing Industries, Govt. of India
Plot No. 97, Sector- 56, HSIIDC Industrial Estate, Kundli - 131028, Distt. - Sonepat, (Haryana)
Phone No. 130-2281000, 2281072, 2281085 & Fax No. 0130-2219772

NATIONAL INSTITUTE OF FOOD TECHNOLOGY ENTREPRENEURSHIP AND MANAGEMENT (NIFTEM) is a Deemed–to-be-University under De-Novo category under Section 3 of the UGC Act, 1956 and an autonomous Institution under the Ministry of Food Processing Industries, Government of India. It has been setup by the Ministry as a Rs. 500 crore (US $125 million) project in a sprawling campus of 100 acres plot located near Delhi NCR at Kundli, Sonepat, Haryana as an apex world-class institute of global standards in Food Technology Entrepreneurship and Management. The Institute will cater to the needs of various stakeholder entrepreneurs, industry, exporters, policy makers, the government and the existing institution.

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SUSTAINABLE AGRICULTURE & RURAL LIVELIHOOD

O.P. Chaturved
Director and
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Agroforestry Research
Institute, Jhansi

AGROFORESTRY FOR LIVELIHOOD OPTIONS IN INDIA

Agroforestry is sustainable land management approach which is practised by more than 1.2 billion people worldwide. The International Panel on Climate Change (IPCC) Third Assessment Report on Climate Change has recognised the potential of agroforestry for addressing multiple problems and delivering a range of economic, environmental and socioeconomic benefits. Secondary environmental benefits include food availability, security of land tenure, increased farm income, restoration and maintenance of above- and below-ground carbon storage capacity, restoration and maintenance of biodiversity, and maintenance of watershed hydrology and soil conservation. Agro ecosystems can be designed to assist adaptation of communities and households to local and global change. Agroforestry systems provide a variety of products and services that are important locally, nationally and globally; but their role is not always fully acknowledged in development policies and practices, reflecting the difficult-to-measure, diverse pathways by which trees affect people's lives.

Given the fact that land-holding size is shrinking, tree farming combined with agriculture is perhaps the only way forward to optimize the farm productivity and thus, enhancing livelihood opportunities of small farmers, landless and the women. Agroforestry interventions can be a potent instrument to help achieve the 4 percent sustained growth in agriculture. In short, trees on farm or agroforestry are uniquely placed for achieving multiple objectives, especially the food, nutrition, employment, health and environmental security. It is contended that an ever-green revolution is unlikely without a major groundswell of growing trees on farms.

Agroforestry provides employment with relatively lesser investment and that too for unskilled rural sector. Products like pole/ bamboo and small timber for rural housing, timber for manufacturing, sawn wood and wood composites e.g. plywood/particle boards/ block boards bamboo for housing, construction, transport, packaging sectors, bamboo and hard woods for all types of paper and paper products, fodder and fire wood, non-timber forest products, medicinal plant extracts etc. can absorb millions of unemployed people. Agroforestry has significant potential to provide employment to rural and urban population through production, industrial application and value

addition ventures. Current estimates show that about 65 % of the country's timber requirement is met from the trees grown on farms. Agroforestry also generates significant employment opportunities. Agroforestry systems offer means to address to a significant extent the present challenges of food, nutrition, energy, employment and environmental security. Agroforestry can become an important tool to build resilience of farmers and rural people against threats of climate change and natural calamities. This can also help in greening the rural employment and rural development opportunities by providing agroforestry tree produce based economic opportunities. This article talks about the importance of agroforestry in generation of employment and sustainable livelihood. The agroforestry sustains the livelihood mainly through providing food and nutritional security, generates income through wood production, NTFP, biofuel and bioenergy production.

Food and Nutritional Security

Agroforestry supports food and nutritional security through the direct provision of tree foods such as fruits and leafy vegetables and by supporting staple crop production, by raising farmers' incomes through the sale of tree products and surplus staples, by providing fuels for cooking and by supporting various ecosystem services such as pollination that are essential for the production of some food plants. Agroforestry trees support food production by a range of other means, including by providing shade and support for crops that need it, supporting animal production and improving soil fertility. Integration of trees in the

croplands can help in maintaining the soil physico-biochemical properties both under sequential and simultaneous agroforestry. Tree litter and pruning biomass improve soil fertility through the release of nutrients in the soil by mineralization. The leguminous and a few non-leguminous trees fix nitrogen in the soil. The contribution of agroforestry in enhancing and maintaining the soil health and sustainability is a win-win situation for the small and marginal farmers.

The different agroforestry systems provide the desired diversification options to increase the food security of the country and act as a shield against the poor production during drought and other stress conditions. The agroforestry also provides nutritional security because of diverse production systems which include fruits, vegetables, oilseed crops, medicinal and aromatic plants in addition to normal food crops grown by the farmers.

Wood Production

Since 1980s, the Government of India has promoted plantations under different agroforestry and social forestry plantation schemes as well as investment in industrial plantations. The plantation area in India is 32.57 m ha, which accounts for 17 % of the global forest plantation and is the second largest in the world after China. About 50% of the plantations raised since 1980 are in agroforestry systems with varying intensities of management. The National Forest Policy, 1988 envisaged that forest industries should meet their raw material requirement from wood grown in collaboration with farmers and local communities. Several industrial enterprises (particularly the pulp and paper companies) have been working with farmers to encourage farm forestry activities with their active technical and financial assistance. The initiatives such as providing quality planting materials, contract farming, minimum support price, tree loan and insurance have popularized the concept of tree farming and have contributed to the cultivation of commercial trees on private lands. This has also provided farmers with an alternative / complementary source of land use for improving their farm income particularly in the event of crop failure. The MAI for planted species in agroforestry/farm forestry

is much higher than in the natural forests. The main species planted in farm forestry are poplars in north India and eucalyptus in all parts of India. The MAI varies between 10 to 60 m^3/ha/year. At present, agroforestry meets almost half of the demand of fuel wood, 2/3 of the small timber, 70-80 per cent wood for plywood, 60 per cent raw material for paper pulp and 9-11 per cent of the green fodder requirement of livestock, besides meeting the subsistence needs of households for food, fruit, fibre, medicine etc. Agroforestry practices have demonstrated that this could be safely enhanced to 10 t/ha/y by carefully selecting tree-crop combinations.

India was found to be the fourth-largest producer of industrial roundwood from plantations in 2012. FAOSTAT reported a total industrial roundwood production of 45 957 000 m^3 from all types of forests in India. A significant share of this volume, about 43 million m^3, is presumed to originate from private plantations, farm forestry plantations and trees outside forests, as for forests under public ownership a number of policies are in place to phase out the supply of wood for wood-based industries. The major paper and pulp mills in India have planned expansion of over 63% in coming years. Currently, the paper mills have been using up to 30% recycled fibre, 31% agro based raw materials and 39% wood.

Agroforestry for Biofuel Production

A large part of India's population mostly in rural areas, do not have access to the conventional source of energies. Further the Indian scenario of the increasing gap between demand and domestically produced petroleum is a matter of serious

concern as the energy demand is expected to grow at 4.8%. To meet the growing needs of energy in the country, biofuel and bioenergy are being emphasized. Biofuels being renewable liquid fuels are gaining worldwide acceptance as a solution for problems of environmental degradation, energy security, restricting imports, rural employment and agricultural economy. The potential tree borne oilseeds holding promise for biofuel are *Jatropha curcas, Pongamia pinnata, Simarouba, Azadirachta indica, Madhuca spp.*, etc. Farmers can use vacant, waste and marginally used land for growing such trees and benefit from the annual produce, which will add as their income. However, biofuel research is still at the beginning with respect to genetic improvement for increasing seed and oil yield of TBOs and will require concerted efforts from all quarters.

Agroforestry for Bio energy

In rural areas, 70-80% energy comes through biomass from trees and shrubs. Due to the agroforestry initiatives, large amount of woods are now being produced from outside the conventional forestlands. Small landholdings and marginal farmers, through short rotation forestry and agroforestry practices are now providing the bulk of country's domestically produced wood products. *Prosopis juliflora* is the major source of fuel for the boilers for power generation plants in Andhra Pradesh. The fuel wood potential of indigenous *(Acacia nilotica, Azadirachta indica, Casuarina equisetifolia, Dalbergia sissoo, Prosopis cineraria and Ziziphus mauritiana)* and exotic *(Acacia auriculiformis,* A. *tortilis, Eucalyptus camaldulensis and E. tereticornis)* trees revealed that calorific values ranges from 18.7 to 20.8 MJ kg-1for indigenous tree species and 17.3 to19.3 MJ kg-1 for exotics. Species such as *Casuarina equisetifolia, Prosopis juliflora, Leucaena leucocephala* and *Calliandra calothyrsus* have become prominent due to their potential for providing wood energy at the highest efficiency, shorter rotation and also their high adaptability to diverse habitats and climates. Agroforestry plantations on community land and live fence on farm boundaries have immense potential in this regards. The option of biomass based power plant where electricity generation

can be aimed from crop/plant residue is yet another option.

Agroforestry for Employment Opportunities

The role of agroforestry products and environmental services to meet the subsistence needs of low income households and providing a platform for greater and sustained livelihood of the society is immense. Increased supply of wood has triggered a substantial increase in the number of small-scale industries dealing with wood and wood based products. Such industries promote agroforestry and contribute to increasing area of farm forestry. Recognizing agroforestry as a viable venture, many business corporations, limited companies such as ITC, WIMCO, West Coast Paper Mills Ltd, Hindustan paper Mills Ltd., and financial institutes such as IFFCO have entered into the business and initiated agroforestry activities in collaboration with farmers on a large scale. One of the major contributions of agroforestry for the economy is the livelihood impact, both in terms of income and employment generation. Besides the existing agroforestry practices, there is a potential to increase by up to 943 million person days annually from the 25.4 mha of agroforestry. In the Indian Himalaya alone there is an estimated potential increase of 5.763 million human days each year). The *Alnus nepalensis*-based agroforestry system of Sikkim state is an excellent example of dependency of people on agroforestry for employment and is distributed on 34,000 ha in north-east India. There are a number of studies from different parts of the country suggesting that agroforestry is more profitable to farmers than agriculture or forestry for a particular area of land. A comprehensive analysis indicated in table that economic viability with IRR ranging from 25 to 68 and B:C ratio of 1.01 to 4.17 for 24 agroforestry systems from different agroclimatic regions of the country. Agroforestry models adopted by the farmers in upper gangetic region and especially in Haryana, Punjab and Western Uttar Pradesh are highly lucrative, therefore, attracting farmers in a big way. In these areas, Poplar planted on agricultural fields and field boundaries are harvested at 6 to 8 years rotation, and the average economic return of Poplar based agroforestry systems is very high compared to that of sole agriculture crop. It is necessary to involve wood based industries for popularising various agroforestry models among the farmers. There is tremendous scope for promoting viable agroforestry models for different agro-ecological regions of the country through quadripartite arrangement among industries, banks, research institutes and farmers. Research Institutes under ICFRE and ICAR have developed a number of agroforestry models but these are mostly restricted to research farms. These models need to be taken to cultivator's field for improvement of farmer's livelihood.

National Agroforestry Policy of India

India launched the much-needed National Agroforestry Policy, 2014 – first of its kind in the world. The New Agroforestry Policy is a path-breaker in making agroforestry an instrument for transforming lives of rural farming population, protecting ecosystem and ensuring food security through sustainable means. The major highlights of the Policy are: establishment of Institutional setup at National level to promote Agroforestry under the mandate of Ministry of Agriculture; simplify regulations related to harvesting, felling and transportation of trees grown on farmlands; ensuring security of land tenure and creating a sound base of land records and data for developing an Market Information System (MIS) for agroforestry; investing in research, extension and capacity building and related services; access to quality planting material; institutional credit and insurance cover to agroforestry practitioners; increased participation of industries dealing with agroforestry produce; strengthening marketing information system for tree products. Initially, twenty important multipurpose tree species grown under agroforestry systems identified at the national level to be exempted from all restrictions related to harvesting, transportation and marketing.

Trees have been an integral part of human civilization since time immemorial. In the past there existed a harmony between man and the nature. The advent of civilization and practices of monocropping have excluded the trees from the modern agriculture. Recent adversities of climate change and monoculture has again paved the way for integration of trees in farmland. Agroforestry has been considered as one of the best bet resilient land use technologies to fight climate change. The trees offer innumerable direct and indirect benefits. Agroforestry system provides food and nutritional security, fodder, wood, fuel, energy and NTFPs, thereby meeting the subsistence and commercial demands of the farmers. Hence, agroforestry is the future of modern agriculture, which aims at creation of sustainable livelihood and food production. ■

Pulses: Solutions to Human Health and Farming Systems Sustainability

Hackett Professor Dr Kadambot Siddique AM CitWA FTSE FNAAS FISPP, Director The UWA Institute of Agriculture, The University of Western Australia, and UN FAO Special Ambassador for the International Year of the Pulses 2016

Pulses or grain legumes (edible seeds of leguminous plants) include dry beans, field pea, chickpea, lentil, mung bean, pigeonpea, urd bean and several other minor ones. As per the FAO definition, the term 'Pulses' excludes grain legumes used for oil extraction (Soybean and Peanut). Current global Pulse production is about 76 million tonnes. Pulses are rich in nutrients important for a healthy diet and relevant to several chronic non-communicable diseases. Pulses are currently underused in comparison to cereals (Rice, Wheat and Maize) despite the known benefits to agricultural productivity, sustainability and human health. Unlike Cereal and Oil seed crops, Pulses can symbiotically fix Nitrogen, leading to significant advantages for agricultural sustainability, both in developing and developed countries. The United Nations declared 2016 as the International Year of Pulses under the banner 'Nutritious Seeds for a Sustainable Future'. Yet, Pulses are a minor component of most human diets at present. Food security and soil fertility could significantly improve with greater pulse usage and crop improvement in a range of pulses. Food security and nutrition are a key international development objective under the Sustainable Development Goal (SDG2) of the 2030 Agenda for Sustainable Development. As 2016 is the first year of implementation of the Agenda, the International Year of Pulses will also link the contribution of pulses to critical targets under SDG2, particularly those on food access, malnutrition, smallholder incomes, and sustainable and resilient agriculture.

Pulse crops will only achieve a competitive advantage if their profitability to the farmer is similar to or exceeds that of the dominant cereal crops. To date, Pulses have received limited attention from policymakers and governments despite their multiple benefits. The current level of research and development funding for pulses is low and unstable. A recent global survey shows an investment of US$175 million per annum for the 13 Pulse crops, a trifling amount compared to the billions of dollars invested in the three major cereal crops each year.

Pulses in cropping systems

Pulses are not only important food and feed sources, but they play a major role in the sustainability and productivity of cropping systems. Pulses contribute to cropping system diversity when grown with crops of other plant families (e.g. Gramineae), disrupting the pest and disease cycles that develop during monocropping. They also contribute to soil fertility, primarily through biological nitrogen fixation but also by adding organic matter and releasing sparingly-available soil phosphorus. A shift in land use toward pulses and away from livestock would substantially lower the carbon footprint for protein production destined for human consumption. There is significant untapped potential for genetic improvement in pulses which would contribute further to the sustainability of cropping systems.

Farming systems need to be profitable and sustainable to meet the growing needs of the global population and to respond to the changing climate. Farmers need to optimise the use of inputs such as water and fertilisers. Pulses play a significant role in cropping systems because of their sustainable and environmental benefits such as reducing the Carbon footprint and the need for Nitrogen fertilisers. Well-grown Pulse crops typically fix between 80 and 120 kg Nitrogen per hectare, such that global Nitrogen fixation could account for up to 27 Mt of Nitrogen without increasing the area planted with pulses. Hence, about 9 Mt of soil Nitrogen would be available for the following crops, which is equivalent to about 10% of global consumption of Nitrogen fertilisers worth US$8–12 billion. Moreover, the grain protein content

of cereal crops following a pulse crop increases, and soil structure and health improve after growing pulse crops. Accordingly, Nitrogen-fixing pulses provide unparalleled sustainable opportunities for minimising future Nitrogen fertiliser use.

The inclusion of pulses in cropping systems can increase the cropping intensity, which enhances annual productivity, increases diversity and reduces overall risk because the reliance on one or more crops declines. Pulse production is static or declining in several countries, in the face of increasing global demand. For example, current Pulse production in India is about 18–19 million tonnes. However, the gap between demand and supply is widening; hence, about 4–5 million tonnes of Pulses are imported annually to India from countries such as Australia, Canada, Myanmar and Turkey. India is the largest producer and consumer of Pulses. These crops are grown across a range of farming systems, from subsistence agriculture to sophisticated commercial production systems, so research and development need to target particular species to these various agro-ecological and cultural systems. Several studies in India show that a yield gap exists in pulses; that is, realised yields were often around half of what they could be, but with considerable spatial and temporal variations. The yield gap can be partitioned into two components: (1) the difference between achievable yields—obtained from on-farm demonstrations incorporating currently recommended production technology—and farmer yields, and (2) the difference between model-calculated potential and achievable yields. The first component is usually greater than the second, suggesting that there is scope for applying known technology. The narrowing of yield gaps depends on an understanding of the causes of those gaps.

Genetic improvement

Pulses have underpinned the development of genetics. The common garden pea was used by Gregor Mendel to demonstrate the 'particulate nature of inheritance' (Mendelian genetics) in 1865. Nevertheless, many pulse breeding programs suffer from low genetic diversity and low rates of genetic progress. In recent years, whole genome sequencing has become an affordable and powerful tool to delineate genomic information in core germplasm. Genomic information can be used to generate high-resolution genetic maps for important agronomic traits, develop molecular markers for breeding, and identify important genes for crop improvement. High-resolution genetic maps are available for 10 legumes with de novo sequence information and low-resolution maps are available for all but Bambara bean, Tepary bean and Lima bean. The establishment of genetic resources and grain legume genome sequencing

together provides the opportunity to apply genomics-assisted breeding strategies toward crop improvement.

Health benefits

Pulses provide nutritious human food and animal feed in both commercial and low-input subsistence agriculture. The health advantages of a pulse-rich diet are many faceted. Their role in global health, including the reduction of non-communicable diseases such as obesity, diabetes, heart disease and neurodegenerative diseases, is underappreciated. A diverse diet including a range of pulses is required for health benefits. Pulses hold a near-unique position among foodstuffs because of their health-determinant properties. For example, all-cause mortality increased by 113% for Chinese women on a pulse-free diet and by 30% for Chinese men. Moreover, the mortality hazard ratio declines by 7–8% in older people globally for every 20 g increase in daily grain legume intake. The first study to assess the link between the Mediterranean diet and health, which included a 20 g intake of pulses per day, found a 10% reduction in all-cause mortality.

Pulses offer a food-based solution to decreasing the risk of certain diseases such as pre-diabetes and diabetes management as well as diabetes-associated complications, especially cardiovascular disease. Since diabetes is a major risk factor for several cancers and neurodegeneration, the future health of ageing populations may depend on a food system that provides pulses in an affordable, palatable and sustainable way. Most benefits from pulses are achieved at an intake of about 30 g per day, but lesser amounts are also beneficial. Recent studies in Western Australia consistently demonstrated that lupin-enriched (a pulse crop grown extensively in Western Australia) foods reduced blood pressure and glycaemic responses, providing strong evidence that lupin-enriched foods may have cardiovascular benefits, particularly in patients with diabetes who are at a significantly increased risk of cardiovascular disease. Moreover, lupins have negligible anti-nutritional properties and can be consumed as snack foods with minimal cooking. However, to increase the global consumption of pulses, more convenient, tasty pulse-based food products that meet the demands of consumers are needed.

Pulses have been included in cropping systems for hundreds of years, especially in rotation with other crop species. A boost in pulse production is urgently needed to oppose the static or declining production trends especially in developing countries, despite increasing global demand. The International Year of Pulses in 2016 provides an excellent opportunity to reflect on the status of global pulse production, consumption and potential opportunities for future expansion. Our current over reliance on a handful of major staple crops (Rice, Wheat, Maize and Potato) has inherent agronomic, ecological, nutritional and economic risks and devalues the contributions made by underused crops such as pulses. The intake of a diverse array of pulses is important in the human diet. Moreover, many underused pulse crops are already an essential source of vitamins, micronutrients and protein for vast areas of the developing world and, thus, a valuable component for nutritional security. More enduring partnerships need to be established between national and international research bodies, non-government organisations, community-based organisations and commercial entities interacting with farmers. Only then can we expect that smallholder farmers will practically implement the extensive knowledge we have so far to increase the production of Pulses. Let us produce and consume more Pulses in our diet in the International Year of Pulses 2016. ■

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FOOD, AGRICULTURE AND SUSTAINABLE DEVELOPMENT GOALS

Concurrent with the launch of Indian Council of Food & Agriculture (ICFA) at New Delhi, 17 Sustainable Development Goals (SDGs) were adopted at the UN Headquarters in September 2015 by 193 countries, encompassing universal aspirations centered on People, Planet, Prosperity, Peace and Partnership where "no one is left behind". Success in achieving these goals by 2030 will depend on countries' capacity to develop and implement national strategies that are economically, socially and environmentally sustainable and mobilize the support of stakeholders – locally, nationally and globally. Specific attention deserves to be devoted to the first two goals for eradicating poverty, hunger and malnutrition. Which is pertinent to India with the largest number of people going to bed hungry, despite so-called green revolution and about five-fold increase in food grain production as against only about four-fold increase in population since independence, but still with about half the yield per hectare for example of rice compared with some other countries even in Asia. Agri-food production, productivity and accessibility has to be enhanced fast forward, also elsewhere with about 795 million people suffering from hunger worldwide. That's about one in nine people on the planet. The international agreement about SDGs has explicitly indicated the importance of food and agriculture in the global agenda for the "future we want". Even though SDG 2 is focused on this theme, the other 16 Goals are correlated with it, one way or the other.The SDGs are interwoven and apply to all countries.

Sustainable Development Goals:

Goal 1. End poverty in all its forms everywhere; Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture; Goal 3. Ensure healthy lives and promote well-being for all at all ages; Goal 4. Ensure inclusive and equitable quality education and promote life-long learning opportunities for all; Goal 5. Achieve gender equality and empower all women and girls; Goal 6. Ensure availability and sustainable management of water and sanitation for all; Goal 7. Ensure access to affordable, reliable, sustainable, and modern energy for all; Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; Goal 9. Build resilient infrastructure, promote inclusive and sustainable

industrialization and foster innovation; Goal 10. Reduce inequality within and among countries; Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable; Goal 12. Ensure sustainable consumption and production patterns; Goal 13. Take urgent action to combat climate change and its impacts; Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development; Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels; Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

The SDG2 to End hunger, achieve food security and improved nutrition, and promote sustainable agriculture plays a pivotal role in the 2030 Agenda for Sustainable development and in achieving other goals. Towards this end, SDG 2 has 8 focused targets as noted here-in-below:

Targets: 2.1 by 2030 end hunger and ensure access by all people, in particular the poor and people in vulnerable situations including infants, to safe, nutritious and sufficient food all year round. 2.2 by 2030 end all forms of malnutrition, including achieving by 2025 the internationally agreed targets on stunting and wasting in children under five years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons. 2.3 by 2030 double the agricultural productivity and the incomes of small-scale food producers, particularly women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets, and opportunities for value addition and non-farm employment. 2.4 by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality. 2.5 by 2020 maintain genetic diversity of seeds, cultivated plants, farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at national, regional and international levels, and ensure access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional

knowledge as internationally agreed. 2.a increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development, and plant and livestock gene banks to enhance agricultural productive capacity in developing countries, in particular in least developed countries. 2.b. correct and prevent trade restrictions and distortions in world agricultural markets including by the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round. 2.c. adopt measures to ensure the proper functioning of food commodity markets and their derivatives, and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.

SDG2 is viable and affordable, especially through private-public-people partnerships. Additional average annual investment needed to eliminate extreme poverty and hunger is estimated at US$265 billion per year between 2016 and 2030. Out of this, some US$198 billion will be for pro-poor investments in the productive sectors, with US$140 billion for rural development and agriculture. The remaining US$67 billion are for social protection programmes. It is noteworthy that US$265 billion is equivalent to barely 0.31 percent of global GDP. While around 1.3 billion tonnes of food are wasted and 7 million productive hectares lost annually, poverty and population pressure for farmland, food, fuel and fibre continue as cause and consequence of hunger. Must realise the multiple benefits food security confers on agriculture and their mutual interdependence for livelihoods with farm products and ecosystems services. Their vulnerability, adaptability & mitigation measures for climate & natural disasters call for food, farms and agriculture sector-wide approach for harmonizing human resilience and SDGs via stakeholder stewardship, ownership, entrepreneurship & leadership, taking note of Mandela Mission: "What is required is a partnership among communities, government and the private sector".

Innovations must address food security and safety, the competitiveness of agri-food industry and the sustainability of food production, processing and consumption–covering the food chain and related services from primary production to consumption. That should make agriculture and fisheries more productive and sustainable, reduce rural poverty, enable inclusive and efficient agricultural and food systems, and increase the resilience of livelihoods to threats and crises. Providing family farmers with adequate financial and scientific support is a bottom line of food and agriculture policies with a zero hunger vision, given that there are more than 570 million farms in the world, of which over 500 million are family owned. They are responsible for at

least 56% of agricultural production. Investing in rural development, establishing social protection systems, building rural urban linkages and focusing on boosting the income of the critical agents of change–smallholder family farmers, foresters, fisher-folk, rural women and youth– is key to-achieving inclusive and equitable growth while tackling the root causes of poverty and hunger. Improving rural livelihoods will also curb rural urban migration and increased urban poverty. Almost 80 percent of the world's extreme poor live in rural areas where most are dependent on agriculture. Agriculture is the single largest employer in the world. Agricultural growth and agrarian economies are at least twice as effective as growth in other sectors in reducing hunger and poverty. A dedicated global goal, SDG2, based on a comprehensive approach to tackling food insecurity and malnutrition, while promoting sustainable agriculture, is a sagacious step to achieving zero hunger and ushering in a new era of sustainable development.

Agriculture is a mainstay of the country's economy and providing a source of employment for more than 47 percent of the population in India. It has emerged as a major agricultural exporter, with exports climbing to more than $40 billion as the world's seventh-largest exporter of agricultural products. Over 58 per cent of the rural households depend on agriculture as their principal means of livelihood. Agriculture, along with fisheries and forestry, is one of the largest contributors to the Gross Domestic Product (GDP) with 15.35 per cent of the Gross Value Added (GVA) during 2015–16. Agricultural export constitutes 10 per cent of the country's exports and is the fourth-largest exported principal commodity. No wonder that India's leadership is taking strategic steps towards reinvigorating the agriculture sector, which includes focus on soil health cards, irrigation, solar pumps, seeds, fertilisers, and crop insurance.

The SDGs are the first Member State-led development agenda of the UN system laying out specific goals for countries to meet by a given timeframe with achievements monitored periodically. India has moved fast forward. Niti Aayog (successor to National Planning Commission) stands designated for the overarching role of Oversight with requisite involvement of various ministries. Regarding SDG2, its Nodal Ministry is Agriculture & Farmers Welfare. Other concerned Ministries and Departments are: Consumer Affairs, Food & Public Distribution, Tribal Affairs, Agriculture & Cooperation, Chemicals & Fertilisers, Commerce, External Affairs, Health & Family Welfare, and Ayush devoted to Indian Systems of Medicine & Homoeopathy for which a national policy is being formulated. Niti Aayog also involves several Centrally Sponsored Schemes for SDG2: National Food Security Mission, Mission for integrated Development of Horticulture, National Mission on Sustainable Agriculture, National Oilseed and Oil Palm Mission, National Mission on Agriculture Extension and Technology, Rashtriya Krishi Vikas Yojana, National Livestock Mission, Livestock Health and Disease Control and National Programme for Bovine Breeding and Dairy Development. Monitoring apart, the Government's recent commitment to doubling farmers' income by 2022 could concomitantly contribute to its strategy for progress of the common man and the achievement of pertinent SDGs.

The SDGs challenge us to be the first generation in human history to eliminate the scourges of hunger and poverty. What is needed is political will and appropriate strategies and partnerships for drawing upon agricultural sustainability, food security and poverty eradication for the wellbeing of all people as well as prosperity and stability of all countries. Food security is a basic human right and agriculture a fundamental sector to the economy. Countries should stay committed to SDGs, push for consensus in the international community, work together for access to safe and secure food for all and create enabling environment for agricultural investment. ■

Doubling Farmers Income
Empowerment of Farmers & Rural Youth

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India's economic security continues to be predicated upon the agriculture sector, and the situation is not likely to change in the foreseeable future. Even now, agriculture supports 58% of the population, as against about 75% at the time of independence. In the same period, the contribution of agriculture and allied sector to the Gross Domestic Product (GDP) has fallen from 61 to 19%. As of today, India supports 16.8% of world's population on 4.2% of world's water resources and 2.3% of global land. And per capita availability of resources is about 4 to 6 times less as compared to world average. This will decrease further due to increasing demographic pressure and consequent diversion of the land for non-agricultural uses. Around 51% of India's geographical area is already under cultivation as compared to 11% of the world average.

Economic & Social conditions of the farmers will largely depend upon the intervention of Food Processing Industries in order to transform the farmer's produce to value added products. The viability model of Agriculture in India will emerge mainly by linking it to value addition, Food Processing, preservation & establishing a large network of Food Processing Micro & Small enterprises in the villages. The growth of Food Processing Industry will bring immense benefits to the economy, raising agricultural yields, enhancing productivity, creating employment and raising living standards of a large number of people across the country, especially those in rural areas. Hence, popularization of food processing technology and creating awareness among the masses are necessitated to develop farmers' income and make them self-reliant.

The Constraints

Though India has very strong agricultural and horticultural production base, it is a matter of great concern that low level of processing, inadequate post-harvest infrastructure facilities and lack of appropriate technologies result in huge wastage of agriculture produce, particularly perishable commodities resulting not only in loss to the national exchequer but a severe hardship to our farmers and consumers. Some studies have revealed that we might be losing around Rs. 93,000 crores worth produce every year due to lack of post-harvest facilities and inadequate processing. The different stages considered for assessment of losses are harvesting, collection, threshing, grading/sorting, winnowing/ cleaning, drying, packaging, transportation, and storage depending upon the commodity. Most of the wastage is happening in fruits and vegetables, pulses and cereals. With adequate processing facilities much of this waste can be reduced thus increasing remunerative wage to the producer as well as ensuring greater supply to the consumer.

Some of the major challenges being faced by the Food Processing Sector are:-

- Supply Chain Infra Gaps; Lack of primary processing facilities; controlled atmosphere storage; cold chain; cold storage and

distribution facilities at the Farm gate in the villages

- Inadequate link between production and processing (Lack of processable varieties)
- Seasonability of operations and low capacity utilization
- Inadequate focus on quality and safety standards
- Lack of product development and Innovation
- Supply Chain Institutional Gaps (procurement dependence on APMC markets)

Apart from the above said constraints, one of the major constraints is availability of skilled/ trained manpower. This calls for major investments in developing Human Resources which in turn will help the farmers to become entrepreneurs, train rural youth for the Food Processing industry which will help agriculture & Food Processing industry to grow further. For achieving this, the following needs to be done on a top-priority basis:-

- To popularize food processing technology and its role in value addition to farmer's produce.
- To motivate and train the farmers and rural youth for setting up micro enterprises by forming SHG or cooperative societies or farmers producers organization or individual enterprise.
- To link quality raw material/ backward linkage from farm gate to food processing establishment and its end users (forward linkage). In other words linkage from Farm to Fork needs to be established in the areas taken up.
- To enhance the income of the farmers by getting best selling prices of the produce.

The Proposed Solution – 'KHUSHHALI Scheme of NIFTEM:-

Based on its last four years' experience of working with nearly 22000 farmers/ rural youth in 39 villages across 18 states under its flagship "Village Adoption Programme" NIFTEM, has formulated the "KHUSHHALI" project with a two pronged strategy – One is to train and handhold the farmers/ rural youth to become entrepreneurs in the food domain; and the second is to create an enabling infrastructure at the farmgate in the village in the farm of a "Food Processing Hub" – A Hybrid Energy Powered Primary-Cum-Secondary Processing Centre-Cum-Cold Storage-Cum Training Centre.

Just like the farmer prepares his field before sowing the seeds so as to get a good crop, in this case also, we have to make the Farmers and Rural youth aware about benefits of value addition, food processing; Train them and give them enough knowledge to become either entrepreneurs or trained workers for food industry & also hand hold them for some time so as to help them establish micro-enterprise in the rural area itself. We need to give them all those facilities in the village itself at their door step by creating a Rural Development Hub for Primary Processing, Value Additions, Training etc.

During handholding, budding

entrepreneurs will be exposed to technique of a) Decision making for products to be produced based on the local raw materials, b) Preparation of DPR, c) Materials procurement & production, d) Schemes of banks and Mudra banks, e) Registration with DIC & FSSAI, f) Recent development in packaging technology, g) Testing of Products on the parameters according to FSSAI, h) Forward marketing linkages techniques and training on the job so that a group of rural youths can go and identify local markets for selling and procuring the raw materials.

To make the programme successful, it is imperative to involve KVKs, Agricultural Universities and Central Universities where food technology is taught. These institutes/ Universities will facilitate in catalysing the process of entrepreneurship with technical inputs from their renowned scientists/resource persons. NIFTEM will also network with the Mudra bank, MSME schemes & NSDC, etc. to smoothen the process of finance to the budding entrepreneurs.

Central Govt. institutions like NIFTEM (National Institute of Food Technology Entrepreneurship and Management) have already started such initiative. But to make the programme successful, it is imperative to involve 640 KVKs and 45 Agriculture Universities and 08 Central Universities where food technology is taught. These institutes/ Universities will facilitate in catalysing the process of entrepreneurship with technical inputs from their renowned scientists/resource persons. NIFTEM will also network with the Mudra bank, MSME schemes & NSDC, etc. to smoothen the process of finance to the budding entrepreneurs.

Since 2011, NIFTEM has been conducting Skill Development/EDPs and Capacity building Programmes on PAN India Basis to Skill the farmers & unemployed youth, besides upscaling the Skill of employed Youth. In this endeavour NIFTEM has conducted 92 Skill Development/ Capacity Building & EDPs and trained 3372 persons and 29 Outreach / Awareness programmes and trained 9146 persons – totalling 12518 persons have been trained.

Establishment of "Rural Development Hub" for Value Addition / Food Processing & Storage – Hybrid Energy Powered (Solar + Biomass) Primary Processing Cum Storage Cum Training Centres in PPP Mode

A Primary processing cum secondary processing centre for horticultural produce with an appropriate set of equipments is proposed to be established under PPP mode. This centre will be equipped with an appropriate set of equipments for sorting, washing, grading, value addition and packaging along with appropriate storage facilities (cold storage) for horticultural produce. The centre will help the farmers and rural youth to a great extent in developing their skills to reduce the post-harvest losses and value addition of their horticultural produce and increase employment opportunities. This centre and storage unit will also serve as a benchmark for establishing Primary Processing Centres with cold storage facility at the farm level.

The project (infrastructure and operational cost) may be fully financed by the Government initially for a period of five years. Later the project may be transferred to a FPO/ NGO/industry operating actively in the production catchment and having domain expertise.

Expected Outcomes:

- Reduction of the post-harvest losses of fruit and vegetables.
- Education, Training & Information.
- Autonomy, Independence & Co-operation among FPO.
- Increasing the income of farmers.
- Processing & storing fruits and vegetables for longer duration.
- Encouraging entrepreneurs and cooperative farmers to go for such kind of units. ■

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Food grains play an essential role in nourishing the nation's populace. Therefore it needs special care like proper storage and transportation. For taking care of these special needs, Adani Group, one of India's fastest growing business houses has set up seven base and field depots spread across the length and breadth of the country, coupled with specially designed top loading and bottom discharge rail wagons. The sole objective of this project is to provide comprehensive supply chain management solutions to FCI- Food Corporation of India. These depots are fully mechanized using state of the art technology for storing food grains. Fully integrated and IT enabled operations make sure that there are no lapses in quantity and quality of grains, and transparent transactions are carried out at all stages.

Salient Features:

- AALL handles 5,55,000 MT of food grain for FCI in the states of Punjab, Haryana, Tamilnadu, Karnataka, Maharashtra and West Bengal. Another 3,00,000 MT of food grain is handled for Govt. of Madhya Pradesh. Additionally, AALL has expanded its foot prints in Bihar and Punjab with capacity of 75,000 MT for FCI.
- Wheat is stored in GI Sheet (Steel) silos. The silos are fully covered and have an elaborate system for preservation of wheat.
- High-end monitoring equipment's for checking critical quality parameters like moisture content, foreign matter, live infestation etc.
- Central Control System using state of the art PLC systems, for automatic operations of the facility.
- Modern cleaning and drying operations, through sieves, magnetic separators etc. to remove dust, tailings and other foreign matter.

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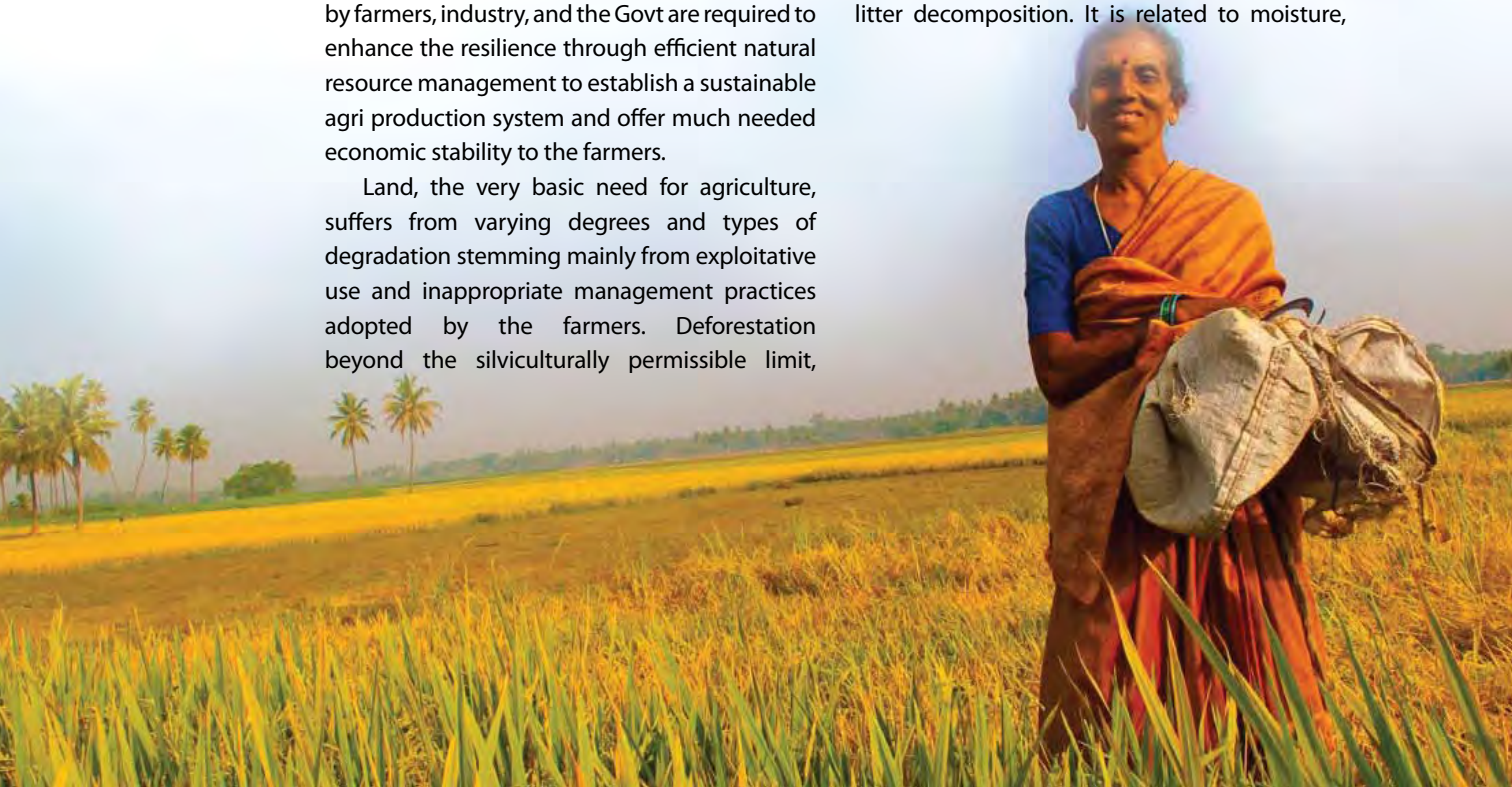
Doubling Farmers' Income
Role of Soil Health Management and Sustainable Crop Nutrition

For a monsoon dependent Indian agriculture, a sustainable and climate resilient agricultural production system is the pre-requisite to sustain productivity in the event of extreme climatic variability. Climatic parameters have become highly unpredictable creating agrarian stresses especially at a time when Indian agriculture is gradually moving away from merely a source of subsistence towards a cost and market sensitive commercial enterprise. Many coping mechanisms have been evolved by the farmers over the years but these have fallen short of an effective response strategy in dealing with recurrent and intense forms of extreme events. Gradual changes in climate parameters including rise in surface temperatures, changes in rainfall patterns, increase in evapo-transpiration rates and distortions in soil health parameters have created visible impacts globally. Therefore, it is imperative for Indian agriculture to synergize modern agriculture research with the indigenous wisdom of the farmers especially to conserve soil, its health and water resources. Concerted efforts by farmers, industry, and the Govt are required to enhance the resilience through efficient natural resource management to establish a sustainable agri production system and offer much needed economic stability to the farmers.

Land, the very basic need for agriculture, suffers from varying degrees and types of degradation stemming mainly from exploitative use and inappropriate management practices adopted by the farmers. Deforestation beyond the silviculturally permissible limit, unsustainable fuel wood and fodder extraction, and encroachment into forest lands, forest fires and over grazing have accelerated the process of land degradation. Soil in most parts of the country have demonstrated signs of sickness due to extension of cultivation to lands of low potential or high natural hazards, inadequate soil conservation measures, improper crop rotation, indiscriminate use of agro-chemicals, inefficient water management, faulty irrigation systems and extraction of ground water in excess of the recharge capacity.

Soil Health and Sustainable Crop Production

Healthy soil is the foundation of the food system. It produces healthy crops that in turn nourish people. Maintaining a healthy soil demands care and effort from farmers because farming is not benign. By definition, farming disturbs the natural soil processes including that of nutrient cycling - the release and uptake of nutrients (FAO). Soil organic matter content is a function of organic matter inputs (residues and roots) and litter decomposition. It is related to moisture,



temperature and aeration, physical and chemical properties of the soils as well as bioturbation (mixing by soil macro-fauna), leaching by water and humus stabilization (organomineral complexes and aggregates). Land use and management practices also affect soil organic matter.

A healthy soil will only be productive and offer stability to crop production system. However, the present key soil health parameters of Indian soils tell a different story. Out of 306 m. ha reported under various land uses, about 141 m. ha is net sown area and a major portion of this has undergone natural and human induced degradations.

Besides, a huge area is affected by problems like water logging, ravines, shifting cultivation etc. By managing the problematic soils and taking steps to prevent spread in wider geographies, an integrated approach involving technological interventions, dissemination of knowledge and Government policies, is much needed.

Soil Organic Carbon

Organic carbon content is one of the most important determinants of good soil health and support system for crucial microbial activities in the top soil. The SOC concentration in most cultivated soils is less than 5 g/kg compared with 15 to 20 g/kg in uncultivated soils. Low SOC concentration in cultivated lands is attributed to intensive working of the soils, removal of crop residues/bio mass and mining of mineral nutrients. The rate of soil organic matter accumulation depends largely on the quantity and quality of organic matter input. Under tropical conditions, applications of readily degradable materials with low C:N ratios, such as green manure and leguminous cover crops, favour decomposition and a short-term increase in the labile nitrogen pool during the growing season. Technical options for carbon sequestration in India includes integrated nutrient management(INM),green manuring, mulch farming ,residue recycling, choice of cropping pattern and balanced nutrients with high use efficiency. Fortunately government has initiated certain steps to address this issue.

Table 1: State of key soil health indicators in India

Parameters	Status
Soil organic content	Low SOC ranging 0.2-0.5% in most of soils
Soil reaction	
Alkali soils	37.88 lakh ha -restricted production due to salt accumulation
Acidic soils	65.00 lakh ha - results toxicity and deficiencies of nutrients

Nutrient Mining

The United Nations Environmental Program has recognized the importance of reconciling nutrient removal with nutrient additions and views that there is a need to define and then assess trends in nutrient performance.

Intensive agriculture, while increasing food production, has caused second generation problems in respect of nutrient imbalance. Negative nutrient balance has resulted in over 30 percent reduction in response of fertiliser (response ratio has decreased from 15 kg per kg of NPK during 5th FYP to about 6 kg/kg grains during 12th FYP. The problem is not only confined to intensive cultivation (assured irrigation) belts of the country, even in the vast non irrigated dry lands; overall nutrient balances are negative as removals exceed additions by 7 to 1 ratio. These lands are estimated to receive 10 % of the fertiliser used in India, but account for 30% of the total nutrient removal. Nutrient loss through soil erosion is next to crop removal. Nutrient management with proper soil conservation practices is the only way out to check further deterioration.

Nutrient Deficiencies and use Efficiency

General indicator of deteriorating soil health is stagnation in yields. The problem lies in inadequate application of nutrient to a particular crop rotation along with low nutrient use efficiency. The scenario has led to a more complex agronomic situation where multi-nutrient deficiency has emerged- causing high cost of cultivation coupled with reduced yield and income. Desperate with the declining responses, farmers are trying to increase the application rates which are short lived, unscientific and unviable. Since agricultural systems, and related Nitrogen and Phosphorus cycles are complex and leakages are unavoidable, zero nutrient loss is not an achievable goal, but nutrient use efficiency can be significantly increased by more precise fertilization.

Balanced Fertilization

The most critical factor for management of soil health is the timely application of essential plant

nutrients (which include primary, secondary and micronutrients) in readily available form, in optimum quantities and in the right proportion, through the correct method, suitable for specific soil/crop conditions. As a bench mark N: P: K combination aggregated for the country is 4:2:1 which peaked to 8.2:3.2:1 during 2012-13. With the increasing awareness and improved availability of non-urea fertilisers distortion has eased and reported to be 6.7:2.4:1 during 2014-15.

Correction of this distortion is one of the major challenges before agricultural experts and policy makers which led to introduction of NBS (Nutrient Based Subsidy) and is considered a landmark policy decision in crop nutrition sector in the recent past. However, imbalance in nutrient application has emerged as one unintended outcome of NBS policy which left urea out of NBS ambit. For instance, the consumption of Urea has gone up from 264.51 Lakh MT in 2009-10 to 308.83 Lakh MT in 2014-15 while that of DAP and MOP has declined by about 30-33% (101.51 LMT in to 75.89 LMT) during post NBS regime. It is pertinent to mention that with the implementation of NBS for P&K fertilisers, subsidy outgo has declined over the years. But the advantage has been negated by rising Urea subsidy which constitutes about 75% of MRP compared to 35-40% in case of DAP and MOP.

Integrated Nutrient Management (INM) – a panacea for soil health and productivity

Integrated Nutrient Management is the conjunctive use of chemical fertilizers, organic manures and bio-fertilisers which enhances nutrient use efficiency, soil health, crop yields and profitability. Efforts are required to augment supplies of organic manures, fortified, coated and customized fertilizers supplying secondary and micronutrients, biofertiliser and soil amendments for sound nutrient management and maintenance of soil health. There is huge gap in availability and use of organic manures which has resulted in low response of fertilisers in most of the crop production belts in India. At present, availability of organic manures is 383 Million tonnes against the moderate requirement of 900 million tonnes / annum (@5 t / ha on gross cropped area of 185 MHa). Promotion of city compost has been initiated by the Govt of India and will narrow the gap and support regaining vigor of biologically degraded soils.

Site Specific Nutrient Management

Precise and timely soil diagnostics (the service presently inadequate with a capacity to analyze only 7 million soil samples/ annum against 130 million farm holdings in the country) is one of the most important enablers to improve and maintain soil health. The ambitious Soil Health Mission initiated by Government of India is one big step in this direction, but it needs to be ensured that recommendations of soil health cards get adopted. There are about 6.5 MHa acidic and 7MHa salt affected soils in the country. With accurate working of lime and gypsum requirement through soil test and their appropriate application, fertiliser requirements can be significantly reduced which otherwise is adding cost to the farmers and impacting ecological balances.

In order to make soil tests and Soil Health Card scheme more practical and adoptable, fertiliser retailers need to be integrated. This integration will provide scientific base to the retailers for supply of required nutrients to the farmers which is the ultimate aim of soil health card scheme.

Responsible Crop Nutrition

Fertiliser industry is one of the key

drivers of agricultural growth in the country. Responding to the changing requirements of farming sector, industry has put its best efforts to meet them. Besides, Fertiliser industry has always shouldered the responsibility for successful implementation of various Government initiatives to promote efficient and cost effective plant nutrition.

- Implementing STCR (soil test crop response based recommendations) which offers more precise nutrient application and value to the money invested by farmers. Adventz group has taken a lead to adopt STCR concept across its 5 soil testing facilities
- In order to reduce nutrient imbalances, industry has focused on indigenous production of complex fertilisers.
  - o Also produced a record 24.5 million tonnes of Urea-highest ever since independence
  - o Industry has demonstrated utmost agility in migrating to 100% production/import of neem coated urea –a step much needed to improve the Nitrogen use efficiency
- To boost the application of cost effective P fertilisers, SSP production has been scaled up. Government has also facilitated industry through supportive policies like removal of minimum capacity utilisation criteria.
- Responding to the needs of changing cropping patterns and agroclimatic requirements, speciality nutrient products are finding more space in product basket of major fertiliser companies. Adventz group alone has a range of 74 highly efficient speciality crop nutrient products.
- Fertiliser industry is playing pivotal role in promoting application of city compost under Government of India's initiative.

Doubling the Farmers' Income – Vision to Action

The farming in India is under transformation and has got a boost as government has also given adequate focus on very basic building blocks like soil health, improving access to irrigation, providing an improved crop insurance scheme that covers the entire gamut of risks at minimum premiums and on-line integration of APMC mandies in the country. Now there is a growing trend of awareness about soil health, efficient water and nutrition management and understanding about which crops to grow in relation to market realization of the produce. Considering importance of irrigation in dominant rainfed agriculture of the country, the Government has fast tracked irrigation projects and emphasized on micro-irrigation and water use efficiency. Efforts to bring energy efficiency by introducing solar pumps to farmers will help to reduce cost of cultivation in the long run. There is need to minimize production cost, introduce more of export oriented products,modernization ofwholesale markets, enhanced processing and warehouse infrastructure with long term agricultural policy.

Income through Efficiency

The Prime Minister envisioned doubling the income (of 2015-16 level) of farmers by 2022, when the country completes 75 years of independence. Certain interventions and policies should be molded to transform this vision into reality. The first step taken in this direction is implementation of National Soil Health Mission and covering all the farmers in 3 years' cycle with soil health cards. The initiative was long back recommended by National Commission on Farmers headed by Dr M.S. Swaminathan.

Soil health is closely associated with balanced nutrition and efficient water management. It entails a lasting impact on productivity of the soil, cutting down costs on excessive

fertiliser and water use alongwith agrochemicals.

Managing Risks and Uncertainties

The cost-risk-return structure of farming is not in a healthy state and resulting into growing despair and indebtedness at farming household level. Though the Govt is facilitating farmers by way of subsidies on inputs as well as offering minimum support prices for major outputs, an inadequate post harvest back up is negating these supports. Agricultural Produce Marketing Committees are not able to offer transparent systems and the ultimate victim is producer farmer. PM's Crop Insurance Scheme launched in January, 2016 is being seen as a great support to farmers vulnerable to various calamities and loss of income.

Competitive Price-Transparent Market

As indicated in report on National Commission on Farmers, policy reform in agriculture is long overdue. A policy reform should be pro-small farmer and pro-women and pro-landless agricultural labour. It should pay particular attention to the promotion of conservation agriculture and remunerative marketing. If production of foodgrains is any indicator of agrarian prosperity, India has achieved record production of food, fruits and vegetable crops but the paradox of farmers committing suicide is also a glaring reality. This indicates they are not getting appropriate returns for their produce. An overview of the entire agri production system makes it apparent- so far farmers have been putting maximum effort to increase production with little awareness about market requirements and lack of access to a transparent marketing system. However, some of the recent steps taken by the Government seems to address this malady.

Initiatives like setting up an online National Agriculture Market (NAM), by integrating 585 wholesale markets across India, is a move that would help farmers have access to a comparatively transparent system and realize better prices. This will enable seamless transfer of agriculture commodities within the state and the market size for farmers would increase as they won't be limited to a captive market. Promotion of organic farming in a mission mode, promotion of agro forestry and ecologically safe and efficient solar pumps for irrigation are potential initiatives to strengthen the farming system.

Shift from Production led to Market led Advisory

With the changing agriculture scenario worldwide, Indian farmers have to transform themselves from mere producers-sellers in the domestic markets to producer cum seller in a market, with the ability to foresee desired returns for their investments, manage risks and improvise efforts. Agri advisory can play its pivotal role not by mere transfer of technology to farm side but also play the role of Decision Support System to plan agronomic interventions based on appropriate market information as well. Extension agencies are required to empower farmers about what to produce, when to produce, how much to produce, when and where to sell, at what price and in which form to sell their produce. Effective linkages of production systems with marketing, agro-processing and other value added activities would play an increasingly important role in process of increasing farmers' income.

To double the farmers' income, farming system approach needs to be evolved. Diversification of crops with efficient production technologies, incorporation of agro forestry, livestocks, fisheries, precision farming and off-farm engagements will be the key drivers. Farm income can't be doubled in a sustainable manner unless round the year engagement of farmers with income generating activities are achieved. ■

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Group Chairman,
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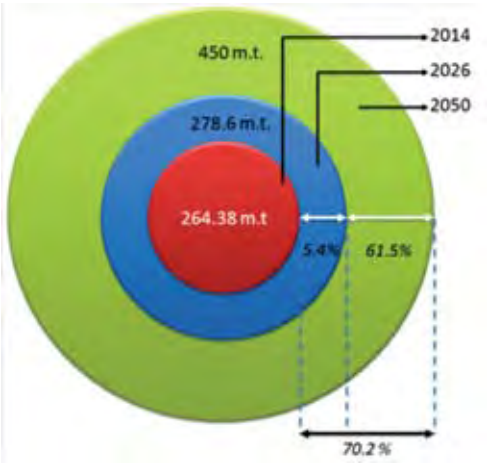
India towards Green to Greener Agriculture

In early years of independence, agriculture was practiced at subsistence level with little technical know-how and low farmer resource endowments.We had only 18.1 % arable area under irrigation and a paltry consumption of 2 kg/ha of N+P+K during 1950-51. Our food-grains production was merely 50.8 million tonnes which was directed to feed approximately 361.1 million Indians. In 1960s, we lived a "ship-to-mouth" existence,when US ships loaded with wheat would dock at our ports, and the grain would be channelled straight to Ration Shops.

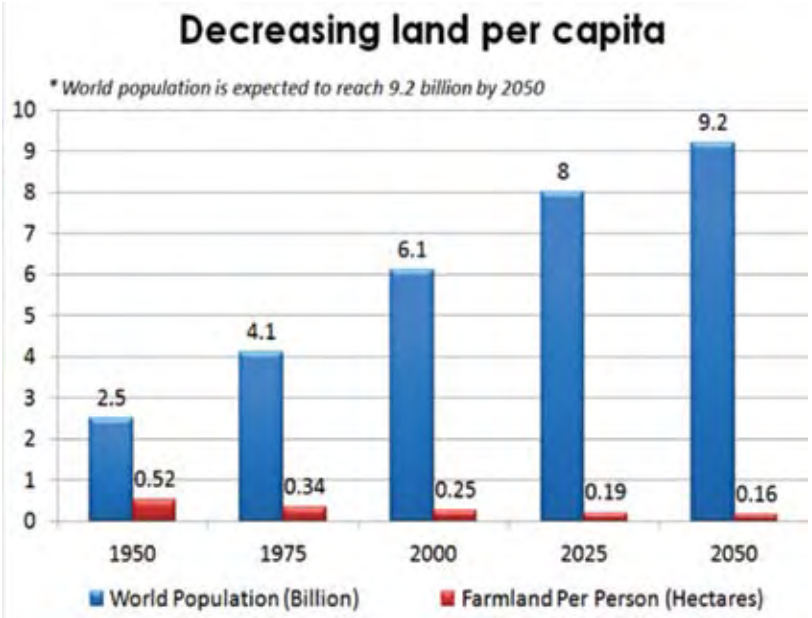
The Green Revolution in India was a period when agriculture in India increased its yields due to improved agronomic technology. It allowed developing countries, like India, to overcome chronic food deficiency. It started in India in the early 1960s and led to an increase in food production, especially in Punjab, Haryana and Western Uttar Pradesh during the early phase. The introduction of high-yielding varieties of seeds (hybrid seeds) and the increased use of chemical fertilizers and irrigation led to the increase in production needed to make the country self-sufficient in food grains, thus



improving agriculture in India. Now our country has become the second largest contributing country in world with Agriculture contribution to GDP INR 23998 Billion and fifth largest exporter country of agriculture commodities with annual export value of INR 3162.08 Billion as per WTO. This happened due to mixed farming and contribution from Dairy, Horticulture, Fisheries and Poultry sectors. Now India is the most potential and favorable country in world for securing food for future.

Challenges for Indian Agriculture Industry

A. Food Security: With a rapidly growing population, India's food requirement is also growing and according to an estimate, the long-term food grain requirements need an increase of 5.4% from the present level by 2026 and 61.5% increase from 2026 projection to meet estimated requirement in 2050. In other words, the country needs 70.2% increase in 2050 from the present level. However, despite a five-fold increase in food grains production from 50.8 million tonnes in1950-51 to a record production of 264.38 million tonnes

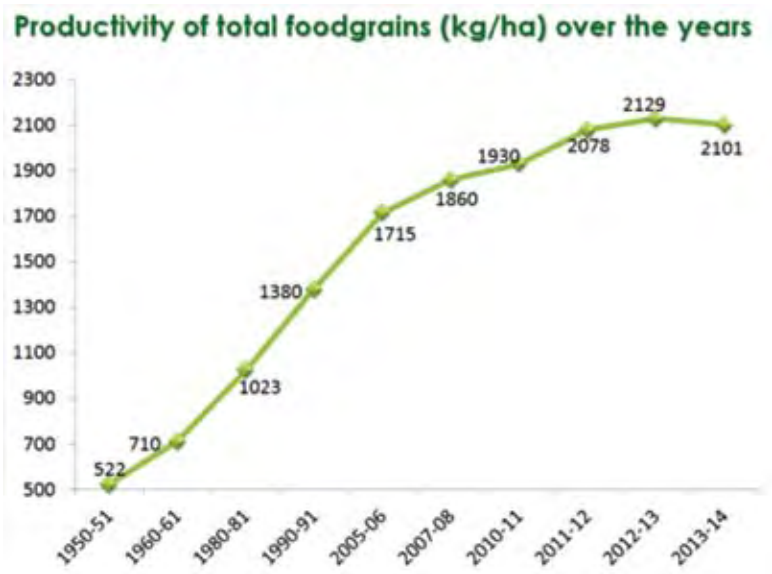


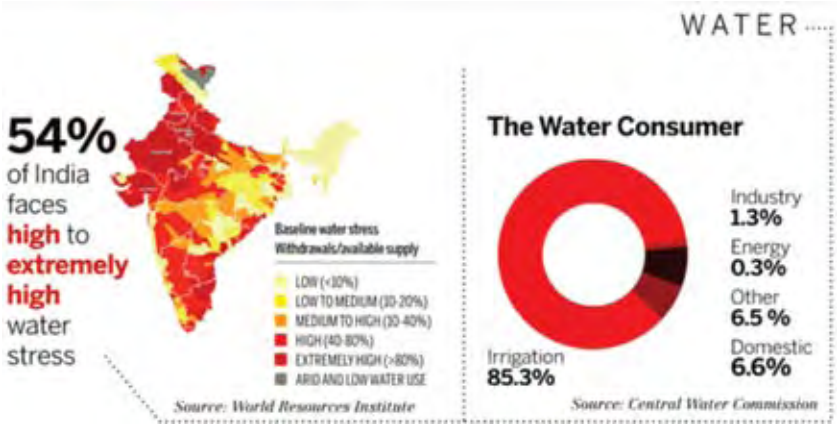
10-year period to 2000-01 to 2010-11, whereas, land under cultivation stayed constant. Another number comes from the Census Department, which says area under urban use jumped by 24,000 sq km during the same period. Much of this would have been at the expense of rural land. As cities grow, agricultural area around them comes down. This has put immense pressure on the current available arable land for the food and nutritional needs of the population.

C. Shortage of Water: The problem is dwindling groundwater supplies due to over-extraction for farming. India extracted 251 bcm of groundwater in 2010, whereas the United States extracted only 112 bcm. Further, India's rate of extraction has been steadily growing from a base of 90 bcm in 1980, while this rate in the United States has remained at more or less the same level since 1980.

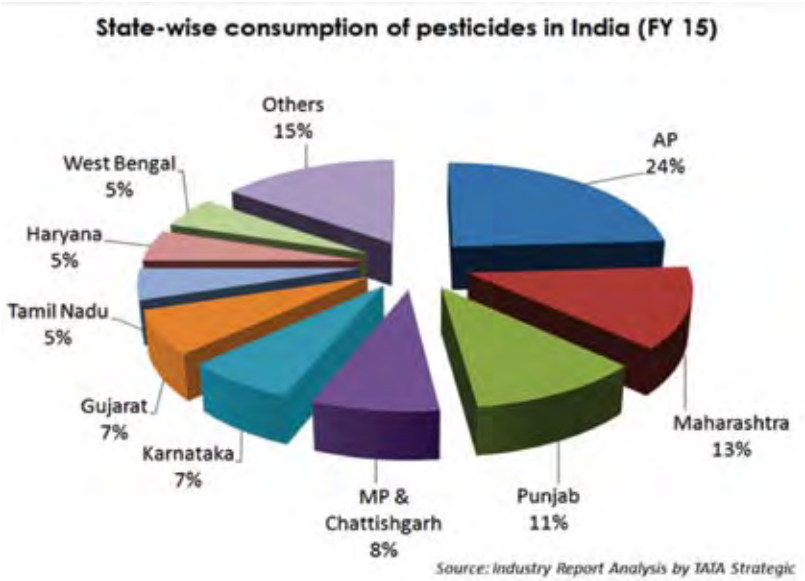
in 2013-14, current growth rate of agriculture is quite low. India's food grains productivity was only 2.1t/ha as compared to 5.0t/ha of China during the same period.

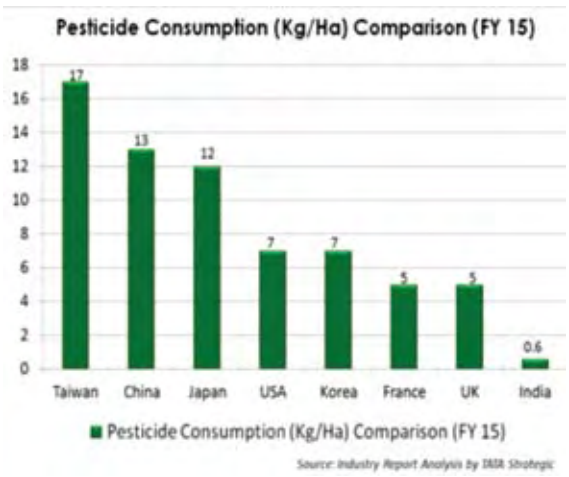
B. Reduction in Arable Land: The amount of per capita arable land in India has consistently declined from around 0.52 ha in 1950s to about 0.25 ha in 2000s. With rising population, it is further expected to reduce to approximately 0.19 ha by 2025 and 0.16 ha by 2050. According to the National Remote Sensing Centre (NRSC), India lost 16,000 sq km, or 0.8% of gross cropped area, in the





D. Productivity: With all the laudable achievements, India's per hectare production is far less to several developed and developing countries





like USA (7 t/Ha), UK (7 t/ha), France (7.5 t/Ha) and Germany (7). Our net per capita /annum foodgrains availability in 2013 was 510.8 g, nearly the same as in 1991 (510.1g). Shift in consumption pattern has also increased demand for Vegetables, Fruits, Meat and other Poultry products. Rapid growth of these sectors can be even more egalitarian and inclusive.

E. Low consumption of pesticides: According to the Industry report analysis by TATA Strategic Consultancy, the per hectare consumption of pesticides in India is amongst lowest in the world and currently stands at 0.6 Kg/Ha against 5-7 Kg/ha in the UK and 20 times at 13 kg/ha in China. In order to increase yield and ensure food security for its enormous population, agrochemicals penetration in India is bound to go up. The demand for pesticides is cyclic in nature and is mostly influenced by timely rainfall and its distribution. In India, Andhra Pradesh (Including Telangana & Seemandhra), Maharashtra and Punjab are top three states contributing to 45% of pesticide consumption. Due to intensive use of pesticides, there had been expansion in area under assured crop protection. The top seven states together account for more than 70% of crop protection chemical usage in India.

F. Myths Regarding Pesticides: Recently there was an NGO report which alleged the presence of banned pesticides like Aldrin, Dieldrin, Heptachlor and Chlordane in Vegetables and fresh Fruits. According to NABL accredited lab analyses,none of the samples contained residues above MRL and none of the banned pesticides like Aldrin, Dieldrin, Heptachlor and Chlordane were found. It proves that the report of NGO is biased and totally wrong. These NGOs used to insist on the sale of organic products but many of these so-called organic food, have more pesticides than crops grown under modern agriculture with application of pesticides. Analysis of 166 samples by Government Laboratories (AINPPR, ICAR) showed that 27% samples contained pesticide residue in these 4.8% of organic vegetable samples pesticide residue level were above MRL.

G. Spurious and counterfeit pesticides: According to TATA Strategic Industry analysis Report, there is a significant share of non-genuine pesticides which include counterfeit, spurious, adulterated or sub-standard products. According to the industry estimates, the non-genuine pesticides could account for more than 40% of the pesticides sold in India in FY14. These products are inferior formulations which are unable to kill the pests or kill them efficiently. Apart from crop loss and damage to soil fertility, use of non-genuine products lead to loss of revenue to farmers, agrochemical companies and government.

Way Forward

A. Transforming India through Agriculture: There is widespread consensus that, relative to the rest of the economy, agriculture is lagging and it can do much better to support India's overall high economic growth and dynamism. Following set of

Pesticide residues in "Organic" Vegetable Sample National Level (2014 - 15)			
Center	Sample Analysed	Sample with Detected Residues	Sample Above MRL
ANGRAU, Hyderabad	17	5	3
BCKV, Kalyani	17	7	1
IIHR, Bangalore	15	1	0
IITR, Lucknow	13	1	1
KAU, Vellayani	15	1	0
PC Cell New Delhi	74	28	3
RPQS, Chennai	15	2	0
Total	**166**	**45 (27%)**	**8 (4.8%)**

Source: All India Network Project on Pesticide Residues, ICAR

recommendations can address this question, (i) make public programs much more focused and effective; (ii) recognize water as a critical, long-term constraint to India's agricultural growth and give top priority to significantly improving the efficiency of water use; (iii) promote new high-yielding seeds, specific and effective low dose pesticides and related technologies, including mechanization, to improve yields and productivity; (iv) improve the effectiveness of agricultural research and extension; (v) support further improvements of the farm-to-market value chain and reduce spoilage; and (vi) improve markets and incentives related to agriculture through reforms of prices, trade, and direct subsidies to farmer .

B. ICT initiatives: ICT Innovation and ICT intervention in the agriculture sector are impacted through synchronization of agricultural informatics and e-Governance programme.In India, the government has made some serious efforts to popularize ICT in agriculture since 1987 onwards through its development programme at the district level (DISNIC-AGRIS). During 1990s as a "agricultural information development programme" through its sub-sectoral informatics network. This approach was outstanding as there was no effort elsewhere in the other parts of the world, to promote "informatics network in agriculture" as it was envisaged and attempted in India for the agriculture sector facilitating"Informatics for Sustainable Agriculture Development (ISDA)"

C. Harmonic Bonding between Institution and Farms: Institutions to Institutions: Collaboration among all the Institutions working on a particular problem like the development of new varieties of seeds, pesticides, farm machinery etc. among others. Institutions to Farms: The Institutions to Farms programme took the form of national demonstrations as well as the establishment of farm science centers, known as Krishi Vigyan Kendra (KVKs). There are now several hundred KVKs spread all over the country. Farms to Institutions: it is clear that there is considerable amount of traditional knowledge and wisdom available with farmers. Farms to Farms: This involves farmers to farmers learning. The National Commission on Farmers (NCF) had laid particular stress on learning through farm school. Fortunately, industrial house and financial institutions are promoting the establishment of farm school under their CSR Programme.

D. Agricultural Infrastructure: The positive effect of infrastructure on agricultural development has been articulated theoretically in several studies. Given the critical role of in-frastructural facilities in agricultural growth, the Indian government has accorded high priority to its develop-ment since the beginning of planning in the country. Elaborating its pattern of priorities, the First Five Year Plan held that, 'For the immediate five year period, agriculture, including ir-rigation and power, must in our view have the topmost priority. The state in this initial period has to concentrate on the provision of basic services like power and transportation'. In subse-quent plans as well, stress was laid on building a meaningful infrastructural network and providing basic services for the development of a modern economy.

Initiatives by Dhanuka Agritech Limited

Being a critical player in India's agri space, Dhanuka Agritech Limited has initiated some programmes in the transporting India's agriculture from green to greener levels.

a. Public – Private Partnership (PPP) for Improved Technology Reach: Recognizing the important role played by agri-input dealers in transfer of agri-technology to the

farmers and need for their capacity building, Dhanuka Group was the first to join hands with MANAGE by providing financial support for Diploma in Agricultural Extension Services for Input Dealers (DAESI) to meet 50 % 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 Anand Agriculture University, Navsari Agriculture University and Junagarh Agriculture University in Gujarat started similar out-reach Diploma for Agri-Input Dealers .

b. Eco-Friendly Molecules: Dhanuka group has been continuously introducing low dose active pesticides and eco-friendly formulations, which are safe to non-target organisms and at the same time have high bioactivity against the target pests at low dosages with greater shelf-life, little or no persistence in environment manufactured through eco-friendly manufacturing technology. Dhanuka Group has introduced several herbicides, insecticides, fungicides, miticides, plant growth regulators etc like SEMPRA, MORTAR, CONIKA, MAXX_ SOY, DHANVARSHA, COVER, SAKURA, LUSTRE, TARGA SUPER, CALDAN, DHANZYME GOLD, VITAVAX, WETCIT etc. which are very effective against their target pest even at very low dose. Earlier most of the pesticides were available as emulsifiable concentrates and wettable powder. But slowly, a new trend has emerged with products 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.

c. Water Conservation: It was nearly a decade ago recognizing the impending scarcity of water, our Group came up with a massive campaign "Gaon Ka Pani Gaon Mein aur Khet Ka Pani Khet Mein" to create mass awareness about conservation and judicious use of water. Dhanuka Group has been celebrating World Water Day on March 22 every year since 2010 in partnership with prestigious National Institutes, State Agricultural Universities etc. where lectures on water conservation & water reuse were organized. In addition, Drawing competition on 'Conservation of Water' theme in schools, Sixty seconds documentary- Insaan Paani Bana toh Nahi Sakta per Bacha Jaroor Sakta Hai, wherein Shri Amitabh Bachchan, Dhanuka's Brand Ambassador highlights the importance of water. Informative literature, Posters, Yagya etc are being regularly undertaken. We have constructed 4 check dams in Jugalpura, Devipura (District Sikar), Mainpuraki Dhani and Sankotra, (Jaipur district), Rajasthan. It is expected to benefit approximately 3000 households having a population of over 20000. Now all Check-Dams are operational.

d. Overcoming Misconception about Pesticides: The mere presence of pesticides in trace amounts does not mean that the product is unhealthy. Many NGOs like Greenpeace, Centre for Science and Environment etc. are spearheading the malevolent campaign against pesticides. But the real situation is quite different from what these NGOs, mischief mongers propagate. In order to educate the farmers about adoption of 'Good Agricultural Practices', a focus on Integrated Crop Management need to be intensified by implementing time-bound programme. Time to time Dhanuka group has been publishing several knowledge papers, books etc. for educating farmers for Integrated Crop Management.

India towards Green to Greener Agriculture: The agricultural and horticultural industry faces a multitude of challenges and the solution involves intensifying agricultural and horticultural industry on a global scale. If we need to transform Indian agriculture to greener agriculture then focus on 'Good Agricultural Practices' with a focus on Integrated Crop Management where pesticide play a major role.

Agrochemicals protect crops against diseases, pests and weeds, thus ensuring a good harvest and plenty of food. Consumers expect the food they buy to be fresh, of high quality and free from disease, moulds and insect damage. It's not an easy feat, as crops throughout the world must face 80,000 types of mould, 30,000 types of weed, 3,000 nematodes and 10,000 insect herbivores. Extensive research into new agrochemicals and technologies is of vital importance if we want to protect crops and avoid plant resistance to certain agrochemicals. In short, "Transforming India Green to Greener Agriculture" cannot be guaranteed without using agrochemicals. ■

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AGRICULTURE TODAY

CLIMATE CHANGE & AGRICULTURE

Climate Change and Agriculture

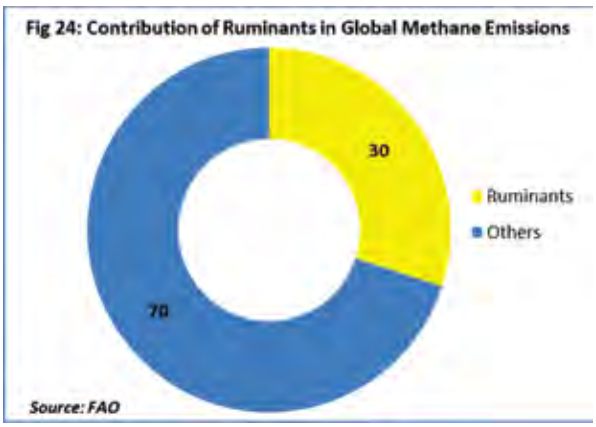
In the Backdrop of The Paris Climate Agreement (COP21/CMP11)

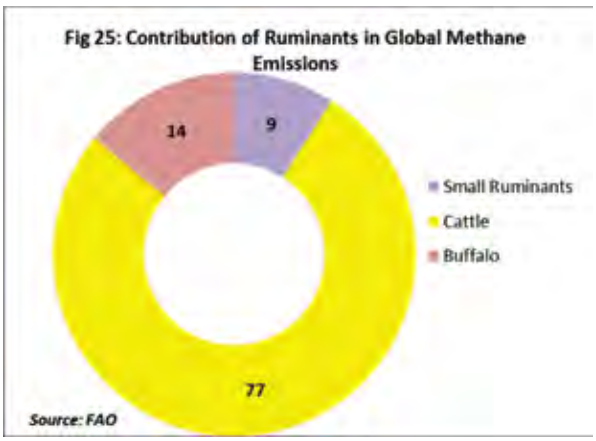
Agriculture remains a major source of Green House gas (GHG) emissions and as a result, it is essential that sustainable efforts are undertaken for adaptation and mitigation of adverse effects from the agricultural sector in terms of climate change. Various countries are seriously focusing on integrated approaches to agricultural development. Elaborate mechanisms like design of National Adaptation Plans (NAPs), Nationally Appropriate Mitigation Actions (NAMAs) and climate actions are being pledged by countries to make our planet a safer place to live for the future generations. While agriculture leads to emission of GHG and acting as one of the sources of climate change, it is also greatly affected by any subtle change in the climate of any region. Even a degree of increase in global temperature creates havoc on crop production.

One of the major undesirable contributions of agriculture sector is the emission of enteric methane (CH4) from livestock sector. Enteric fermentation is a natural part of the digitive process of ruminants. During the digestive process in ruminants that include cattle, buffaloes and small ruminants, microbes decompose and ferment feed present in the digestive tract to produce energy and protein. In the process, some amount of methane is also produced. Enteric methane is simply a by-product of this process and is expelled by the animal through burping. The other productions of the decomposition and fermentation process are used by the animal to make products such as milk, meat and wool.

Enteric methane is termed as Short-Lived Climate Pollutant (SLCP) and has a half-life of 12 years. This methane is worse in terms of global warming in comparison to carbon dioxide. Parts of methane may even stay in the atmosphere for many hundreds to thousands of years. Methane traps 84 times more heat than carbon dioxide over the first two decades after it is released into the air. Reducing the rate of enteric methane emissions would help reduce the rate of warming in the near term and, if emissions reductions are sustained, can also help limit peak warming. Some of the major harmful impacts of enteric methane emission from the global cattle industry are:

- Even over a 100-year period, the comparative warming





effect of 1 kg methane is 28 times greater than 1 kg carbon dioxide

- Ruminants are responsible for 30% of global methane emissions (Fig 25)
- Globally, ruminant livestock produce about 2.7 Gt of carbon dioxide equivalent enteric methane annually
- This is about 5.5% of total global greenhouse gas emissions from human activities
- Cattle account for 77% of these emissions (2.1 Gt), buffalo for 14% (0.37 Gt) and small ruminants (sheep and goats) for the remainder of 0.26 Gt (Fig 26).

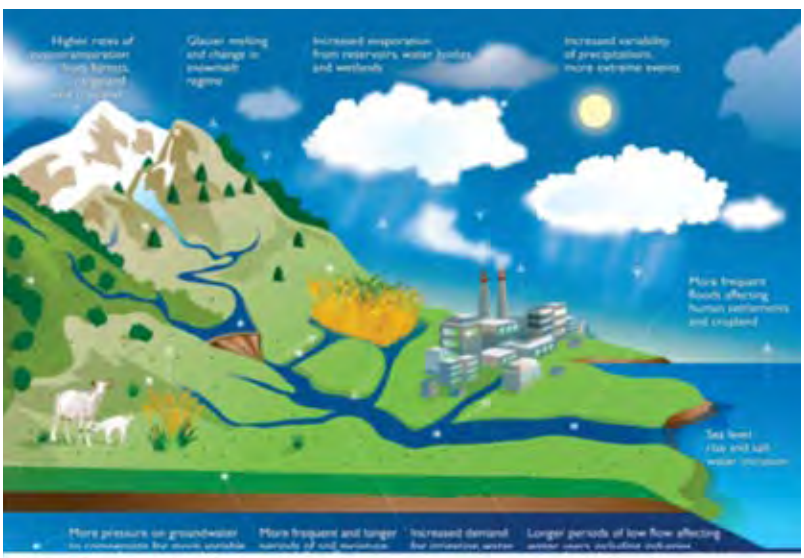


Fig 26: How Climate Change Affects All the Elements of Water Cycle and its Impact on Agriculture

- Emissions intensities of enteric methane vary greatly across the countries and or regions
- It also varies between and within production systems

Efforts to address enteric methane emissions in developing countries are relatively new and fragmented and the link between increasing productivity and enteric methane mitigation has only recently been highlighted. In the recent years, a number of initiatives have been undertaken to contain the emission of enteric methane from animal husbandry operation across the world. Efforts are on to identify and prioritize high potential areas for intervention. Ruminant systems that are highly exposed and under pressure from a number of challenges like climate change, increasing competition for resources like land and etc. are being identified for effective interventions. At the same time, cost-effective technologies and approaches that will enable farmers to increase productivity while at

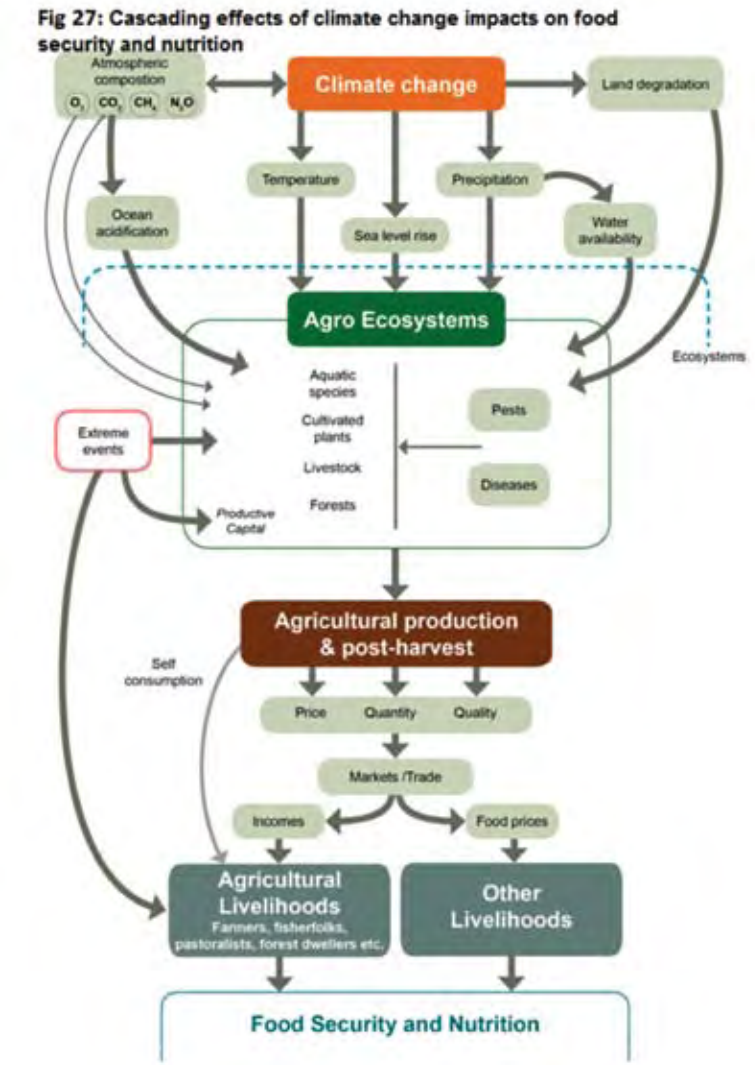


Fig 27: Cascading effects of climate change impacts on food security and nutrition

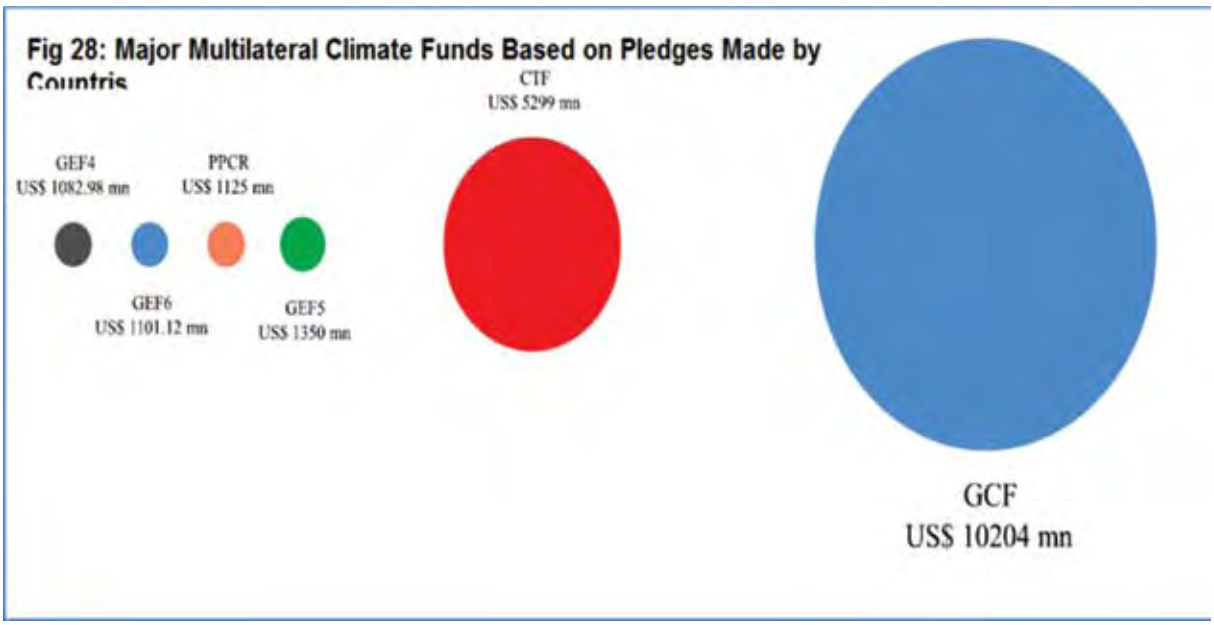
the same time reduce emissions are being identified and developed. And above all, detailed strategies are being developed for communication dissemination and outreach.

Other than enteric methane emissions, another major source of global Green House Gas emissions as a result of agricultural activity relates to the losses of soil organic carbon (SOC) due to soil management in agricultural areas. This has been identified as a factor that accelerates the greenhouse effect, especially by emitting (CO2) in the atmosphere. Losses of SOC can be assessed either by directly measuring changes in SOC content or by monitoring soil CO2 emissions. The impact of tillage on the loss of SOC and associated emission factors under different management systems have been studied. It has been observed that 'no-till farming' combined with the maintenance of crop residues on the soil surface has been identified as an important strategy for sequestering carbon (C) from the atmosphere. Tillage induces the loss of Carbon as CO2 by breaking up soil aggregates and exposing the protected organic matter to microbes. Tillage also incorporates and mixes residues, improving aeration, which can lead to additional Carbon losses by maximizing soil-residue content compared with no-residue incorporation. All these lead to substantial emission of CO2 and results in climate change.

Overall, there are four different pathways of GHG emissions and atmospheric concentrations, air pollutant emissions and land use, from mitigation scenario to higher GHG emissions. Climate warming has been usually determined in terms of GHG emissions, internal climate variability, aerosol, land-use change and volcanic eruptions. As seawater continues to warm and glaciers and ice sheets are lost, global average sea level will rise during the twenty-first century faster than the past decades. In the backdrop of the lowest and highest GHG concentration pathways, it is estimated that between 2046 and 2065, global average sea-level rise is likely in the range of 0.17 to 0.32 m and 0.22 to 0.38 m respectively. This is relative to 1986–2005 sea levels.

It is also feared that there will be a significant increase in the frequency of future sea-level extremes in some regions across the world. Rise of atmospheric CO2 concentration shall lead to ocean acidification in the surface ocean. It is also likely that salinity will increase in the tropical and subtropical Atlantic along with the likelihood of a decrease in the western tropical Pacific over the next few decades.

Thus, climate change is profoundly impacting the conditions in which agricultural activities are conducted. In every region of the world, plants, animals, and ecosystems are adapted to the prevailing climatic conditions. Even a minor change in these conditions, even in a direction that could seem more favourable, the plants and animals present are impacted significantly. Some will



become less productive, or even they run the risk of getting disappeared from the world vegetation. Some of these impacts can be easily predicted, like the direct impact of a heat wave on a specific plant at a specific moment of its growth (provided that it has been well studied enough). The cascading and adverse effect of climate change on food production is depicted in Fig 27.

Paris Climate Agreement and Agriculture

As discussed already, climate change has a profound impact on agriculture and on food security. At the same time, agriculture contributes to climate change to a considerable extent. It is fortunate for mankind and our earth that the agricultural sector holds a significant potential to mitigate climate change through reductions of greenhouse gas emissions and enhancement of sequestration. This is also referred to in expert circles as "mitigation and sequestration". As a sector, agriculture offers a range of important and critical opportunities to deliver on improving agricultural resilience to climate change, increasing food production, and lowering emissions, all at the same time. What is also important is that many of these opportunities can be realised through practices, technologies, and systems that are already available and affordable. What may be additionally required is tailoring them to specific contexts and incentivising through climate finance to ensure adoption of mitigating interventions and adoption of 'climate smart agriculture'.

According to the opinion of various experts across the globe, the Paris Climate Agreement unfortunately does not provide a powerful stimulus to adopt and implement climate smart agriculture policies. Agriculture was neither specifically mentioned in the various versions of the Negotiating Text for the Paris Climate Agreement nor in the final text that was adopted at COP21. It is unfortunate according to experts that the final Agreement Negotiating Text by the Co-chairs, there was absolutely no mention about "agriculture". As a consequence, the Paris Climate Agreement, as adopted at COP21, does not refer to agriculture at all.

However, the term "food security" found mention in the full text proposals which aimed to set adaptation goals. After surviving a series of negotiations, the preamble to the Paris Climate Agreement now states: "Recognizing the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change".

It is also a fact that in Paris Climate Agreement, food production was discussed as a topic in the full Negotiating Texts. It was discussed as a limiting factor to mitigation. Ultimately, one major reference was seen in the final version of the Paris Climate Agreement in the form of Article 2. This refers to the main objectives of the Agreement and one of the objectives is: "Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production." ■

Conservation Agriculture

Way Forward to Manage the Effects of Climate Change

Dr. HS Gupta
Director General
Borlaug Institute for South Asia (BISA),
Ranjan Bhattacharyya and T.K. Das
IARI

'We can't solve problems by using the same kind of thinking we used when we created them.'

-Albert Einstein

Conservation agriculture (CA) is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels, while concurrently conserving the environment (FAO). The major aim of CA is to conserve natural resources and attain sustainable production in this climate change era. As per FAO, CA is characterised by three interlinked principles namely: (i) Continuous minimal mechanical soil disturbance, (ii) maintaining permanent organic soil cover, and (iii) diversified crop rotations of annual crops and plant associations of perennial crops. These three principles ensure improvement or maintenance of soil organic carbon at the desired level. The CA practices have potential to arrest or reverse the land degradation, boost productivity and increase food security.

The history of CA in South Asia is linked with wheat production constraints in the rice-wheat system. In India, growth of CA is linked to the ill-effects of intensive agricultural practices associated with rice-wheat system in the Indo-Gangetic Plains (IGP). Hence, it was perceived that the conventional agricultural practices used in the region should be improved or replaced by resource conserving technologies (RCTs). Zero tillage (ZT) in wheat was introduced in the early 1980s in South Asia by using a New Zealand-imported seed drill for the first time in Pakistan's Punjab province. The testing of ZT was based on an innovative low-cost seed-cum-fertilizer drill. Later, it was felt that the CA could enhance system productivity, improve input use efficiency and increase the farm profitability on a sustainable basis. The Rice Wheat Consortium (RWC) planned and successfully implemented a second generation machinery in 2002 onwards for seeding in the presence of anchored and loose residue. Different kinds of machineries including double-disk coulters, the rotary disc with a powered fluted or straight edge disc in front of double disks, turbo seeder and combo happy seeder have been successfully developed to facilitate residue retention as an integral part of CA. That change towards CA perceived a fundamental shift from age old practice of

excessive tillage to a new paradigm shift. It has been reported that the area planted with wheat adopting the zero-till drill has been increasing rapidly and about 25–30% of wheat is zero-tilled in rice-wheat growing areas of the IGP.

Conservation agriculture integrates the concepts of mitigation of resource degradation, productivity enhancement, restoring the multi-functionality of soils and other environmental and socio-economic benefits to the society on a sustainable basis. As enumerated by several researchers, the ecological approaches of CA are based on following five overall objectives that an appropriate CA practice generally fulfils:

- Increased agricultural productivity, profitability and enhanced ecosystem services
- Enhanced input use efficiency, including that of water, nutrients, energy, pesticides, land and labour
- Protected soil, water and biodiversity through minimum soil disturbances
- Judicious use of external inputs (mineral fertilizers and pesticides) and preference for alternatives (organic materials and integrated pest management)
- Use of the species' biodiversity to build systems' resilience to abiotic, biotic and economic stresses with improvement of soil organic matter for activities of soil biota coupled with reduction in greenhouse gases (GHGs).

Thus, CA adapts to and mitigates climate change by several means and helps in better nutrient cycling, as discussed below.

A zero-till seed drill in operation at Indian Agricultural Research Institute farm.

Conservation agriculture moderates the impact of high temperature on and within the soils. It prevents the negative impact of heat on seed germination, gives high agronomic resilience through extending the seeding period and improves seedlings growth. It also suppresses weed growth and creates better conditions for root development and seedling growth. Improved infiltration and retention of soil moisture under CA results in less severe, less prolonged crop water stress and increased availability of nutrients. The CA also adapts to climate change due to reduction in risks of pest and weed infestations and the total crop failure. Wider diversity in plant production also contributes to minimize the risk. By reducing organic matter decomposition and increasing C inputs coupled with increased humus formation and carbon accumulation, CA leads to enhanced C sequestration that mitigates GHG emissions. The CA also reduces energy needs on account of reduced fuel and mechanization usage, further contributing to climate change mitigation. Better physical soil quality ensures that the cropping system is optimized to cope up with both heavy rainfall events and prolonged drought, events that are likely to increase in frequency due to climate change. This diversity allows an ecosystem to remain stable when facing changes in environmental conditions.

Despite the promising effects of no-tillage, researchers like Pittelkow and co-workers observed recently that benefits in crop yields are only seen when the other two CA principles are also implemented. Greater concern is that conservation tillage alone tends to have the opposite of the intended goal, thereby placing farmers at increased risk of yield losses, despite improvement in soil quality parameters due to a number of factors. Adoption of CA reduces the cultivation cost and energy consumption, enhances the crop productivity, input use efficiency, and improves the farm income in a rice-wheat cropping system in the lower IGP. In the whole IGP, it is the fact that a relay seeding of a legume crop enables the build-up of soil

Wheat under (a) permanent broad bed and (b) permanent narrow bed with residue retention at Indian Agricultural Research Institute

organic matter, mops up the residual nitrate-nitrogen from the surface soil layers, and overcomes terminal heat stress in wheat. Thus, it is a reality to sustainable intensification in the region.

The three basic principles of CA can be complemented with the following technologies for harnessing synergetic benefits:

- Laser levelling provides the same benefits to CA as to conventional agriculture under surface irrigation conditions (flood irrigation). However, since it involves significant soil movement in the beginning, it would be considered as an initial investment before converting to CA.
- Bed planting would provide the benefits of water-saving in systems where surface irrigation is applied. Under CA the beds would be converted into permanent beds whereas, any soil tillage would be limited to a periodic cleaning and reshaping of the furrows. A permanent bed system also leads to the controlled traffic. In the IGP, bed planting generally saves irrigation water and labour requirements without sacrificing on crop productivity. For instance, plots under permanent broad bed (PBB; Plate 2) with 20% cotton residue and 40% wheat residue retention (PBB + R treatment) had significantly higher economic profitability and crop productivity than farmers' practice (CT; conventional tillage) under a cotton-wheat cropping system. In the permanent beds, water savings of 26% for wheat with yield increases by 6.4% have been reported by the RWC.

Conservation agriculture-based farming systems appear to be the best available option for meeting future food security while contributing to sustainable agricultural development. It is likely to help alleviate poverty, rehabilitate and enhance the ecosystem functions and adapt to climate change. Conservation agriculture reduces soil erosion, increases or maintains soil organic matter, and can improve the efficiency of inputs, farm income, and crop yields. Hand-in-hand, it protects and revitalizes soil biodiversity and the natural resource base. Thus, it is an ecological approach that mitigates climate change and provides many benefits to the non-farming population. For promotion of CA practices across diverse agro-ecologies, suitable policy and institutional and technology support would be an essential prerequisite. ■

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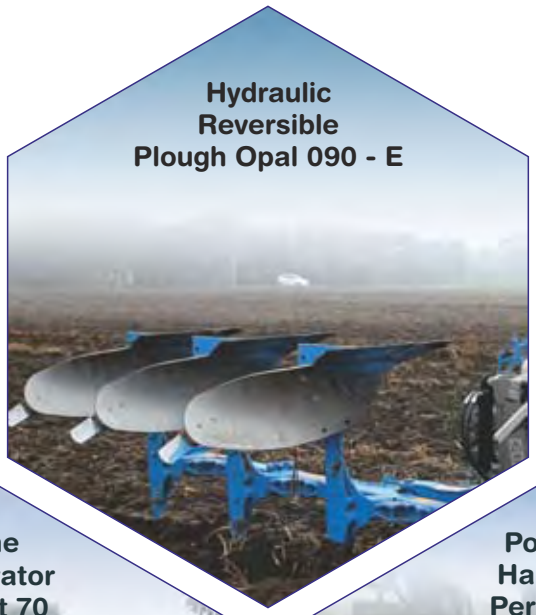

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Technological Innovation in Agriculture can Curtail the Effects of Climate Change

Dhiraj Pant,
Technology Development & Agronomy Lead,
Monsanto South Asia region

Post their meeting last December at the COP21 summit in Paris, World leaders from 200 countries have finally signed a historic international treaty on climate change at the UN headquarters in New York, US in April 2016. With ambitious targets to limit global temperature rise to 'well below' 2°C above pre-industrial levels, and limit it further to 1.5°C to protect the most vulnerable low-lying and small island nations, is in a way a culmination to all the discussion surrounding this rather grim global phenomenon. For decades now the international community has been in a constant dialogue over climate change and its ramifications. But to be successful in achieving these targets all industries and stakeholders must dedicatedly unite in this quest to make the planet greener.

Unlike industries such as automobile, power, chemicals and many others, agriculture is not a major emitter of carbon di oxide. However, there are certain aspects of this industry that can be worked upon in order to alleviate climate change. As per the 'Biennial Update Report' (BUR) submitted to the UN Framework Convention on Climate Change, India's energy sector comprising of electricity, manufacturing and transportation etc. accounts for 71% and agriculture for 18% of Green House Gas (GHG) emissions. With the world's population expected to increase by a third by the year 2050, agriculture production will have to increase by over 60% to meet the future demand for food.

However, weather patterns such as scarce monsoon and extreme heat and cold wave, large parts of farming lands around the world have transformed into drought-hit zones. This is going to make meeting the agricultural demands tough, posing a serious threat to agriculture production and food security. Shortage of food production is among the many repercussions of climate change. In developing countries such as India, 50 per cent of the workforce is dependent on agriculture and is also a key element in its development. As a result, third world countries and vulnerable populations stand to be the most affected by climate change.

Moreover, it should be noted that these countries have limitations to monitor and report GHG emissions/ removals. Hence, it's pertinent to tackle the climate change issue with collective efforts on a global scale. The fundamental question here is how can agriculture organizations reduce their carbon footprint and do their bit to make the planet a better place to live?

New Technology for Crop Production

It is about time that the agriculture sector imbibes climate-smart agriculture methods, and encourage production of carbon neutral crops. To begin with, one can focus on product development with agronomic innovations such as breeding, plant biotechnology, crop protection, conservation tillage and cover cropping etc. combined with expertise in data science and extensive modeling. Further on, application of new drought and saline tolerant crop technologies have the capability to positively transform the lives of farmers globally. The kind of crops sown also has an impact on controlling emissions. For example, producing corn and soybeans such that absorption of greenhouse gases is equal to or greater than the total amount emitted from growing these crops. Efforts to ensure crop protection is another step to reduce carbon footprints. Monsanto has already committed to and announced its plans to make its global operations carbon neutral by 2021 through a unique program targeted across its seed and crop protection operations, as well as through collaboration with farmers.

Sustainable Practices

Taking a systematic approach towards delivering innovative agricultural solutions and educational efforts at farmers' level will address the biggest challenges of climate change and resource conservation. To achieve the ultimate goal of sustainable agriculture and fulfill the needs of India's expanding population, conservation systems need to be put in place urgently.

Public Private Partnerships in the sector will play a crucial role in developing sustainable practices as well. Policy support from the government, knowledge and research of public sector institutions supported by private organizations will create ideal means to increase farmers' incomes and productivity sustainably. At this point, controlling carbon footprint may appear to be a colossal task, but climate change targets will be achievable if the seeds of change are sown in time.

Innovative technology in farming methods, reinforces agriculture's unique role in alleviating climate change. It not just an environmental issue, but a developmental challenge that impacts each one of us in more than one way. ■

Amul.
It means "priceless" in Sanskrit.

The brand name 'AMUL', derived from the Sanskrit word 'Amoolya', was suggested by a quality control expert in Anand.

Amul products have been used in millions of homes since 1955. Brands like Amul Butter, Amul Milk Powder, Amul Ghee, Amulspray, Amul Cheese, Amul Chocolates, Amul Shrikhand, Amul Milk and Amulya have made Amul the largest food brand in India (turnover $ 3.4 bn. in 2014-15).

Today Amul is a symbol of many things - high quality products sold at reasonable prices, genesis of a successful co-operative network, the triumph of indigenous technology, a marketing-savvy farmers' organisation, and a proven model for dairy development.

It all began with a strike

The first Amul co-operative was the result of a meeting of farmers in Samarkha (Kaira District, Gujarat), on January 4, 1946 called by Shri Morarji Desai on the advice of Sardar Vallabhbhai Patel to fight the rapacious milk contractors. It was decided that Milk producers' unions in villages (further federated into a district union), should alone handle the sale of milk from Kaira to the government-run Bombay Milk Scheme. The government (it was the British govt. then), resisted the move. The farmers called a milk strike. After fifteen days, the government capitulated. This was the beginning of Kaira District Co-operative Milk Producers' Union Ltd., Anand, vregistered on December 14, 1946. Similar milk unions came up in other districts too. They formed the Gujarat Co-operative Milk Marketing Federation in 1973. Today GCMMF has 3.6 mn. members affiliated to 18,536 village co-operative societies and 17 district unions.

In the early days of Kaira Union, there was no dearth of cynics. Can 'natives' handle sophisticated dairy equipment? Can western-styled milk products be processed from buffalo milk? Can a farmer's co-operative market these products to the sophisticated consumers in cities? Amul proved the scoffers wrong, by processing a variety of high-grade dairy products, several of them for the

first time from buffalo milk, and also successfully marketing them nationally against a tough competition!

A much applauded brand

Marketers who believed that only English-sounding brands would succeed in post-British India were proved wrong by Amul. Its production, networking and advertising has been much admired. The current Amul Butter advertising campaign ('Utterly Butterly Delicious Amul') with its topical one-liners and preference for outdoor media, has run for over 50 years now. It is probably the longest running ad campaign in India, and also the winner of the largest number of awards. The popular 'Amul Butter Girl' from the ads, soon found its place on the packaging too. Most Amul products are now leaders in their respective segments. Ultimate tribute to Amul was paid by the late Prime Minister, Lal Bahadur Shastri. He wanted to replicate the Amul model all over India. This was accomplished by National Dairy Development Board under Operation Flood. India now has 1,61,916 village milk co-operatives with 15.8 million farmer-members, making India the largest producer of milk in the world.

Hope and confidence to farmers. Or premium quality to consumers, at very reasonable price. Amul is a priceless brand name, whichever way you look at it.

Amul

THE TASTE OF INDIA

A TOAST TO THE WORLD

World Moves into Ecological Red

Rita Sharma,
Former Secretary to Government of India, Ministry of Rural Development;
Former Secretary to the National Advisory Council, Former Extension Commissioner, Ministry of Agriculture;
Currently, Member, Board of Trustees of the International Rice Research Institute and World Agroforestry Centre and Chairperson, Policy Group of the Indian Council of Food and Agriculture

August 8, 2016 was Earth Overshoot Day. Never heard of it? This marks the day by when humanity used up all the natural resources and ecological services produced by the Earth in the entire current year. The Earth Overshoot Day in 2015 was 13 August; in 2014 it was 19 August; in 2010 it was 21 August; in 2000 it was early October and in 1970 the Earth Overshoot Day was late December.

The Global Footprint Network (GFN), a California based think-tank, estimates the date for each year on which, the world exhausts its ecological budget. Nature can produce only so much resources and absorb so much waste each year. When human kind's collective demand on the planet's biocapacity exceeds what it can provide, we enter the zone of ecological debt, putting at risk the life supporting systems on which we all depend.

In less than 8 months humanity has blown the Earth's budget for the entire year. From August 9, Planet Earth is in the red. For the rest of the year the world goes into overdraft, operating at an ecological deficit, living on resources borrowed from future generations. This represents an overuse of about 60 percent. In other words it would currently take 1.6 Earths to produce the renewable natural resources needed to sustain the annual human consumption.

Since time immemorial, this planet has replenished its resources faster than humans consumed them. But now, the biocapacity of the Earth, its natural capital is being eroded faster than replenishment by nature. The impact of this ecological deficit can be witnessed through land degradation, impoverished soils, deforestation, depletion of water resources, dwindling biodiversity, shrinking of food stocks, accumulation of greenhouse gases (GHG) in the atmosphere. In this situation, the life-support systems that we depend on are worn ever thinner. Farms become less productive, fish populations collapse and there looms the threat of irreversible climate change. There is lower resilience in the face of extreme weather events.

It was not too far off in 1970, with the world population hovering around 4 billion, when the first Earth Overshoot Day fell in late December. It has shifted from early October in 2000 to August 8 in 2016 (world population 7.2 billion). The problem is worsening with the planet sliding into ecological debt earlier and earlier each year, a sign of increasing stress on the Earth's resources.

If population pressure continues to mount and consumption patterns persist unabated, by 2030, Earth Overshoot Day will creep up the calendar to land in June. At this rate, by mid-century when the Earth's population is estimated to be about 9 billion, the Earth Overshoot Day

will fall in April and mankind will need the equivalent of three Earths to meet its requirements.

The date of the Earth's overshoot is a striking number put out each year to bring awareness of the grim reality, the inconvenient truth that humankind is living way beyond its means. It needs to be urgently realized that with finite global resources a scenario of infinite-growth is untenable. Unbridled population increase, over-consumption and unjust distribution are testing the limits of the planet's biocapacity.

The actuaries at the GFN determine the Earth Overshoot Day by using 6,000 data points per country for about 200 countries. Each country also has its own overshoot day. India's overshoot day falls in June implying that it uses the resources of 2 Indias each calendar year. The USA Overshoot Day is in July this year. This means the USA uses the resources of 1.9 USAs. China uses the equivalent of 2.7 Chinas each year, UK an equivalent of 3, and Japan an equivalent of 5.5. The States that currently remain in "ecological credit" include Brazil, Indonesia and Sweden.

Is it possible to turn planetary debt into planetary dividend? Can there be a reversal of fortune? Can the Earth Overshoot Day be rolled back? What can we do to avoid greater debt and eventual disaster? To bring down our collective ecological footprint requires efforts at all levels – global, regional, national and local. GFN estimates that if global carbon emissions are cut by 30 percent, Earth Overshoot Day could be pushed back to mid-September.

In the case of India, which exhausts its biocapacity in 6 months, the commitment made by the Government in its Intended Nationally Determined Commitments (INDCs) at the Climate Conference in Paris in December 2015 is notable. The country's contribution towards reducing its ecological footprint includes a target of 35 percent reduction of emission intensity, creation of additional carbon sink of 3 billion tonnes of carbon dioxide equivalent through afforestation, and increase in non-fossil fuel energy to 40% of the total installed power capacity, all by 2030. INDCs also state that expenditure on several development programmes with environment co-benefits account for 2.8 percent of India's GDP.

Two development programmes deserve special mention as they are potent instruments in reducing the ecological footprint and restoring biocapacity. The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) 2005 and the Agroforestry Mission under the National Agroforestry Policy 2014 are unparalleled in terms of rejuvenation of the natural resource base and natural capital creation.

MGNREGA with an annual budget of Rs. 35,000 crore guarantees wage employment of 100 days to rural households. The law also mandates taking up works related to water conservation, drought-proofing, afforestation, tree plantation, rain-water harvesting, renovation of traditional water bodies, desilting of tanks, land development, flood control and protection, drainage and rural connectivity. Of the approximately 10 million works being undertaken in over 650 districts, about 70 percent are land, water and forestry-related.

The agroforestry programme with its campaign for har medh par pedh (trees on every field boundary) is expected to increase India's tree cover from the present 23 to 33 percent. Trees on farms provide benefits to smallholders in terms of food and fibre but also provide eco-services in terms of carbon sequestration, bringing up water from depth, recycling nutrients, supporting biodiversity and building resilience to climate variability and natural disasters.

The Earth Overshoot Day is a wake-up call to remind us that the world has moved into ecological red. If we do not take the warning seriously for making concerted efforts to reverse the trend of overshooting the planet's resources, a time will come when this fateful date will fall on First April. Then we will not only be fools but damned fools and doomed fools. ■

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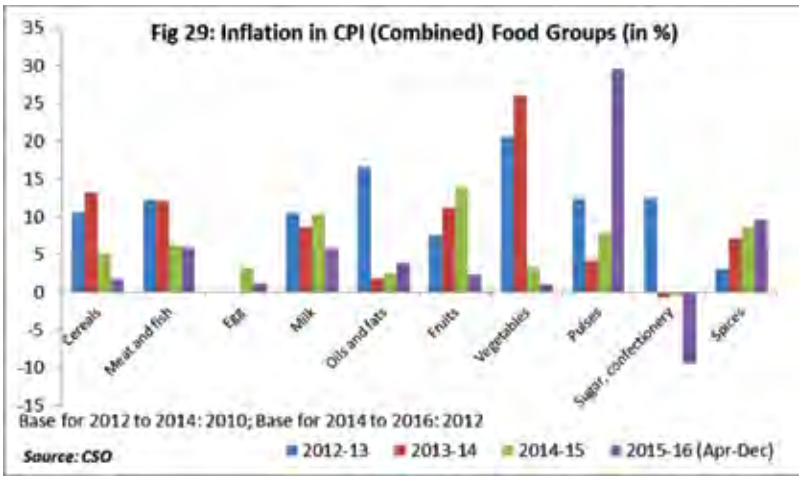
Agriculture and Indian Economy

Consumer prices in India shot up to 5.77 % year-on-year basis in June of 2016, the highest since August of 2014. Though the average anticipation of inflation in the consumer price by the market was about 5.73%, it shot further high to 5.77% driven by food cost. Inflation rate in India averaged 7.67% from 2012 until 2016, reaching an all time high of 11.16 percent in November of 2013 and a record low of 3.69 percent in July of 2015.

Fig 29 provides the inflation level in the recent years. While in 2015-16, most of the important food items have been contained or have marginally increased in terms of inflation, pulses have witnessed a very high inflationary trend. The percentage inflation in pulses was as high as almost 30%. A similar high level of inflation was seen in vegetables in 2012-13 when the inflation was almost 21%. The most considerable drop in inflation

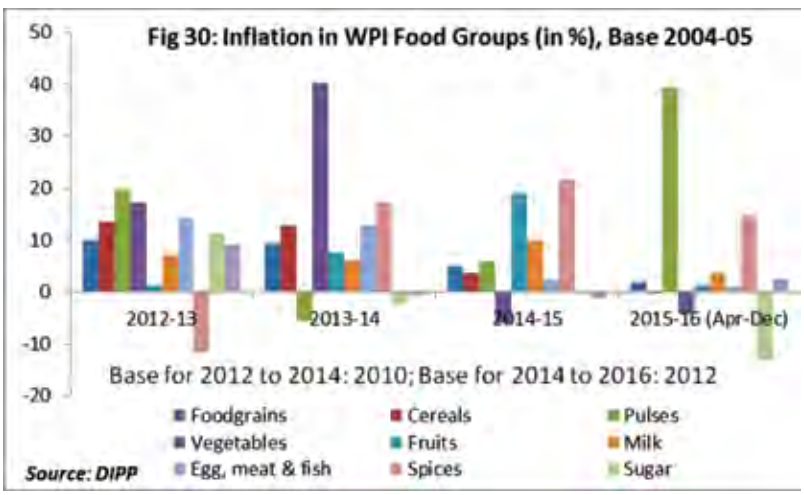


was observed in cereals both in 2014-15 and 2015-16. From an already high and double digit inflationary level of around 10.5% in 2012-13, the inflation increased to 13.2% in 2013-14, inflation with the cereals fell considerably to 5.2% in 2014-15 and to further significantly lower level at 1.7% in 2015-16. Similarly, inflationary level has also reduced significantly in the meat and fish category. After hovering around 12% for two consecutive years in 2012-13 and 2013-14, the inflation level in meat and fish category decreased to 6.3% in 2014-15 and 1.7% in 2015-16. It is indeed noteworthy that in the sugar and confectionaries segment, the country has been experiencing negative inflation or deflation for the last three consecutive years. Milk and milk products have also witnessed a decreased inflationary trend in the last four years. From 10.4% in 2012-13, it has come down to 5.7% in 2015-16. Consumer Price Indices (CPI) measure changes over time in general level of prices of goods and services that households acquire for the purpose of consumption. It is useful as a macroeconomic indicator of inflation apart from being used by governments and central banks for understanding the dynamics behind inflation. This in turn is useful to take measures related to monitoring price stability, and as deflators in the national accounts. CPI is also used for indexing dearness allowance to employees for increase in prices.

Table 2: Key Indicators of the Agriculture Sector *Vis-a-Vis* Indian Economy

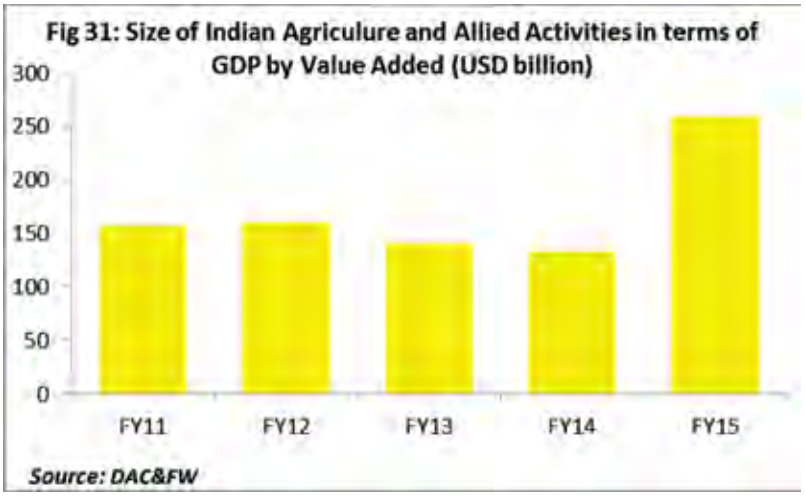
	2011-12	2012-13	2013-14	2014-15
Growth in GDP in Agriculture & allied sectors (at constant 2011-12 prices)	5	1.5	4.2	-0.2
Share of Agriculture & allied Sectors in total GVA (at				
current 2011-12 prices)	18.5	18.2	18.3	17.4
Share of Crops	12.1	11.8	11.9	10.9
Share of Livestock	4	4.1	4.1	4.4
Share of Forestry and logging	1.5	1.5	1.4	1.2
Share of Fishing	0.8	0.9	0.9	0.9
Share of Agriculture & allied Sectors in total Gross Capital Formation (GCF) (at current 2011-12 prices)	8.6	7.8	8.6	7.7
Share of Crops	7.3	6.6	7.3	6.4
Share of Livestock	0.8	0.8	0.8	0.8
Share of Forestry and logging	0.1	0.1	0.1	0.1
Share of Fishing	0.4	0.4	0.5	0.5
GCF in Agriculture & allied sectors as per cent to GVA of the sector (at current 2011-12 prices)	18.3	16.3	17	15.8

Source: CSO



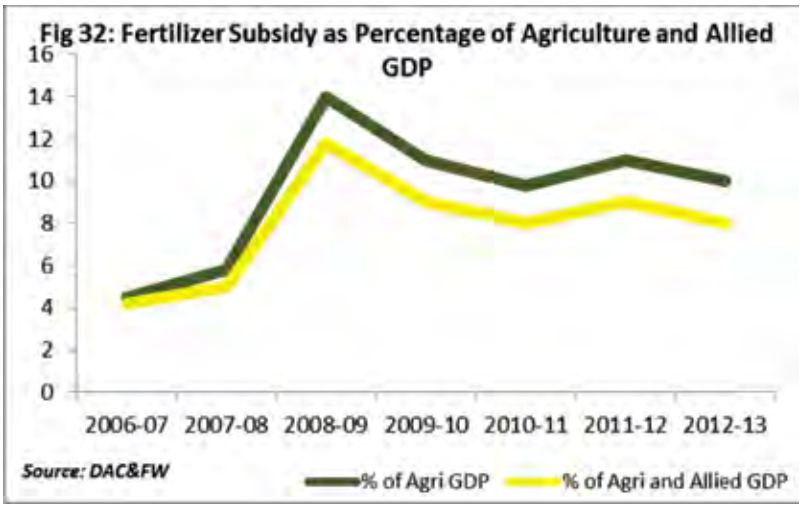
On the other hand, Wholesale Price Index (WPI) is calculated by monitoring the prices of certain goods that are traded at the Wholesale Market. Currently in India, there are 435 items that are monitored and there is a fixed weightage given to each item to arrive at the WPI. Primary food and primary non-food items are important constituents other than minerals.

Fig 30 provides a snapshot of the WPI of the food items. This has followed a trend similar to the CPI and in 2015-16, WPI related inflation has reduced significantly in the cereal group. From almost 10% in 2012-13, the WPI related inflation in 2015-16



was a meagre 2%. However, pulses category has experienced steep rise in inflationary trend. From just 6% in 2014-15, it increased to a massive 39.5% in 2015-16. Inflation in the egg and meat category was very high in 2012-13 but has come down significantly in the last few years. The WPI related inflation in this category was reduced to 2.4% in 2014-15 and further reduced to a negligible 1% in 2015-16.

Agriculture continues to drive the Indian economy as the country marches ahead to be one of the fastest growing economies of the world. Share of agriculture and allied sectors in total Gross Value Added (at current 2011-12 prices) in 2014-15 was 17.4%. GDP of agriculture and allied sectors in India was recorded at USD 259.23 billion in 2015-16. According to the advanced estimates of Central Statistical Organisation, agriculture and allied sector recorded a growth of 8.3% in the last fiscal year and continues to be the primary source of livelihood for about 58 per cent of India's population. Table 2 provides an overview of the contribution of the agriculture and its allied sectors in the overall economy of India.



In terms of absolute value, as seen in Fig 31, contribution of agriculture and its allied sector in total GDP in terms of gross value added has witnessed fluctuating trends in the recent years from 2011-12 till 2015-16. In 2011-12 or FY11, the total value of the sector in terms of GDP by value added was USD 157.35 billion. It marginally increased to about USD161 billion in the following financial year of 2012-13. During 2013-14, it decreased by about 12.5% to USD 141 billion, further dropping to USD 133 billion in 2014-15. In between FY12 and FY 14, Indian economy witnessed a decline of more than 17%. However, the sector recovered significantly in 2015-16 when the total value of GDP from it increased to USD 259.23 billion, registering a significant 95% increase from the previous financial year.

Talking of the agriculture sector in the back drop of Indian economy makes it important to discuss about various subsidies channelled to the agriculture and its allied sectors. A major portion of the country's financial subsidy goes into providing- subsidy for fertilizers to farmers across the country. Fig 32 provides a trend analysis of the amount of subsidy going to the fertilizer sector as percentage of the agriculture GDP. Over the years, it has been constantly increasing on an overall scale with minor decrease in few years. In terms of percentage of the total agri GDP, fertilizer subsidy has increased from 4.5% in 2006-07 to 10% in 2012-13. During this period between 2006-07 and 2012-13, the highest amount of subsidy in fertilizer was incurred in 2008-09 when it had accounted for 14% of the total agri GDP and about 12% of the total agri and allied GDP.■

A Special Feature International Year of Pulses (IYP)

The 68th UN General Assembly declared 2016 the International Year of Pulses (IYP) and The Food and Agriculture Organization of the United Nations (FAO) has been nominated to facilitate the implementation of the Year. Governments of various countries, relevant organizations, non-governmental organizations and all other relevant stakeholders will work in collaboration with FAO. The IYP 2016 aims to enhance significantly public awareness about the nutritional benefits of pulses. It is also considered to be important as part of sustainable food production aimed towards food security and nutrition. It is anticipated that the Year will create a unique opportunity to encourage connections throughout the food chain that would better utilize pulse-based proteins, further global production of pulses, better utilize crop rotations and address the challenges in the trade of pulses.

Significance of Pulses

Pulses Contribute to Food Security

- Pulses are an affordable source of protein and minerals for a large proportion of rural population in the world
- Pulses have a long shelf life which means they can be stored for long periods without losing their nutritional value
- Many pulses are drought-resistant and are suitable for marginal environments

Key Objectives IYP 2016

Promote the value and utilization of pulses throughout the food system

Encourage connections to further global production of pulses

Foster enhanced research

Advocate for better utilization of pulses in crop rotations

Raise awareness about the benefits of pulses, including sustainable agriculture and nutrition

Address challenges in the trade of pulses

Source: Adapted from related FAO literature

Considerable Health Benefits of Pulses

- While pulses are low in calories (260-360 kcal/100 g dried pulses), they are high in complex carbohydrates and fibre, which means they are slowly digested and give a feeling of satiety
- Pulses promote a steady, slow-burning energy while their iron content helps transporting oxygen throughout the body, which boosts energy production and metabolism
- The fibre in pulses is not generally absorbed by the body and thus increase stool volume and transit
- The fibre also serves to bind toxins and cholesterol in the gut so these substances can be removed from the body. This improves heart health and lowers blood

Box 1: More Crop Per Drop With Pulses

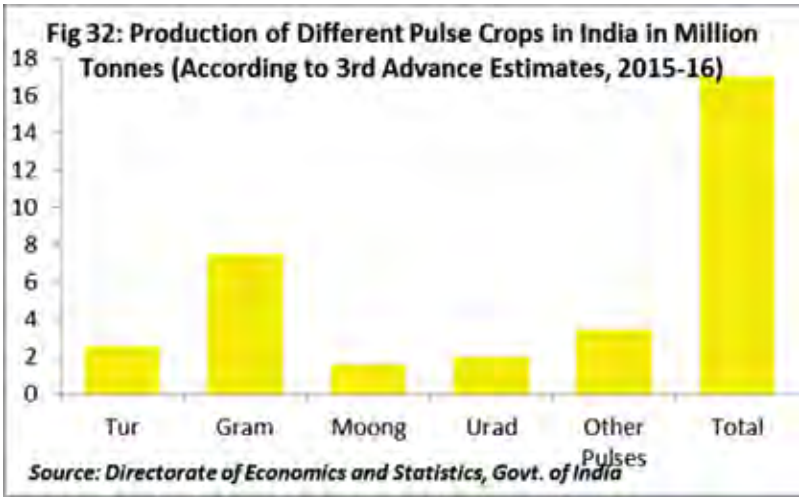
When mung beans *(Vigna radiate)* are introduced in rotation with winter wheat and cotton during the short fallow period, farmers obtain an income increase from US$1384 to US$2907 from 0.5 ha of land.

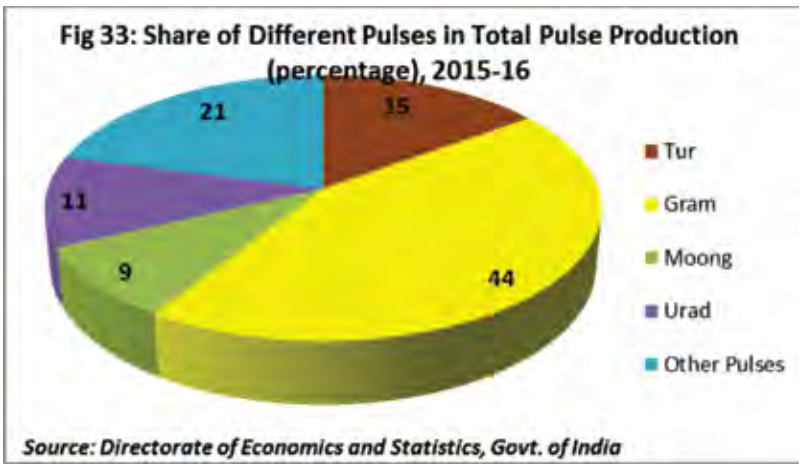
cholesterol

- Pulses and grains are a perfect pairing. The protein of pulses is high in lysine and low in sulphur-containing amino acids. Grains' protein is low in lysine but high in sulphur-containing amino acids. Combining them provides a higher protein quality

Pulses and Climate Change

- Pulses are climate smart as they simultaneously adapt to climate change and contribute towards mitigating its effects
- It is estimated that globally, some 190 million hectares of pulses contribute to five to seven million tonnes of Nitrogen in soils. As pulses can fix their own Nitrogen in the soil, they need less fertilizers, organic and synthetic, and in this way, they play a part in reducing greenhouse gas emissions
- Including pulses in crop rotations reduce the risks of soil erosion and depletion
- Multiple cropping systems, such as intercropping or crop rotations with pulses, have a higher soil carbon sequestration potential than monocrop systems
- When included in livestock feed, pulses' high protein content contributes to increase in the food conversion ratio while decreasing methane emissions from ruminants, thus at the same time reducing greenhouse gas emissions





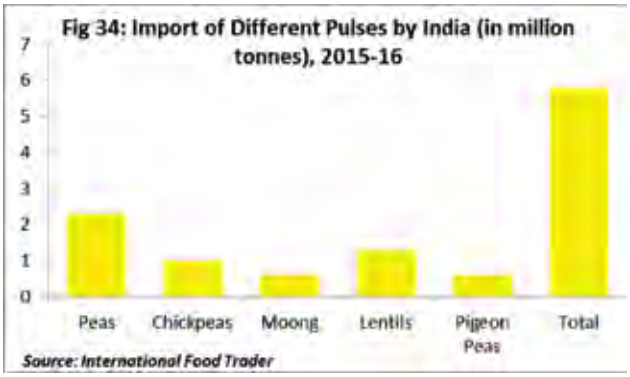
Pulses in Numbers- India and International

According to the third Advance Estimates, the total production of pulses in 2015-16 was 17 million tonnes. This is similar to the production levels of 2015-16, when the total production of pulses was 17.1 million tonnes. The production of Chickpeas in 2015-16 was about 7.5 million tonnes - a marginal increase from 7.3 million tonnes of 2014-15. India is also a major producer of Tur and in 2015-16, the total production of Tur was about 2.6 million tonnes. However, this was a reduction in the total Tur production across the country when compared to 2014-15, when the production was about 3 million tonnes.

In terms of percentage of total pulse production, as seen in Fig 33, Chick peas or Gram constituted 44% of the total pulse production in the country in 2015-16. Globally, India is

Box 2: IYP's successful social media campaign

- 300 million impressions across all relevant hashtags
- 5.2 million active engagements
- 2.6 million video views.
- Past January 2016, 141 Pulse Feast events held in 36 countries
- Collectively, a social media reach of 21 million people



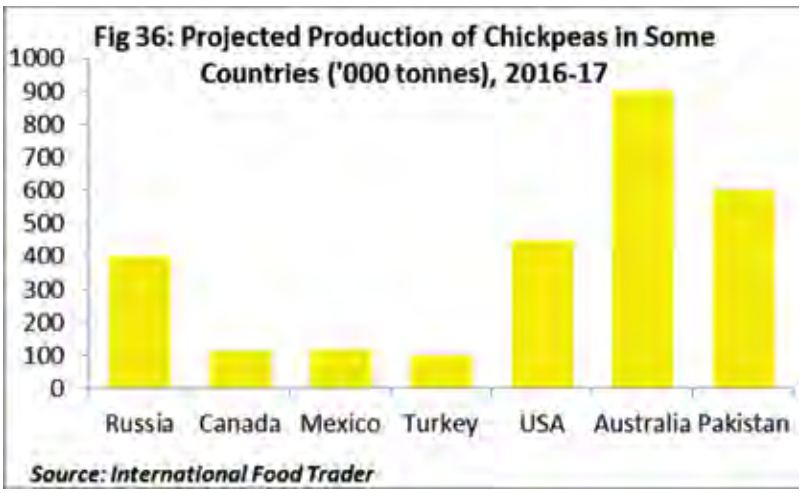
a major Chickpea producing country and this crop is basically grown in the drier regions of the country. The major Chickpea producing States of India are Madhya Pradesh, followed by Maharashtra, Rajasthan, Uttar Pradesh, Andhra Pradesh and Karnataka. Chickpeas are of two types which are grown in India, Desi and Kabuli. Desi chickpeas are spilt peas and are relatively smaller in size having a thicker seed coat. They appear dark brown in colour and they can be used and served in many ways. Kabuli Chickpeas have a whitish-cream color and are relatively bigger in size having a thinner seed coat. They are generally used in soups or salads or as flour. Followed by chick peas, Tur constitutes 15% of the total production of pulses. Moong and Urad constitutes 9% and 11% respectively.

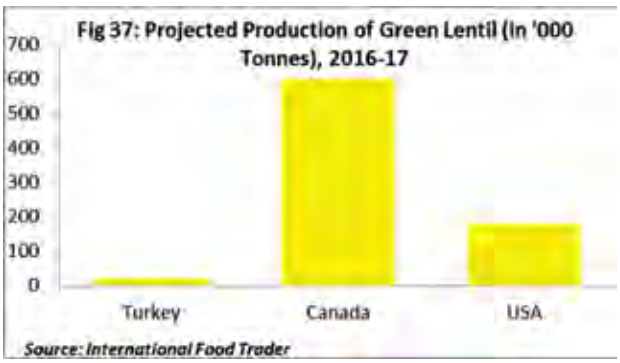
Besides being a major producer of Pulses, India is also a major importer of pulses, driven by a high domestic consumption. A significant population in the country is vegetarian and they consume pulses in high quantities.

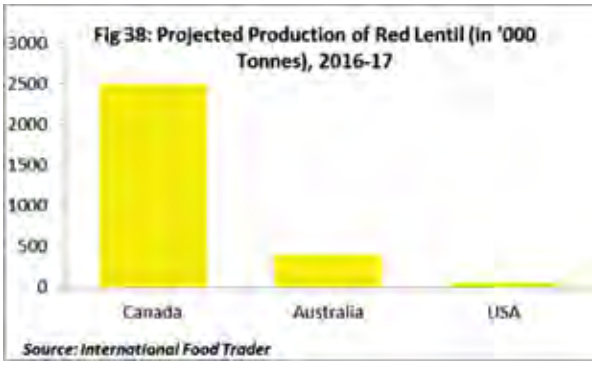
In 2015-16, India imported a total of about 6 million tonnes of pulses. Out of these, 2.3 million tonnes of Peas, 1.3 million tonnes of Lentils and 1 million tonne of Chickpeas were imported. Other than that, Moong and Pigeon peas of 0.6 million tonnes each were also imported. Major exporting countries are Canada, USA, Argentina, Russia etc.

In 2015-16, India also exported 255.6 thousand tonnes of pulses to various destinations. Amidst a scenario where there is a growing global pulse production deficit, countries like India are undertaking efforts to boost domestic pulse production, investing in research projects, including the development of genetically modified pulses. Amongst different pulses, India exports a maximum quantity of Chickpeas. In 2015-16, India exported 217 thousand tonnes of Chickpeas. Major export destinations for Chickpeas from India are Pakistan, Algeria, Turkey, Sri Lanka and UAE. India exports commodities like Peas to countries like Sri Lanka, Nepal, Bangladesh, USA and Ukraine. In 2015-16, India exported about 6.44 thousand tonnes of Peas. Last year, as seen in Fig 35, India exported about 12 thousand tonnes of Lentils to countries like Sri Lanka, Bangladesh, UAE, Egypt and USA.

Fig 36 provides an overview of the projected production of Chickpeas in







some major producing countries across the world. According to projections available from the International Food Traders recent conference on global pulse production, this year, Australia is expected to produce about 900 thousand tonnes of Chickpeas. Pakistan, which is another major producer of Chickpeas behind India and Australia, is expected to produce around 600 thousand tonnes of Chickpeas, followed by USA (450000 tonnes) and Russia (400000 tonnes) of the crop. Canada, Mexico and Turkey are also important producers of chickpeas.

Globally, Canada is one of the major producers of Green lentil apart from USA. Fig 37 provides the lentil production scenario in some of the major producing countries. In 2016-17, Canada is projected to produce about 600 thousand tonnes of Green lentil. USA is projected to produce about 180 thousand tonnes while another major producer Turkey is scheduled to produce about 20000 tonnes of Green lentil. Canada is the world's largest exporter of Lentils to the global marketplace, exporting to over 100 countries each year.

Similarly, in case of Red lentils too, Canada is a major producer. This year, based on the area under cultivation, Canada is projected to produce around 2.5 million tonnes of red lentil (Fig 38). Australia is scheduled to produce around 400000 tonnes while is projected to chip in with about 60000 tonnes of red lentil. It has been observed as a trend that since 1993, the global production of Red lentil has been consistently increasing and this year, it is projected to hit the 6 million tonnes. Of that amount, an estimated 75%, or 4.5 million MT, will be Red lentils. During 2016, it is estimated that the Red lentil trade will be around 2.5 million tonnes, with India and Turkey, the major buyers, taking 1.2 million tonnes and 350,000 tonnes respectively. ■

Table 3 provides a projected production scenario of different pulses in some major pulse growing countries during the current 2016-17 season

	China	Argentina	Brazil	USA	Canada
Dark red kidney beans	40,000	9,180	--	53021	15789
White beans	40,000	--	--	--	--
Light specked kidney beans	1,50,000	9,180	--	40068	9074
Black beans	1,00,000	1,53,000	3,87,000	190703	30108
Alubia	--	1,07,100	--	--	--
Cranberry Beans	--	13,770	--	6011	15766
Great Northern Beans	--	--	--	35303	16016
Navy Beans	--	--	--	153720	68557
Pinto Beans	--	--	2090000	469766	48003
Small Red Beans	--	--	--	41991	5344
Moong	--	26,775	--	--	--

Source: International Food Trader

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Atul Chaturvedi
CEO,
Adani Wilmar Limited

Edible Oils
"A Ticking Time Bomb"

One of the biggest failures of our planners and decision makers has been the lackadaisical approach in handling our 'Energy' and 'Edible Oil' security in the last few decades. The situation had been allowed to deteriorate to such an extent that India now spends $160 billion on Petroleum Imports and $ 12 billion on Edible Oil Imports. We see some action on addressing 'Energy Security' issues, but it seems 'Edible Oil' is still on the backburners. Policy of drift continues to plague the Oilseeds and Edible Oil Sector.

Lack of Coordinated Policy

What has gone so horribly wrong that our Nation now requires almost 16 million tonnes of Edible Oil imports making it the second biggest drain on our forex reserves and seriously compromising our 'Food Security'. Just imagine a situation where exporting nations decide to increase their export duty on Edible Oil or create tariff barriers in the export of oil to India. I am not saying this is going to happen but if we are complacent and do not plan in advance the results could be catastrophic for Indian consumers. How can we afford to forget Indonesian action in case of coal which has very nearly destroyed our power sector.

The situation in early nineties was not as bad as it is today. Indian dependence on imported Edible Oils was only 3% compared to 70 % currently. With the opening up of the Indian Economy and consequent rise in income levels of average Indian, imports continued to grow alarmingly. The average per capita consumption from a level of about 8 kgs in early nineties has now gone up to more than 16 kgs.

Our policy makers in the last few decades had a blinkered vision and were obsessed with flogging the production and procurement of Wheat and Rice. This obsession has resulted in lopsided development and has had a serious detrimental effect on Oilseed cultivation in our country. Our Nation merrily continues to produce Wheat and Rice much in excess of our consumption, challenging our storage system on the one hand and on the other, we import approximately 16 million (and growing) tonnes of Edible Oil to feed our teeming millions.

Demand Projection by 2025 – Edible Oils

The total Edible Oil consumption in our country which is currently pegged at about 21 million tonnes is likely to grow to 34 million tonnes by the year 2025. We estimate Indian Vegetable Oil consumption would grow at around 4 to 5% per annum. The growth can actually be more with relatively low international edible oil prices.

The per capita consumption in the developed world is around 22 kg and India at 16 kgs still has a lot of catching up to do.

Changing food habits are also likely to drive consumption growth in our country. The aspirational Indian is no longer interested in eating basic food and this is getting reflected

in the plateauing Wheat and Rice consumption. The shift to processed foods is also contributing in no small measure to Edible oil consumption growth.

Demand – Supply gap

With Indian consumption expected to touch 34 million tonnes, by 2025 and domestic oil supply growing to around 10 million tonnes our import dependence would rise to a whopping 24 million tonnes.

- Can our Nation afford to close its eyes in the face of this looming disaster?

Can Exporting Countries continue to increase their production and exports to satisfy Indian and Chinese growing appetites?

Will our 'Food Security' not be compromised?

The writing on the wall is clear and we need to wake up from our slumber before events overtake us.

What can be done ?

First and foremost we need to enlarge the definition of the word 'Food Security' to include not just Wheat and Rice, but Edible Oil and Oilseed as well. The relevant Department should be tasked to suggest road map for 'Food Security' along with action plan.

Technocrats and domain experts should not only be consulted but also given due importance in the decision making process. Their suggestions and ideas should be taken seriously as they understand the ground realities.

MSP driven Wheat and Rice has done wonders in our country in increasing production. Why not replicate a similar model of incentivising oilseed production. Our Agri Scientists should be given specific task of increasing yield of oilseeds. With Indian Oilseed yield around 40% of the world average, scope of improvement is huge.

Rampant increase in imports of Refined Edible Oils should be curbed in line with Our Stated policy of Make In India. The import duty differential between Crude Edible Oils and Refined Edible Oils should be increased to minimum 20%. Every nation protects its domestic industry and encourages value addition within its boundaries. India would be well within its rights to protect its own Refining Industry.

'Palm Cultivation' in South India should be seriously encouraged as it is high oil bearing fruit.

India should actively encourage GM cultivation in Oilseeds as our opposition to the same has done more harm than good to our Nation. The stupendous success of BT cotton should give our policy makers the required confidence to bite the bullet. Recent clearances for trials of GM Mustard is an encouraging sign.

Create buffer stock of Edible Oil to manage volatility and inflation and insulate consumers. Involve private sector as they not only have the required infrastructure in place but can also suggest and implement the most cost effective method.

We have a Government which understands economic realities and is not afraid to take decisive actions. Being an incorrigible optimist, we hope the Oilseed and Edible Oil Sector which has long been neglected would get due attention and can hope for "acche din." ■

C.D. Mayee
Former Chairman,
ASRB, New Delhi
and
President, South Asia
Biotechnology Centre,
New Delhi

INDIAN COTTON AT CROSSROADS AGAIN

In India, cotton is cultivated only in 6.7 % of the total cultivated area and that too in only ten states out of 29, but still it occupies a big chunk of coverage in national media , parliamentary debates and discussions on wide ranging issues concerning GM technology,seed price,pests outbreaks, MSP, trade, export-import and textile mill demands. This is mainly due to its economic significance in the national economy and the technological changes in the production systems. Nearly 0.8 million small and medium land holder farmers grow cotton and for them it has been an important the source of income. Cotton contributes 33% to the total export and 35 million people are directly or indirectly dependent on the crop from production to processing. Out of the 80 countries in the world which produce cotton, India has the largest acreage and it is amongst the top three nations in production along with the USA and China. However, the country stands at 30th position with respect to productivity owing to several factors including diverse growing conditions, plethora of permitted cultivars and dependence on monsoon rains.

The history of Indian cotton is replete with instances where several technological changes helped in achieving better output and quality. Before Independence, only arboreum and herbaceum cottons, called desi cotton, were cultivated, but the rulers then introduced hirsutum - the American cotton - to suit their mills in England because the new world cottons were better in terms of fibre quality. By 1961, nearly 30% desi cottons were replaced by the American cotton, and the Indian research system also laid emphasis on improvement of the new world cottons including the barbadense, the Egyptian cotton which is the best quality cotton in the world.Cotton being consumed by mills, the advances in ginning and processing machineries also influenced the cultivar and cultivation patterns . Another milestone in Indian cotton improvement was the discovery of 'Hybrid ' cottons by an Indian scientist, Dr Mehta, at Cotton Research Station, Surat (Gujarat) around the late sixties which further revolutionized the cotton cultivation. By 2000, nearly 65 % area was occupied by hybrid cultivars largely by the intrahirsutum ones. The hybrid technology has yet another dimension in the economics of the country as it shifted the onus of seed production and supply from public to private sector. The first Indian seed industry was established in a modest

town of the most backward region of Maharashtra, the Marathwada, at Jalna, in 1965. In short span of 5 years, Jalna became the seed hub of the nation and was referred to as the seed capital of the country. The entire credit of establishing the Indian seed Industry goes to Dr Badrinarayan Barwale of MAHYCO whose contributions have been duly rewarded nationally and internationally by honouring him with Padmabhushan and World Food Prize.

The new cultivars also brought with them new problems and new solutions. The minor pests of Bollworms became a major issue in successful cultivation of cotton. The country witnessed frequent epidemics of these pests. The first solution came from the pesticide Industry in the form of a new elite molecule, Pyrethroid. Unfortunately, the ultimate misuse of this technology created new problem of pests developing resistance and aided resurgence of the minor sucking pests and diseases. The situation became grave between 1985 and resulted in stagnation of cotton yield for the next 16 years. India went out of the international map as a leading cotton country and became a net importer of raw cotton to feed the textile mills.This paved way to yet another latest technology in management of bollworms; the Bt cotton, the first GM crop accepted for cultivation in India in 2002. Between 2002 and 2015, cotton yields doubled from 300 kg lint per ha to 550 kg, import ceased with annual export of 8 to 12 million bales, pesticide consumption reduced by half, and seed and textile industries flourished. In 6 years of the release of the new technology, it was adopted by 0.77 million farmers and the Bt cotton was grown in 95% of the total cotton area, an adoption unparallel in the history of technology uptake and absorption in spite of resistance by several non -farmer city activists to GM technology. India became a leading nation in the world and naturally other countries began respecting the country for cotton and textile trade . After 14 years of successful cultivation of Bt cotton in the country, 2015-16 season for cotton production became a waterloo as there was an outbreak of whitefly pest in North and pink bollworm in Central and South Indian states. The production which reached nearly 39 million bales earlier has been predicted to fall to 32 million bales. This is again a classical example of misuse of technology that the Indian cotton saw earlier, but as usual instead of a scientific analysis of the fall, the country witnessed vote bank debates, superficial discussions and conclusions blaming the GM technology. As a consequence to this, Government's intervention became obvious. Added to this, the private Indian seed industry which was the true beneficiary of the Bt technology became worried as to what will happen to them if the cotton seed business dwindles. In India, the annual cotton seed business in 2002 which was mere Rs 150 crores; rose to around Rs 4000 crores, totaling 33% of the total private seed business. Seed industry in India which was fairly united all these 14 years became divisive with money power and the uncertain future to retain the empires. Bt cotton therefore could change this crop geography as the cultivation extended from 8 to 13 million ha but could not change the history of management of technology. How much the technology has been responsible for the saga of 2015-16 is a matter of scientific analysis but those who are

opposed to the technology from day one naturally got something to beat around against the GM crops per se. The media, social networks, activists, government, parliament, scientists, farmers, ginners, mill owners and all other stakeholders commenced debating the cotton issues from seed to cloth bringing the crop at crossroads again.

At this stage the Ministry of Agriculture and Farmers Welfare (MOA&FW) sent the first missile by way of a Gazette Notification through its power under Section 3 of the Essential Commodity Act, 1955 enacting the Cotton Seed Price (Control) Order, 2015 on December 7, 2015. With this order knowingly or unknowingly the Ministry also fixed the trait value of Bt cotton ignoring the bilateral agreements between the companies for licensing the technologies and further widening the fractured relations between the players in Indian private seed conglomeration. It was all done in good spirit except for the fact that benefit of reducing the trait value by Rs. 114 per seed bag should have gone to farmers as the Farmers Welfare and earned a new reputation for changing the name of the Ministry ;instead it has been directly passed on to few seed companies who have monopoly over the popular genotypes in the markets. As this was not enough, MOA & FW proactively issued another Gazette Notification on March 8,2016 for 'Licensing for GM technology Agreement Guidelines, 2016' which if implemented as such would have tremendous ramifications and permanent damage to the nation for development of any new technologies or obtaining one from any source in the world in future. Fortunately wisdom prevailed very soon and within 3 days of the issuance of the notification it was withdrawn to show case that as a nation we welcome the new technologies.

Last year, therefore became a unique year in the history of cotton and obviously it has a spill over effects in current season of 2016-17. The latest figures from the Ministry indicate that cotton area is down by 1.7 to 2.0 million ha mostly in Northern states, Gujarat, and Telangana. The minimum support price (MSP) has not been substantially enhanced to attract farmers towards this crop .But interestingly, the raw cotton prices have soared and at one time in recent months it touched Rs. 6800 per quintal from Rs. 4200 per quintal prevailing in the season. Unfortunately the benefit has gone to stockists and not farmers who have no resources to keep the stocks. It is also predicted that the cotton prices shall be much higher than MSP by Rs 1000 per quintal in the coming season and farmers who are taking cotton should get that benefit. This is based on two developing situations; one that China who created huge stocks of raw cotton to slow down the market are in no position to do that once again and their stocks are dwindling fast and two, that in International market the fibre rates are soaring at Rs 40-45 per kg. Reduction in cotton acreage in India, Pakistan, and heavy damage to 15 % cotton area of China are additional reasons to forecast that Indian farmers shall benefit from cotton cultivation this year as happened earlier in 2010-11.If one studies the trend of cotton prices over the last 20 years, it has been observed that the market prices have always been better over the MSP announced by Government ,may be except for 2-3 years. This further substantiates the prediction of current year and remember that cotton is basically an International commodity and the price determination must take in to account what is happening in the world. To get maximum benefit to farmers it is high time that policy of export and import be devised keeping the welfare of farmers and processors. ■

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come in bunches

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Sweet Revolution

Stevia is a money plant for farmers as it has potential of doubling farmers income in the first year of adoption as a crop . Once planted it goes for five years with harvest after every three months with minimum three harvests a year and fifteen to twenty harvests in five years from the same plant. The water requirement is very low when compared to sugarcane, rice and wheat. For producing one kg of sugar about 1500 liters of water is required, whereas to produce one kg sugar equivalent from Stevia, only 75 liters of water is required. No chemical fertilizers, pesticides or insecticides are required for cultivating Stevia. One hectare of Stevia farming can give 4000 kg of dry leaves and can fetch price of about rupees four lakhs in a year.

Stevia is a genus of about 240 species of herbs and shrubs from the Sunflower family (Asteraceae). Native to subtropical and tropical regions, the plant is cultivated as a commercial crop in Japan, China, Kenya, Vietnam, India, Argentina, Colombia, Thailand, Paraguay, and Brazil. Stevia plays an important role in maintaining biodiversity due to relatively smaller area required to grow it, allowing farmers to diversify their crops. Unlike commodity crops, Stevia is grown on smaller plots of land and provides supplemental income to more commonplace crops.

Stevia is a miracle plant for diabetics as it has been used for centuries for managing diabetes. It has minerals, vitamins, amino acids and anti oxidants. It has multiple health benefits with many therapeutic values. It has been approved by all developed countries in the world as sweetener and in fact Japan is the country where majority of the population is consuming this sweetener for more than 50 years. Companies like Pepsi, Coke, Cadbury, Nestle etc. have started manufacturing their sweet products with stevia as main ingredient in US, Canada and UK. Stevia is the safest sweetener with no side effects and has been approved as GRAS (generally recognized as safe).

Stevia is a native of Paraguay in South America having history of more than 1500 years, but there are some facts which proves that this plant belongs to India. Lord Mahatma Buddha used to consume stevia as favorite tea amongst twelve teas in his times which is more than 500 years B.C. It means our rishi munis used to consume the leaves of Stevia to

sweeten their food in ancient times. Writer visited Jade Buddha Temple in Shanghai, China and found a tea section on first floor where nine favorite teas of Buddha had been kept and were offered for taste to tourists and visitors. To a great surprise in box no.5 there were stevia leaves along with other teas like Jasmine tea, flower tea etc.in different boxes. When asked about box no. 5 leaves it was told that it was Mahatma Buddha's favourite tea which was naturally sweet without adding any sweetener. Nature has made it sweet with many health benefits. It is a proof in itself that this miracle plant belongs to India.

Stevia has been cultivated in China for more than 40 years and has been declared as an economic crop. In India, area under stevia cultivation is not much as on date. If compared with China from climatic suitability point of view, India is definitely much better for Stevia. For example, in China, in most of the areas under Stevia cultivation, only one crop is harvested in a year because of low temperature in majority of the months in a year. Only three-four months of summer are suitable for Stevia and hence every year new plants are sown for cultivation like Wheat and Paddy for the rest of the year. Whereas in India once planted, one can have minimum three to four harvests in a year and fifteen to twenty harvests in five years with the same plant. So, from climatic suitability point of view India is at a better position in comparison to China.

Stevia has been declared as safe for human consumption by almost all developed and developing countries. Japan has been using Stevia sweetener for more than 50

years and majority of the population use it as regular sweetener. Countries like US, UK, Canada, Austrialia, New Zealand have approved stevia as sweetener and people prefer this sweetener over others because this is totally natural and virtually with no side effects. Many international publications are available which advocates the fact that stevia sweetener is safest for human consumption with many health benefits even for curing diabetes. Stevia leaves have minerals, vitamins, amino acids and ani-oxidants which are usually not present in any other sweeteners.

Stevia has been approved in India by FSSAI in November,2015 as non- nutritive sweetener under artificial sweetener clause to be used in specified foods.Representation through applications has been submitted to FSSAI to place stevia in natural sweetener or sweetener category as sugar because stevia is not made in a plant but it is made by a plant. Artificial sweeteners are synthetic with distinct chemical combinations which are developed in labs, whereas stevia leaves are grown in the fields like Sugarcane and powder is made without any chemical solvent. Many companies are using stevia in combination with sugar to reduce the sugar calories. For example, if one kg of Stevia powder is mixed in ten kg of Sugar, then total eleven kg material will be equal to 411 kg of Sugar sweetness with much reduced calories.

Stevia can be a solution for multiple problems for farmers and to derive better income as compared to other crops. For diabetes and health conscious consumers, Stevia is a solution for using a calorie free, chemical free natural sweetener. It canalso be used as a tool for saving drinkable underground water along with making our soil chemical free resulting in cleaner environment. Nature has given this miracle plant to mankind which needs to be commercially exploited for the betterment of society. India has witnessed many revolutions in agriculture like Green Revolution for Hunger, White Revolution in the field of milk, Golden Revolution in the field of Horticulture etc. and now is the time for SWEET REVOLUTION with the mission of WEALTHY FARMER AND HEALTHY SOCIETY. ■

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ICAR-Central Institute
for Cotton Research

Cotton in India - Through the Ages

Cotton has been grown over centuries in India. Excavations in Mohenjodaro provided evidence of cotton fabric made from *Gossypium arboreum* used by the Indus Valley Civilization five to six thousand years ago. The two cotton species, *Gossypium arboreum* and *Gossypium herbaceum*, (diploid, 2n = 2x = 26) are commonly referred as *Desi* cotton, because of their origins in India. It is believed that farmers domesticated the perennial cotton trees of the Desi species to convert them into annual crops. Several land races were developed by farmers across the Indian sub-continent. These were sturdy enough to withstand drought, salinity, insects and diseases. In the year 1790, two exotic species *G. barbadense* (Egyptian cotton) and *G. hirsutum* (American upland cotton) were introduced to India, mainly to cater to needs of the spinning machinery developed in Europe during the Industrial revolution. The first efforts to acclimatize *G. hirsutum* cotton in India, during the pre-independent era, resulted in a few varieties called 'Punjabi Narma' in Punjab and Cawnpore-American variety in 1909 in Kanpur. In 1912, a jassid tolerant variety '4F' was developed by Milne from 'Punjabi Narma' which was grown in 72,846 ha out of 1,11,697 ha under American cotton in Punjab. Subsequently SardarLabh Singh developed LSS (Labh Singh Selection) from F4 in 1933. LSS was a late maturing jassid resistant variety, which replaced 4F. In South India, intensive efforts were carried out by Hilson and Ramanatha Iyer who developed two varieties called Co.1 and Co.2 from Cambodia cotton in 1920-29 for cultivation in south India. For more than 200 years,India has been the only country in the world to cultivate all the four cultivable *Gossypium* species, *Gossypium arboreum* and *G. herbaceum* (Asian cotton), *G. barbadense* (Egyptian cotton) and *G. hirsutum* (American upland cotton).

Interestingly, despite strong efforts by the British regime to replace the coarse and short staple *Desi* cotton species with varieties of the medium to long staple Egyptian and American cotton species for machine spinning, the area under *Desi* cotton in India remained high at 97%

during 1950. *Desi* cotton varieties were preferred by native farmers due to their resilience to biotic and abiotic stresses. Traditionally, the coarse and short *Desi* cotton fibre was used to produce high quality yarn through charkha and fabric through handlooms, whereas the medium to long staple American cotton fibre was used in mills for machine spinning. When the sub-continent was partitioned in 1947, 21% of the prime cotton area became a part of Pakistan but 409 out of the 423 cotton mills remained in the Indian Union. The cotton area in Pakistan produced American cotton which constituted 40% of the total cotton production. The partition caused a huge shortage of domestic cotton in India, necessitating heavy annual imports. Thus, in the post-independence era, the cotton sector posed several challenges periodically and the cotton R&D continuously re-oriented its priorities to address these challenges. To ensure sufficient cotton to its domestic mills "grow more cotton" programme was implemented in the 1950s. Special efforts were initiated to increase in area under American cotton, increase in coverage under irrigated cotton, supply improved seeds and fertilizers

at subsidized rates and raise the basic ruling price.

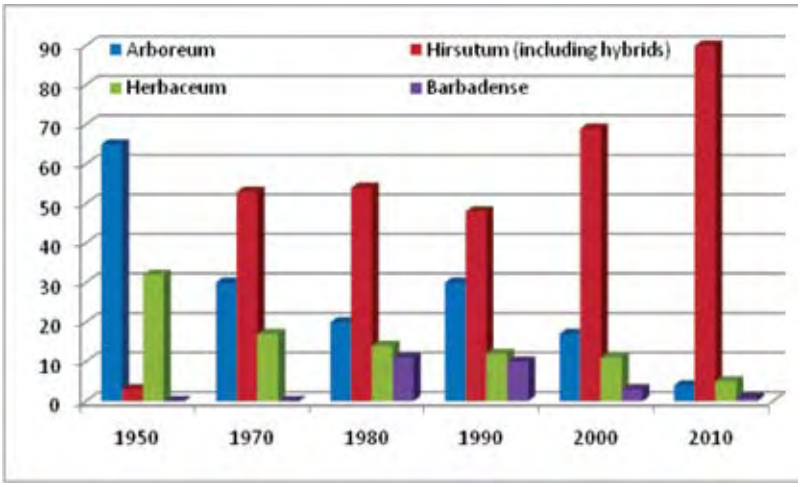
In the post independent era, a few major structural changes in cotton R&D and trading institutions influenced the cotton sector immensely. The All India Coordinated Cotton Improvement Project (AICCIP) in 1967 to facilitate multi-location and multi-disciplinary research; the establishment of Cotton Corporation India (CCI) in 1970 to provide procurement support to cotton growers; the launching of Intensive Cotton Development Programme (ICDP) in 1971 to accelerate technology dissemination; the Cotton Monopoly Procurement Scheme in Maharashtra in 1972-73; the establishment of Central Institute for Cotton Research (CICR) in 1976 to conduct basic and strategic studies on cotton production and the Technology Mission on Cotton (TMC) from 2000 to 2017 made a significant difference to cotton production and trade in India. To modernize the entire cotton scenario, the government initiated the "Technology Mission on Cotton" in 2000.

During the 1950s and 1960s, India was producing more of short staple cotton from *Desi* cotton. More than 10 lakh bales of long and extra-long staple cotton mainly from *G hirsutum*and *G barbadense* were imported every year to feed the textile industry. During 1950's, research efforts intensified to develop suitable American (*G. hirsutum)* cotton to replace short staple *desi* cottons. Subsequently, a few spectacular varieties were released during the early part of independent India.The Punjab-American varieties 'P 216F' and '320F' in the northern regions brought about substantial quality improvement. The *Gossypium herbaceum* variety 'Jayadhar' released in 1950 in Karnataka; the *Gossypium hirsutum* variety 'MCU 5' for 60's counts released in 1968; The *Gossypiumbarbadense*variety 'Suvin' suitable for 120's counts released from CICR in 1974 are popular until date. The world's first commercial Hybrid 'H-4' released in 1970, the world's first Inter specific tetraploid hybrid 'Varalakshmi' released in 1972; the

world's first GMS based hybrid 'Suguna' released from CICR in 1978 and the world's first Inter-specific diploid hybrid 'DH 7' released in 1983. A few other spectacular achievements on hybrid technology were the development of 'H-6' in 1980, Inter specific tetraploid hybrid 'DCH 32' in 1981and the widely adaptable hybrid NHH-44 released in 1983. A few American cotton varieties became extremely popular and were preferred by farmers over hybrids. 'Bikaneri Narma' and its selections 'F414' and 'H 777' were identified for adaptability and high yields in North India in 1976. The highly adaptable variety 'LRA 5166' was released from CICR in 1982 and rapidly spread across central India. The premium fibre variety 'Suraj' was released from CICR in 2008. However with the advent of Bt-cotton hybrids, the scenario changed completely in India.

With the adoption of improved varieties, the acreage under *G. hirsutum* cotton increased from 3% in 1950 to 29% in 1960 and 50% in 1970. By the year 2000, the area under *G. hirsutum* cotton increased to 72% of which 37% was under varieties and 38% was under hybrids. However, indiscriminate replacement of *Desi* cotton with G.*hirsutum* cotton changed insect pest scenario, with more intensity of pests on American cotton varieties. Soon, insecticide usage gained prominence for the control of conventional insect pests viz. the leaf hoppers, spotted bollworm, spiny bollworm and pink bollworm especially on American cotton. Introduction of carbamates and organophosphate group of insecticides in 1960s initiated an era of chemical based pest control in cotton. To maximize the productivity from hybrids, chemical fertilizer use increased during the 1980s and soon pest scenario became even more complicated. Synthetic pyrethroids were introduced in 1982 to control *Spodoptera litura*. However, leaf hoppers, whiteflies *Bemisia tabaci*, and the American bollworm *Helicoverpa armigera* gained prominence, mainly because of wide-spread cultivation of *G. hirsutum* hybrids coupled with the indiscriminate use of synthetic pyrethroid insecticides. Following outbreaks of whitefly and bollworms, research and development of integrated pest management (IPM)

Relative composition (% area) of various species of cotton grown in India



strategies began in 1990's. By 1990, *Helicoverpa armigera* was found to have developed resistance to almost all the insecticides recommended for its control. Insecticide Resistance Management (IRM) strategies were developed by CICR and disseminated effectively across the country.

Bt Cotton

Repeated crop failure and high levels of insecticide resistance in bollworms in the late 1990s led to the introduction of *Bacillus thuringiensis* (Bt) toxin containing cotton in 2002. The technology had a spectacular impact on bollworm control at least for the first 5-6 years. Yields increased by 67% and insecticide use decreased by 33.0%, albeit possible also because of a few other additional factors. Interestingly, by 2006 there were only 20 Bt cotton hybrids. Cotton scenario in India changed after the introduction of Bollgard-II in 2006. For nine years after 2006, yields stagnated despite 70% increased usage of fertilizers (Source: cost of cultivation data from Ministry of Agriculture). More than 2000 Bt-cotton hybrids were released by the private seed companies during 2002 to 2016 and by 2011, more than 95% of the cotton area came under Bt-cotton hybrids (Figure 1) replacing the *Desi* varieties and American cotton varieties developed by public sector institutions. The biggest concern was that -insecticide usage increased by 92%, because of increase in sap-sucking insects on the Bt-cotton hybrids. A whopping 734 Bollgard-II hybrids were approved to saturate the entire country's cotton area with Bollgard-II in just 5 years after its introduction. Most of them were highly susceptible to leaf hoppers

and whiteflies. Insecticide use increased significantly resulting in rapid development of 'insecticide-resistance' in whiteflies and leaf hoppers. The most worrisome news is that the pink bollworm which was almost forgotten in India after 1980, appeared back recently and thereafter rapidly developed resistance to Bollgard-II. In summary, the increase in area of Bt-cotton from 38% in 2006 to 96% in 2015 made no difference whatsoever to the 1500 to 1700 kg seed cotton yield per hectare in India. This season cotton area declined by about 15% compared to the previous year and yields are expected to touch 300 to 310 lakh bales as compared to 398 lakh bales in 2013-14.

Bt-cotton was introduced into India, exclusively in *G. hirsutum* hybrids and not in open pollinated varieties. Within 7-8 years after introduction, the Bt-hybrids captured more than 90% of India's cotton area (Fig. 1). Despite the massive replacement of native cotton varieties with Bt-cotton hybrids, farmers in some parts of the country persisted with *Desi* species of *G. herbaceum* mainly in the saline tracts of Gujarat and Karnataka and *G. arboreum* in Rajasthan, Punjab, Haryana, Maharashtra, Madhya Pradesh and Tamil Nadu to an extent of 3.0 to 5.0% of the total area in the country. This year, in the 2016-17 season, reports indicate that farmers in India are reverting back to non-Bt native cotton varieties to an extent of 14-15% of the area in the country.

The ICAR-CICR has introduced the deregulated event containing Bt gene Cry1Ac into 16 elite public sector American cotton varieties. In addition, MPKV Rahuri, PAU Ludhiana, OUAT Bhawanipatna and SIMA have also developed 5 'Bt varieties'. A total number of 21 Bt-varieties are now being tested during Kharif 2016-17 at 15 locations across India in high density planting system, a technology standardized by ICAR-CICR. The varietal performance will be compared with the best Bollgard-II hybrids of the respective regions. Currently there is no difference in the efficacy levels of the single gene Cry1Ac based Bt-cotton and two gene Cry+Cry2Ab based Bt-cotton against bollworms, because of resistance development in the pink bollworm to both toxins. The Bt-varieties of CICR potentially escape the pink boll worm due to short duration, while there are hardly any hybrids that escape because of the long duration.

Improvement of fibre quality in *Desi*cotton:

Desi cotton species were known to produce coarse and short staple only suitable for 'charkha' spinning and not for high speed machine spinning. Over the past few years, Indian plant breeders made spectacular progress in developing

new *Desi* varieties that produce fibre which is better than majority of the American cotton varieties. Initially, a few *G. arboreum* varieties such as AKA 8401, PA 183, PA 255 were developed to produce superior medium staple of 27-28 mm. In South Zone, varieties such as K 8, K 9, K10 and K 11 were developed to produce 24-25 mm staple length. In the North zone *Desi* varieties such as LD 230, DS 5, LD 123, RG 18, HD 107 and LD327 were high yielders to produce 20-30 quintals per hectare but could also spin up to 30-40 counts, which is equivalent to the American cottons. Recent efforts focused on improving ginning percentage, short duration and fibre qualities. Varieties LD 694, DS 5 and LD 327 have more than 40% ginning percentage. Over the past few years, a few short duration *Desi* varieties were developed to produce fibre of premium quality. These are Vinayak

(PA 402), Rohini (Na 48), Sawata (PA 183), DLSa 17, and TKA 9102/03 with fibre length of 27-29 mm and fibre strength of 21-23 g/tex making them spinnable at 30s to 40s counts. More recently, some improved cultures like PA 812, PA 785, PA 778 and PA 740 with 30-32 mm fibre length and good fibre strength have been developed. The fibre produced by these cultures is superior to majority of the Bt-cotton hybrids. The Desi varieties are robustly tolerant to insect pests, diseases and drought. The cost of cultivation is less than half as compared to any commercial hybrid cotton. The new cultures are being tested in multi-location trials at 15 farms across the country this season in 2016-17 to identify the best varieties for each location.

Cotton production technologies have revolutionized the sector over the past few decades. Today, India has the highest area under cotton and is currently the world's largest cotton producer. The Indian textile industry contributes about 11 percent to industrial production, 14 per cent to the manufacturing sector, 4 percent to the GDP and 12 per cent to the country's total export earnings. The country exported textiles worth $40 billion in 2015-16, 90% of which was cotton-based textile worth $36.2 billion. Cotton is a multi-component crop, and apart from lint that is spun into yarn, it yields several industrially useful by–products like cotton seed, linter, oil, meal and cotton stalk. Genetically modified (GM) technologies that confer tolerance to herbicides, sap-sucking pests, bollworms, diseases, nematodes and drought stress have been developed and may be commercialized. Small scale machinery developed in India and elsewhere in the world has resulted in the reduction of drudgery. With the cultivation of newly developed short duration long staple *Desi* cotton varieties, compact varieties, it may be possible for India to establish sustainable cotton production systems with least chemical inputs, low input cost and high yields. A beginning is just being made from CICR on this front. We hope to achieve the target of setting up ecologically sustainable cotton production systems in the near immediate future. ■

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Way Forward for Improving Indigenous Cattle

India is a rural country, having two-thirds of its total population in villages and about one-third of rural population below poverty line. Cattle rearing has been supplementary to agriculture. Cattle have been the source of livelihood security for landless and resource poor farmers. 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% of cattle. However,the intrinsic production potential of indigenous cattle has not been 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.

Indigenous Cattle - Population Scenario and Dynamics

India has vast population of cattle (190.9 million), out of which 151.17 million are indigenous and 39.73 million crossbred/exotic cattle. Among the indigenous cattle, only 22.21 million heads (11.64%) have been described and categorized into 44 different populations including 39 distinct/registered breeds. Indigenous cattle breeds are generally classified on the basis of their utility like milch breeds (Sahiwal, Gir, Red Sindhi, 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 in different agro-climatic regions of the country. 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 indigenous cattle are non-descript and low producers mainly attributed to the poor genetic make-up for milk production and inadequate availability of feed and fodder.

Major concern is that the population of indigenous cattle has declined over the years, while the population of crossbred cattle has increased. The share of indigenous cattle to total cattle population has declined from 93% during 1992 to 79% during 2012. On the contrary, the share of crossbred cattle has increased from meager 7% to 21% during the corresponding periods. The comparison of cattle population as per 19th Livestock Census (2012) with 18th Census (2007) revealed a decline of 4.1% in total cattle population. The decline in indigenous cattle population was -8.94%, while the exotic/crossbred cattle population increased by 20.2%. This is a matter of satisfaction that there was only slight decline (-0.01%) in indigenous female cattle population. The decline in indigenous males was -19.32% as compared to -12.75% decline in crossbred males (2007 versus 2012). As per 2012 census, out of 61.95 million males of indigenous cattle, 39.85 millions were used for draft work, 2.98 million used for both draft

and breeding purpose, and 2.08 million were used for breeding only. This indicates that 44.91 million males (79.25%) have been used every year and about 17 indigenous males are still surplus in our country. Hence, efforts should be made to increase the population of female cattle by using sexed semen of indigenous bulls and sexing of semen has to be taken on priority in the country to check the population of redundant males.

The distribution of indigenous cattle population over different states in India ranges from 13948 heads in Sikkim to 18.76 million in Madhya Pradesh as per the 19th Livestock Census. The second state having the highest number of indigenous cattle (15.98 million) is UP followed by West Bengal, Maharashtra, Rajasthan, Odisha, Assam, Chhattisgarh, Bihar and Jharkhand. Top 10 states having highest number of indigenous cattle possess 78.7% of total population of indigenous cattle. As per 18th Livestock Census, about 22.2 million population of indigenous breeds were recognized. Rajasthan tops all the states with a population of 5.29 million indigenous cattle, followed by Gujarat (4.29 million) and other states. First 10 states contribute 95.77% of total indigenous cattle population. Rajasthan, Gujarat and Karnataka possess 13.48 million cattle, which constitutes 60.72% of total indigenous cattle population. The UP and MP has highest number of breeds (8 each), followed by Rajasthan and Bihar (7 each), Karnataka and TN (6 each), Odisha (5), Maharashtra (4), Gujarat and Haryana (3 each).

The comparison of breed-wise population in India reveals that Kankrej has highest population (38.8 lac) followed by Hariana (26.0 lakh), Gir (21.3 lakh), Rathi (9.2 lakh), Tharparkar

(5.6 lakh), Red Sindhi (5.5 lakh) and Sahiwal (4.6 lakh). These seven breeds constitute 50% of total recognized 39 indigenous breeds. Hariana breed has its spread in 11 states and 1 UT, followed by Sahiwal (8 states, 2 UT), Gir (6 states, 2 UT), Tharparkar and Red Sindhi (6 states each). On the contrary, Rathi was prominent only in Rajasthan.

Indigenous Cattle – Potential for Productivity

The biodiversity of our cattle breeds has been diluted during last few decades due to use of only few improved breeds besides crossbreeding of local cattle with exotic breeds. Both these factors have contributed to the dilution of well-defined indigenous cattle breeds resulting in reduced herd sizes of these breeds at organized farms and under field conditions. It is obvious from the declining trend of indigenous cattle and ascending trend of crossbred cattle over the last two decades. This has attributed to lower milk production of only 2.37 kg/day of Indian cattle at the national level with a range of 0.76 kg/day (Meghalaya) to 6.52 kg/day (Punjab). Punjab is 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 demonstrated better milk production (3.54 & 3.85 kg/day) due to availability of good breeds like Gir, Kankrej, Rathi, Sahiwal and Tharparkar in these states. Other four states namely Bihar, J&K, TN and UP have higher per cow per day productivity than the national average. Punjab and Haryana have only 0.24 and 0.54% of total cattle population as indigenous breeds.

The milk production scenario of the country from indigenous cattle indicates that UP was top producer followed by Rajasthan, MP, West Bengal, Bihar, Gujarat, Karnataka, Maharashtra, AP and Jharkhand. Top 10 states contributed to 22.49 million tonnes of milk from indigenous cattle, which is 84.24% of total milk from indigenous cattle. Top three states' contribution to indigenous cow milk pool was 41.82%. However, the ranking of top ten milk producing

states on the basis of milk yield/cow/day ranged from third (Gujarat) to eighteenth (Maharashtra).

Way forward for improvement of indigenous cattle:

- Semen sexing to produce higher number of female calves to overcome the huge number of surplus redundant males.
- Strengthening field performance recording system for major important breeds of indigenous cattle to have effective progeny testing program at present and genomic selection in near future.
- Faster multiplication of superior germplasm at organized / nucleus herds using state-of-the-art assisted reproductive technologies like ET, ONBS, Ovum Pick-up and IVF.
- Characterization and conservation of not yet defined subpopulations/ecotypes of indigenous cattle. 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.
- Grading up of non-descript low producing cattle with well-defined breeds of the area/ adjoining area.
- Breeding policy for different breeds should be revisited looking their importance in present context of economically important traits.
- Revisiting cattle policy reforms to address IPR issues.
- Conducting breed-wise livestock census.
- Declare all the cattle breeding farms as in-situ conservation and breeding centres and effective use of 4355 gaushalas in this regard.
- Unravel the unique genes and bio-prospecting the special utility traits, biomolecules, products etc. of indigenous cattle for enhanced productivity using emerging biotechnological tools.
- Develop branded products from indigenous cattle and creation of niche markets for these products.
- Pasture development program with dual purpose of grass and seed production may be taken up to 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.
- Cheap pen side diagnostic kits needs 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.
- 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 germpasm of indigenous breeds from other countries having superior germplasm of indigenous breeds.

The overall productivity of indigenous cattle 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 and creation of niche markets for these products would ensure livelihood security. Conducting breed-wise livestock census and developing a roadmap for breeding and conservation of indigenous cattle should be taken up on priority. ■

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Multiplying Farm Income through Sustainable Livestock and Agriculture Production: An Opportunity

Livestock rearing in our country is quite different for subsistence farmers, where risk management is more important than the developed market driven systems. Apart from unfriendly climate, we face challenges of large human and animal population, pressure on land, scarcity of pasture land, shortage of feed & fodder, resulting in comparatively low productivity and consequently low economic returns.

Inspite of the above, livestock sector is showing better promise (growth of 4-5%). The key point to be observed here is that our majority of the ruminants are reared under suboptimal conditions, as the small livestock holders and landless together hold around 70% of our country's livestock. However, planning and involving the stakeholders for holistic interactions with plants and soil, involving Total Resources Management, which means optimum utilization of the available resources including the available dung, urine through its recycling would help in improving the overall Animal & Human & Soil Health.

The Livestock revolution is stretching the capacity of existing production, but may also be exacerbating environmental problems. Therefore while it is necessary to fulfill demand of the consumer, improve nutrition and improve income growth opportunities, it is also necessary to alleviate environmental stress. Conventional Agriculture system is known to cause soil erosion and pasture degradation as it involves intensive tillage. The increasing pressure on the land and its growing demand for livestock products make it more important to ensure the effective use of resources with use of appropriate technologies.

It is therefore important to work on sustainable model involving Agriculture and Livestock production systems. Both these systems of food production require water and energy. However, while calculating the cost of produce, the cost of both these nonrenewable resources gets ignored most of the time. Allocating the suitable cost would help in developing the cost of produce more appropriately.

Agriculture and Livestock give us food

Food, apart from air, is the most important thing for the living being survival. This is true globally. The challenge today is terms of improving productivity of the food and its preservation. The water and energy required for producing every kg of food also offers a

great challenge. Hydroponics Paddy nursery production, where seedlings for instance grows in just seven days is known to conserve few lakh liters of water required than in conventional system. The approach is to bridge the yield gap with respect to these crops through dissemination of improved technologies and farm management practices. The implementation of the related missions would improve health and create additional employment opportunities. In this mission, Livestock is also expected to jointly play an important role with daily income to farmer.

Agriculture produces raw materials and residues for Animal Feeding

Feed is also the main input factor for milk and meat production, which constitutes 60-70% of the cost of livestock production. In livestock farming, it becomes very important for us to feed livestock with proper balanced feed. The basic principle of GIGO applies here. If you feed them right, they will remain healthy and more productive during their lifespan. As a matter of fact, we need to realize that production is part of reproduction. In our country, we have immense problem of tackling the issue of infertility in animals or we may refer it as decline in the reproductive efficiency in animals. One of the most common factors affecting this is improper nutrition or animals being not fed the nutritionally balanced compound feed.

Land and Water for Fodder Production Competes with Food Production

Fodder is important part of Livestock feeding and can never be under estimated. The fodders are rich in Omega 3 Fatty acids which is essential for maintaining a healthy heart, flexible joints, healthy growth and strong bones and teeth. Another important constituent is Conjugated Linoleic acid (CLA), which is believed to boost immune function and reduce the growth of tumors.

In India, the area under fodder cultivation has remained static for the last three decades at 4.5% of the total cultivable land, due to pressure of human population. The only way to increase fodder production is through intensive fodder production, especially using high yielding varieties of fodder crops. But it is important that the farmers are supplied seeds of high yielding fodder varieties, as its non availability is yet another bottleneck in enhancing fodder production.

In our country, we do not get the green fodder round the year which affects the health of the animals and the quality of the milk which they produce.

Comparative heat values and thermal efficiency of commonly used fuels

Commonly used fuels	Calorific values in Kilo calories	Thermal efficiency
Bio-gas	4713/M3	60%
Dung cake	2093/Kg	11%
Firewood	4978/Kg	17.3%
Diesel (HSD)	10550/Kg	66%
Kerosene	10850/Kg	50%

Technology for Water and Land Conservation: Non-competitive with human food

The word hydroponics has been derived from the Greek word where 'Hydro' means water and 'Ponic' means working, i.e. Water working. Plants require 3 things to flourish-water, nutrients and sunlight. It is referred as green feed because when compared to conventional fodder, Protein content is about three times higher and Energy values are about double in Hydroponics feed. The conventionally harvested green fodder consists only cut grass but the Hydroponics feed consists of grass, along with grain and root.

Apart from conserving water, this technology produces completely natural green feed, and does not use pesticides or fungicides for production. Feeding Hydroponics green feed improves reproductive efficiency and milk quality.

Livestock provide Dung for Fuel production (Biogas) towards Energy Needs and Environment Sustainability

Energy is a necessary concomitant of human existence. Today, energy crisis has mainly emerged from the fear that the boons of fossil fuel may turn into a bane as the disappearance of fossil fuels would compel the society to change its habits and practices. That is the crisis and that is the compulsion for searching alternate sources of energy. Presently, the country is spending a fortune in importing fossil oils which can hardly be afforded for long in the face of developmental needs. Methane gas, more popularly known as bio-gas, is one such alternate source of energy which has been identified as a useful hydro-carbon with combustible qualities as that of other hydrocarbons. Though its calorific value is not high as some of the fossil fuels and other energy sources, it can meet some of the needs of households and farms.

It is estimated that alternative sources of energy like bio-gas plants, wind mills etc. may reduce the dependence on conventional sources of energy by about 20% by the turn of the century. Presently, the cooking media in rural areas consist of burning dung cake, fire-wood and to some extent kerosene where it is available easily. The installation of bio-gas plants would directly replace the use of above three and helps in saving them. In addition, it would help in accomplishing the Swach Bharat Mission of our Prime Minister.

Livestock Biogas Slurry and Vermicompost as Fertilizer: Recharging the soil for quality and Safe produce through Agriculture

The government's recent decision on deregulation of the chemical fertilizer is indicative that it is not possible for the government to foot the subsidy bill. As a matter of fact, the use of synthetic fertilizer is reducing the soil fertility and affecting the food production. One of the reports further mentions that micro nutrients of the soil are lost with over use of nitrogen fertilizer, urea.

It is important to look at the possible drivers of income growth for farmers. The first source is diversification of farm activities towards high-value crops and enterprises linked with livestock. The second source is irrigation, which can double productivity. The third source is better price realization for farmers through competitive markets, value chains, improved technologies linkage between field and fork.

This would only happen if we effectively integrate Agriculture & Livestock sectors. This may involve use of new technologies for improving the cost. This will not only help us in succeeding in the Mission of Each Drop More Crop bringing back the soil fertility & improved crop production and farm profits. This may not happen overnight, but then there is always a possibility to begin at some point. A successful model of Ayurvet 5F needs to be tried for scaling up towards improving farm income. ■

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Challenges and Opportunities under Small holder Dairying System and Contribution of NDDB in the Emerging Scenario

Ownership of dairy animal and their relative contribution in national production is a true indicator of the extent of inclusiveness. According to National Sample Survey (NSS, 70th Round 2013), small and marginal and landless with land less than one hectare of land, account for 93% of operational holding, 53% of the operated area and 78% of bovines (cows and buffaloes). Within this category, marginal famers are the largest accounting for 75% in terms of numbers and 58% in terms of bovine ownership. In addition, about 7% of medium farmer, including semi-medium farmer (2-10 ha), own 20% of the bovines.

In another cross country Baseline Survey in the NDP I area (Development and Research Services, 2013) it was found that small, marginal and landless constituted 82% of the dairy farmers in major 14 milk producing states. Empirical as well as contemporary evidence therefore adequately establish that Indian dairy space will continue to be dominated by the smallholders.

Milk Production and Productivity under Smallholder Production System

The combined strength of the small producers has taken India into the league of largest milk producing countries with an estimated production of 155 million tonnes in 2015-16 and per capita availability of milk at 337 grams– higher than the world average of 294 grams per day.

Milk is now the most important agricultural commodity, both in value as well as in quantity, as compared to paddy and wheat– the two principal staple crops. Sustained growth in milk production over a longer horizon is indicative of its resilience to adversities arising out of environmental and economic events.

Milk production grew at 3.78% per annum between 1994-95 and 2004-05. The two factors that contributed to this growth were increase in yield of animal (53%) and increase in their number (47%). This trend remains even during the period 2004-05 and 2014-15, when production grew at 4.69% annually.India can achieve much higher growth in milk production if yield of our animals could be increased without increasing the number of animals.

At the national level, the average yield per day is 2.54 kg for a local cow, 7.15 kg for a cross bred cow and 5.15 kg for a buffalo. Data on yield of major milk producing states show that yields vary between 2.66 kg per day (Odisha) and 9.20 kg per day (Punjab) in case of in-milk

Table 1: Operational holding and bovine ownership in India

Land holding Group	NSS Land & Livestock holding in India (70th Round 2013)			DRS Baseline Survey: 2013
	% Operational holding	% Area operated	% Bovine ownership	% Milch animal owning households
Landless, Marginal & Small	92.8	53.3	78.1	82
Semi Medium	5.9	22.1	13.4	11
Medium	1.9	18.8	7.0	6
Large	0.3	5.8	1.5	1
All	100	100	100	100

bovine(cattle and buffalo). If this yield gap is narrowed by say 10%, an estimated incremental production of 13% could be realised with the existing animals.

Income from Smallholder Livestock

The Situational Analysis Survey of the farmers, a contemporary publication of NSSO (70th Round 2013), provides some important perspectives to look at smallholder production of our livestock farming. As per this survey, livestock accounts for a major share of the household's income in about 11% of all agricultural households. Within this category that derives a major share of its income from livestock, about 44% of them have land holding of less than 0.4 ha group.

While average income earned by a typical agricultural household from livestock is about Rs. 763 per month, it is Rs. 4292 per month for those households with livestock accounting for the largest share of income. If we can raise the average income from livestock, it can help in a significant way in increasing the overall income of households.

This appears possible considering that animal ownership in our society is far more equitable compared to other assets like agricultural land, or possession of tangible assets.

Opportunity for the small holder dairy sector

The private final consumption expenditure data of National Account Statistics, GoI indicates that expenditure on milk and milk products constitutes about 7 percent of total final expenditure. About 22 per cent of total food expenditure is spent on milk & milk products.

NSSO data indicates that nearly 85 % of urban households and 78 % of rural households report consumption of milk.

A population of about 970 million reported consumption of milk and milk products in the country, translating into nearly 200 million households.

In spite of a large proportion of low income households, India's milk production is almost entirely consumed within the country.

The market for milk and milk products within the country is likely to be sustained due to

- Growth in national income trickling down as increase in household income
- Growing urbanization

Such a large market that is likely to grow at a sustained pace would provide the opportunity for India's milk producer to meet the rising demand.

Challenges for the small holder dairy sector

In spite of the significant achievements of India's dairy sector, there are still a number of challenges that needs to be addressed:

- **Improving genetic potential:** While India has a large milch animal population, the average yields are relatively low partly due to the

existing stock of animals having lower yield potential.

- **Improving nutrition:** A majority of milk producers in India feed their animals with one or two feed ingredients that are relatively abundant in that area. As a result, there is imbalanced feeding which prevents the milch animal from producing milk that is commensurate with its potential.
- **Increasing market access:** Even with the substantial growth of the dairy cooperative network, the cooperatives cover only about 25 percent of villages and 20 percent of producers, with a share of about 18 per cent in the marketable surplus. The entire organized sector dairies including the private sector dairies account for only 30-35 percent of the marketable surplus. Increasing the proportion of milk procured through the organized sector is however constrained by the dispersed location of villages, inadequate availability of milk for collection from each village,highly perishable nature of the commodity, economics of managing a milk collection system, quality of roads etc.
- **Ensuring food safety and quality:** A large number of small holders implies significant efforts in disseminating hygienic practices in milking and handling of milk. Further, establishing and managing a cold chain to store and transport milk is a challenging task where ambient temperatures are relatively high as well as due to the issues with reliable supply of power and water.
- **Managing volatility in markets:** As countries increasingly get integrated into the global economy as well as within the country, there has been greater volatility of prices in both domestic and international markets. Events that impact prices cascade from domestic to international markets and vice versa. Small holders are more vulnerable to such volatility as they would find it difficult to absorb large swings in not only prices but also the ability of the market to absorb the supply.
- **Adapting to climate change:** In case of the dairy sector, droughts can lead to households either under-feeding them leading to greater mortality or selling their animals away. These can result in milk production getting affected in those regions till such time households are able to rebuild their herds. Helping milk producers to tide over difficult events is a challenging task for both governments as well as producer institutions.

Contribution of NDDB

Over the years NDDB has been contributing to the development of the dairy sector through a variety of measures, of which some salient aspects are given below.

Implementation of national

dairy development programmes

NDDB implemented Operation Flood (OF) in three phases between 1970 and 1996 with a total investment of over Rs. 1700 crore. Operation Flood was launched to support an ambitious nationwide programme for development of rural milk production through an extensive network of village milk producers cooperatives based on the cooperative experience gained at Anand.

By the end of Operation Flood, NDDB had provided technical and financial assistance to set up and strengthen 15 state cooperative dairy federations, 170 milk unions covering about 73,000 village dairy cooperative societies and about 93 lakh milk producers. Dairy cooperatives were procuring about 110 lakh kilograms per day and marketing close to 100 lakh litres of liquid milk per day. Operation Flood had helped setup an aggregate processing capacity of about 190 lakh litres per day, milk powder manufacturing capacity of close to 1,000 MT per day, cattle feed manufacturing capacity of 5,200 MT per day.

Post Operation Flood, NDDB has continued to provide technical assistance and finance to cooperatives.By March 2015, there were about 165,500 village dairy cooperative societies and around 154 lakh milk producers (of which about 30 percent are women). Dairy cooperatives are currently procuring about 378 lakh kilograms per day which is about 18 % of the marketable surplus, and marketing close to 311 lakh litres of liquid milk per day. Their aggregate processing capacity is around 655lakh litres per day, milk powder manufacturing capacity is close to 1570 tonnes per day, cattle feed manufacturing capacity is 14383 MT per day.

Implementation of National Dairy Plan Phase I (NDP I)

While productivity of existing animals can be increased to some extent by feeding and management practices, to enable them to produce as per their genetic potential, the genetic potential of future generations of animals for milk production can be increased only through well planned scientific initiatives in breeding. Milk producers are incentivized to produce more if they are provided greater access to the market to producers through a fair and transparent system for collection as well as payment for their produce that is linked to the quality of the milk. These measures are intended to effect changes in milk production activities in a manner that will stimulate milk production commensurate with increased demand and will be self -sustainable from a long term perspective.Recognising these two broad strategies, NDDB submitted a proposal to the Government of India for addressing these issues, which was approved as the National Dairy Plan Phase I (NDP I).

NDP I, a Central Sector Scheme of Government of India, a scientifically planned multi-state initiative is being implemented by National Dairy Development Board (NDDB) with the network of End Implementing Agencies (EIAs) for the period 2011-12 to 2018-19 with the following objectives:

- Increase productivity of milch animals and thereby increase milk production to meet the rapidly growing demand for milk.
- Provide rural milk producers with greater access to the organised milk processing sector.

NDP I is an externally aided project with the total outlay of Rs. 2242 Crore and is being implemented in 18 States which accounts for more than 90 percent of the country's milk production. However, benefits accrued from the project will be on pan India basis.Under NDP I, 364 sub projects of 158 EIAs from 18 States have been approved with total approved outlay of Rs. 1904.22 Crore

out of which Rs.1585.73 Crore would be grant assistance from NDP I and Rs. 318.49 Crore would be contributed by End Implementing Agencies. As of date, Rs. 914.79 Crore has been received from DADF and Rs. 839.74 Crore has been released by NDDB.

Other contributions of NDDB

NDDB has also been contributing in a number of other ways

- Training & capacity building for milk producers, Board of Directors and employees of dairy cooperatives. Till March 2016 – 8.5 lakh persons trained/oriented (5.55 lakh milk producers, 5000 BoDs, 2.9 lakh employees)
- Consultancy and turnkey execution of engineering projects for dairy plants, Chilling centres, Powder plants, cattle feed plants (including bypass protein plants, Mineral mixture) as well as for specialized projects such as Bio Security labs.
- Development of software to help farmers balance ration of animals, development of feed supplements , Design of bypasss protein and mineral mixture plants, coordination of breeder seeds to dairy cooperatives, supply of fodder planting material,
- Maintaining a germplasm bank of indigenous cattle breeds and buffalo breeds by in-vitro methods in the form of frozen embryos and frozen semen
- Selection of strains for FMD vaccine, development of vaccines for Thielieorisis and Brucellosis, undertaking of pilots in field for control of brucellosis and mastitis (currently underway), promoting biosecurity in semen stations
- Testing services for Feed and feed ingredients, Milk and milk products, and genetic analysis
- NDDB has also set up its wholly owned subsidiaries to provide support for the dairy and other agro based industries.

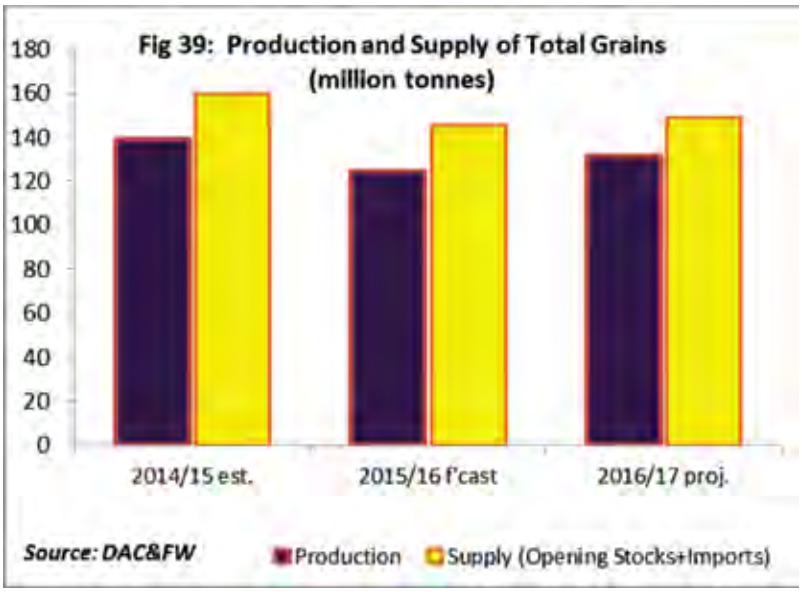
Plans for the future

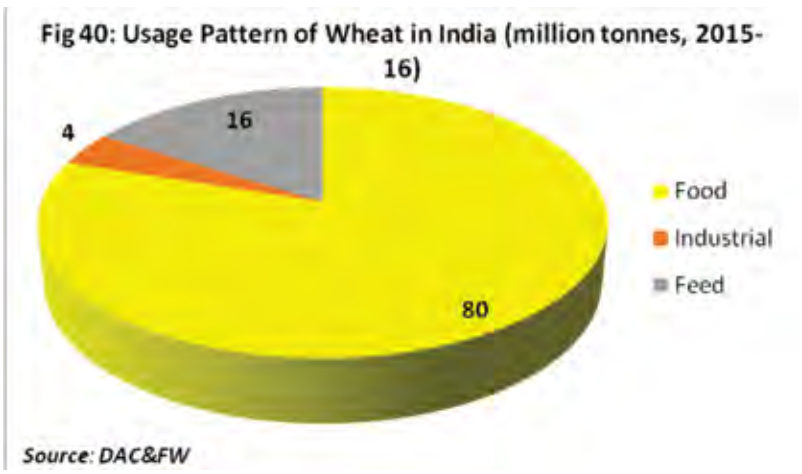
Interventions being implemented under NDP I are likely to put in place systematic processes and scientific method of production aimed at promoting growth and development of the sector in a sustainable manner. NDDB is also exploring different options to engage with development credit institutions for investments into modernisation and refurbishment of the dairy processing infrastructure and creating cold chain system to improve product quality and make cooperative dairy industry FSSAI compliant and globally competitive. ■

INDIAN AGRICULTURE – IN DIFFERENT LAND FRONTIERS

Crop Production Scenario- India

As a country, India is the second largest producer of wheat in the world. However, during the recent years, the production of wheat has witnessed a marginal decline. Total production of wheat was about 96 million tonnes in 2014-15 which decreased the following year in 2015-16 to 86.5 million tonnes (Fig 39). Consequently, the total supply consisting of production, opening stocks and imports fell from about 114 million tonnes in 2014-15 to 10.4 million tonnes in 2015-16. Wheat production in 2016-17 is projected to improve marginally to about 90 million tonnes. The total supply is also expected to improve marginally to 105.5 million tonnes.

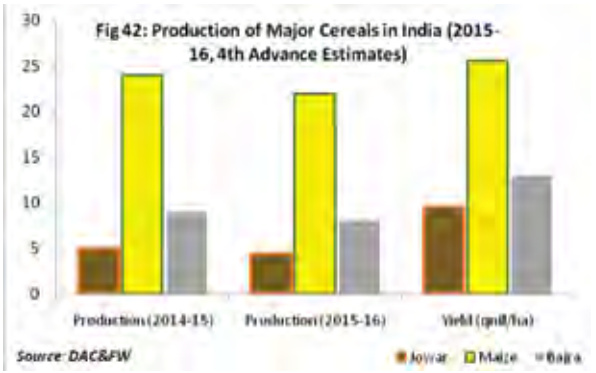


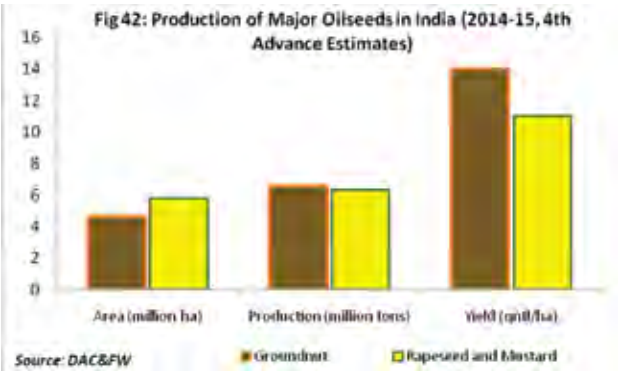


With about 3.5 per cent of the global wheat production and 14.0 per cent of the total wheat growing area in the world, India utilises a maximum share of its production as food for its vast population. Almost 80% of the total wheat in India is used for human consumption with 16% as feed and the remaining 4% for various industrial usages (Fig 40). Wheat is the second staple food crop of India.

India ranks second in terms of total rice production in the world, behind China. The production scenario in the country has remained more or less same in the recent years. India's internal production of rice in 2014-15 was 105.5 million tonnes and the total supply of rice in the country including imports was about 128 million tonnes. India exported about 12 million tonnes of rice in 2014-15. However, in 2015-16, rice production decreased marginally to about 104 million tonnes. The total supply of rice in the country too decreased and was about 121 million tonnes in 2015-16 (Fig 41). The total quantity of rice export from India in 2015-16 was about 9 million tonnes. This year, the projection of total rice production in the country is about 107.5 million tonnes and the total supply is projected to be around 119.5 million tonnes in 2016-17. Total export of rice from India is projected to decrease to about 7.5 million tonnes in 2016-17.

Fig 42 provides the data related to production and yield of other coarse grains in India during 2014-15 and 2015-16. The production of Jowar in 2014-15 in India was about 5 million tonnes. According to 4th advance





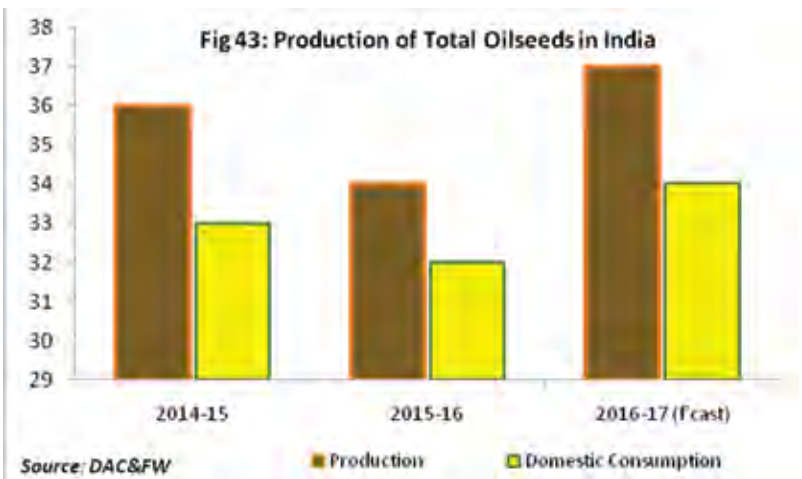
estimates, production of Jowar in 2015-16 was about 4.4 million tonnes. Yield of Jowar in India is 9.5 quintals per hectare.

Maize cultivation in India has been becoming popular in the recent years with new areas like parts of Bihar adopting the cultivation of the crop. In 2014-15, total production of Maize in India was about 24 million tonnes which according to the fourth advance estimates in 2015-16, fell marginally to 22 million tonnes. The average yield of Maize in India is about 26 quintals/ hectare. With an average yield of about 13 quintals per hectare, another important coarse grain in the country is Bajra. Production of Bajra in India in 2014-15 was 9 million tonnes which decreased marginally to 8 million tonnes in 2015-16 according to the fourth advance estimates.

Oilseeds

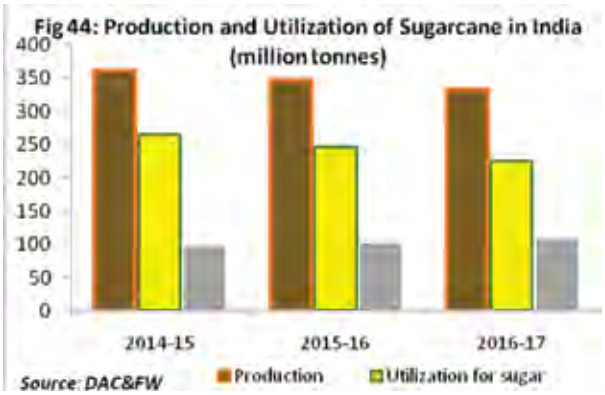
According to the 4th advance estimates, India cultivated Groundnut over a total area of 4.7 million hectares and the total production of Groundnut was 6.6 million tonnes. The average productivity of Groundnut in India currently is about 14 quintals per hectare. India cultivates Mustard and Rapeseed over in about 6 million hectares and the total production in 2014-15 was about 6.3 million tonnes with an average yield of 11 quintals per hectare (Fig 42).

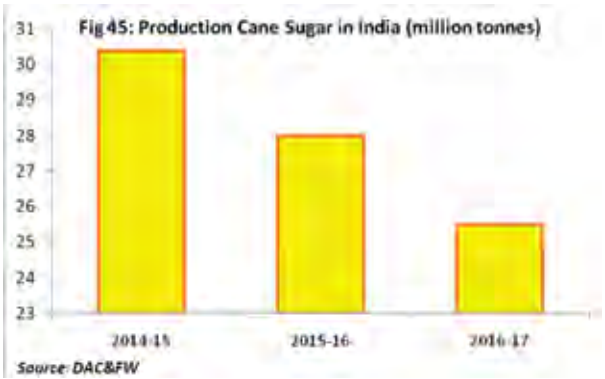
Fig 43 depicts the total Oilseed production scenario in India. The country produced 36 million tonnes of total Oilseeds in 2014-15 which decreased by a small amount in 2015-16 to 34 million tonnes. This year in 2016-17, the total forecast is about 37 million tonnes. Majority of the internal produce is utilised in domestic edible oil consumption and in addition, India relies heavily on edible oil imports too.



Sugarcane

India is the second largest Sugarcane producing country in the world, with Brazil as the leader in the league. In 2014-15, India produced a total quantity of 362 million tonnes of Sugarcane out of which about 265 million tonnes





was utilized for the production of cane sugar. The remaining amount was utilized for alcohol production (Fig 44). In 2015-16, India produced a total quantity of 347 million tonnes of Sugarcane. While 245 million tonnes of it was utilized to produce cane sugar, the remaining amount went into production of alcohol. According to latest projection for the current 2016-17, total production is forecasted at around 333 million tonnes. 225 million tonnes of it is expected to be utilized for sugar production with the remaining being consumed for production of alcohol.

As seen in Fig 45, India produced about 30.4 million tonnes of Sugar in 2014-15 which dropped to 28 million tonnes in 2015-16. This year in 2016-17, the projection is further low at 25.5 million tonnes of Sugar projected to be produced in India. However, assuming normal market conditions, India is expected to be a net Sugar exporter in 2016-17 and imports will be negligible. Production figures for Sugar also include Khandsari, which is a local type of low recovery sugar prepared by open pan evaporation. This year, losses in production are expected from states like Maharashtra and Karnataka. However, production gains in Uttar Pradesh, Tamil Nadu, and other states will compensate for about one third of the combined losses from those two states.

Cotton

Production of Cotton in 2015-16 was 125000 bales (of 480 lbs/bale). The opening stock last year was 67000 bales, and 172000 bales were imported. This resulted in a total supply of 364000 bales of Cotton in the country. This year, according to projected figures, there is expected to be a marginal decline in Cotton production in the country. Production is expected to be about 117000 bales. At the same time, owing to anticipated reduced domestic demand, total import of Cotton is also projected to decline marginally to 164000 bales. Including 51500 bales of opening stock of Cotton, the total supply is projected to be about 332500 bales in 2016-17.

Cotton prices in India have not experienced major fluctuations in the recent time. India has recently an-

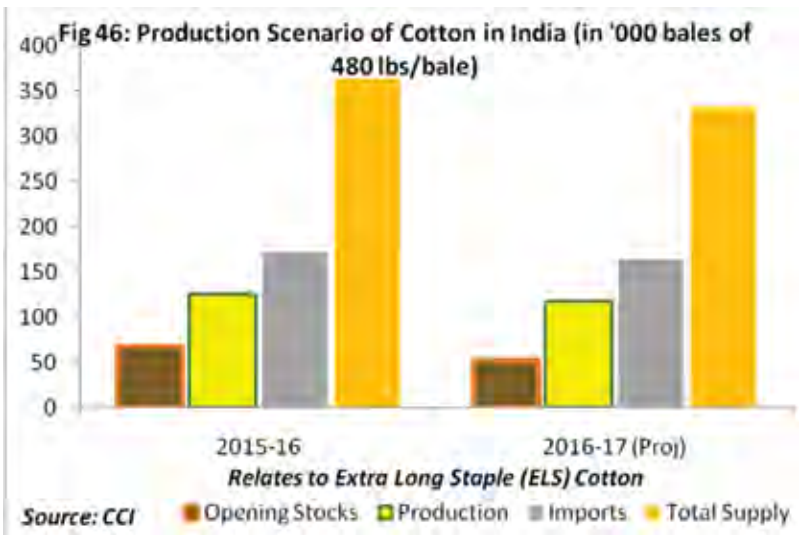


Table 4: Spot Price of Major Indian Cotton Varieties during End of Month in 2015-16 (in cents/lbs)

Month	ICS 201 (< 22 mm)	ICS 202 (26 mm)	ICS 105 (28 mm)	ICS 105 (29 mm)	ICS 106 (32 mm)	ICS 107 (34 mm)
April '05	0.72	0.72	0.68	0.7	0.75	0.94
May '05	0.71	0.7	0.67	0.69	0.75	0.9
Jun'05	0.7	0.71	0.66	0.68	0.72	0.88
Jul '05	0.68	0.66	0.68	0.68	0.71	0.86
Aug '05	0.67	0.67	0.64	0.68	0.69	0.83
Sept '05	0.59	0.61	0.61	0.64	0.66	0.86
Oct '05	0.62	0.63	0.61	0.63	0.65	0.88
Nov '05	0.59	0.61	0.61	0.63	0.64	0.87
Dec '05	0.63	0.63	0.63	0.65	0.69	0.91
Jan '06	0.59	0.62	0.63	0.64	0.69	0.93
Feb '06	0.57	0.61	0.6	0.62	0.68	0.92
March '06	0.56	0.61	0.6	0.62	0.69	0.92

Source: CCI

nounced a new approach to its MSP program. Instead of physical procurement of Cotton, the central government will directly transfer cash to farmers based on the difference between the market price and the MSP. Initially, the new program will be offered as a pilot program in a few regions. The price trend of Cotton of various varieties is presented in Table 4.

Fig 47 provides the export import trend of Cotton that prevailed during 2015. Apart from November and December months, when the export figures of Cotton were 1016000 bales and 1384.5 million bales respectively, the export quantity had a high range of 592000 bales in April 2015 and a lower export amount of 163000 bales in June 2015. On the other side, monthly import of Cotton increased from July till September and remained flattened during the initial and the final months of 2015. The highest quantity of Cotton being imported by India in 2015 was in the month of September at 143000 bales and the lowest in the month of December when the import was a meagre 37000 bales.

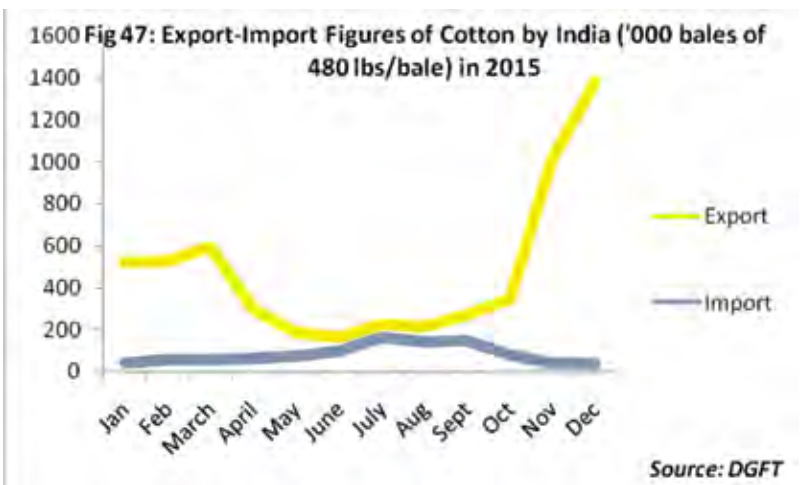
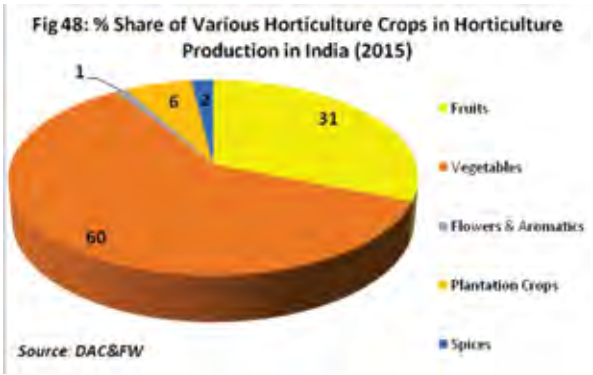


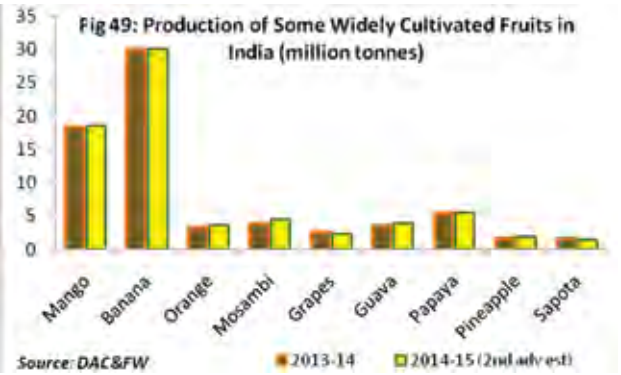
Fig 47: Export-Import Figures of Cotton by India ('000 bales of 480 lbs/bale) in 2015

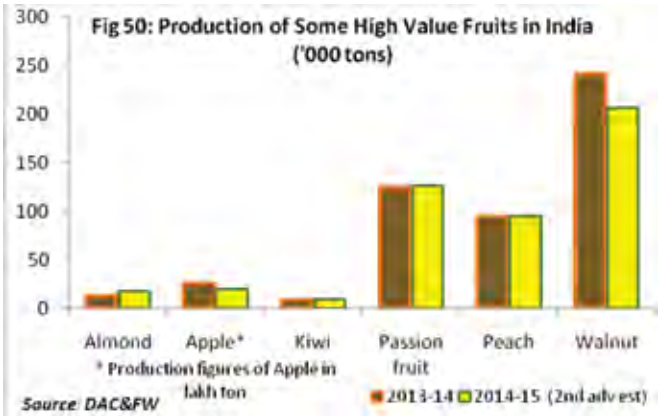
Horticulture Crops

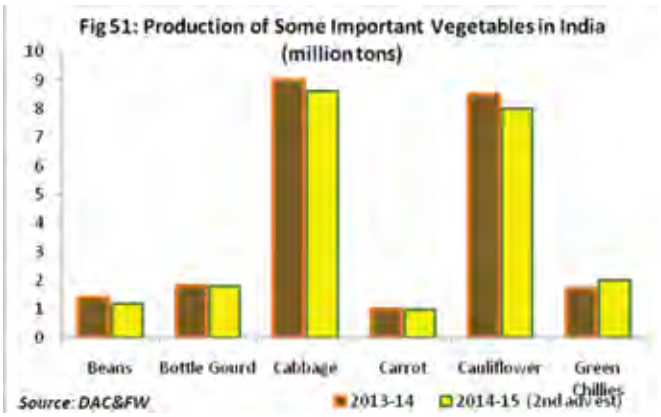
Fruits and Vegetables account for nearly 90% of the total horticulture production in the India (Fig 48). Being the global leader in production of several horticultural crops like Mango, Banana, Papaya, Cashew Nut, Arecanut, Potato, and Okra, on an overall scale combine both fruits and vegetables, India stands apart as the second largest producer in the world. Though Spices constitute about 2% of the total horticultural crops in the country, Indian spices are famous globally and being exported to many countries abroad. As a whole, the percentage share of horticulture output in agriculture has become more than 30%. Further, from a share of about 4% in the plan outlay for horticulture during Ninth Five Year Plan, it has increased to 4.6% during the Twelfth Plan, indicating at the increased significance and attention towards the sector.

India has witnessed dramatic









increase in horticulture production in the recent years. Significant expansion in total cultivated area under horticulture crops has taken place resulting in significantly higher production. In between 2003-04 and 2013-14, the area under horticulture grew by about 2.7% per annum and annual production increased by 7.0%. During 2013-14, the production of horticultural crops was about 283.5 million tonnes from an area of 24.2 million hectares. As seen in Fig 49, India produces a huge quantity of Fruits like Mangoes and Bananas. In 2014-15, India produced as much as about 1.8 and 3 million tonnes of Mangoes and Bananas respectively. India leads the world in Banana production with Brazil, Ecuador, China, Philippines, Indonesia, Costa Rica, Mexico, Thailand and Colombia as the other leading producers. India is also a major producer of good quality Grapes (about 4 lakh tonnes of production in 2014-15). India exports different types of fruits to the various countries, and Grapes occupy the premier position in exports. India exports as much as over 100 thousand tonnes of Grapes valued Rs 10865 million. Other fruits which have attained significant position in exports are Banana and Mango.

Amongst some of the high value fruits, India produced about 20 lakh tonnes of Apples in 2014-15 according to the second advanced estimates. About 99 percent of India's Apple area falls under the North Western Hills region. This includes 6 districts of J&K (Srinagar, Budgam, Pulwama, Anantanag, Baramullah, Kupwara), 6 districts of H.P. (Shimla, Kullu, Sirmour, Mandi, Chamba, Kinnaur) and 8 districts of U.P. (Almora, Nainital, Pithauragarh, Tehri, Pauri, Chamoli, Uttarkashi, Dehradun). India also grows considerable amount of Passion fruits, Peach and Walnut. In 2014-15, India produced about 126000 and 206000 tonnes of Passion fruits and Walnuts. Passion fruits have significant commercial use in the form of being consumed as juice and having important health benefits. It is mostly grown

Table 5: Production of Some Important Spices in India ('000 tonnes)

	2013-14	2014-15 (2nd adv est)
Cardamom	21	21
Dry Chillies	1492	1492
Cinnamon/ Bay Leaf (Tejpata)	5	5
Clove	1	1
Coriander	314	314
Cumin	514	514
Garlic	1252	1252
Ginger	655	655
Turmeric	1190	1190

Source: Spices Board, India

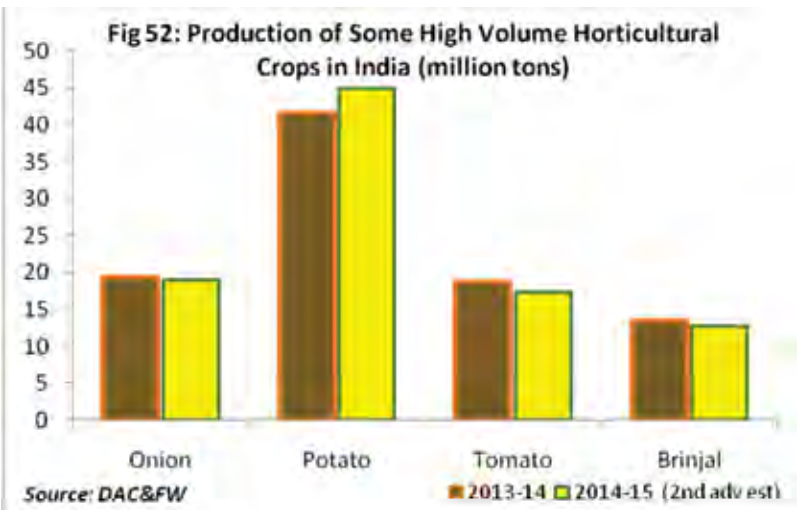
in parts of Western Ghats like Coorg, Nilgiris, Kodaikanal, Malabar etc. It is commercially grown in states like Himachal Pradesh, North Eastern states like Mizoram, Manipur and Nagaland. For Walnut, major growing areas include Jammu and Kashmir, Uttaranchal, Himachal Pradesh and Arunachal Pradesh, with Jammu & Kashmir occupying the largest share in total area and production. India exports Walnuts to countries like Germany, United Kingdom, Netherlands, Egypt Arab Republic and United States.

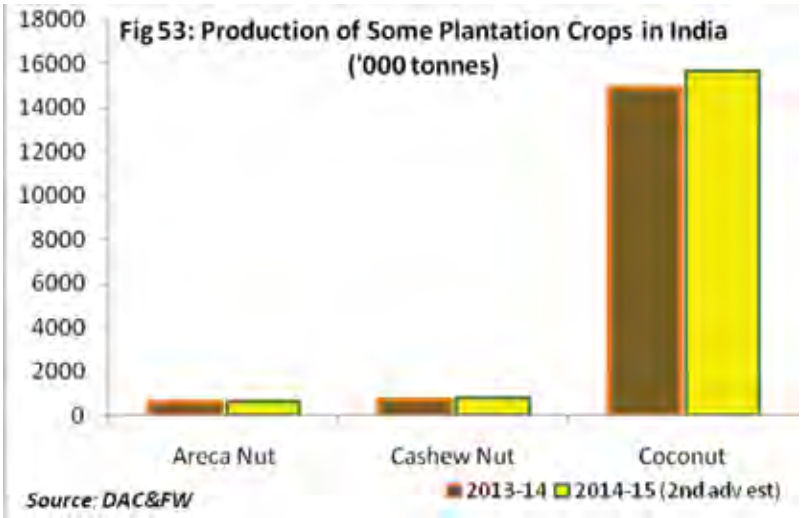
India produces about 18000 tonnes of high value Almonds. Indian Almond is quite distinct and is a native to SE Asia. Bearing fruits during winter,

Indian Almond is grown throughout the warmer regions of India, including Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, and Kerala. The tree also grows in West Bengal and other warmer regions in the North.

Production figures of some of the important and widely used Vegetables in India are shown in Fig 51. India produced about 17 tonnes of Cabbage and Cauliflower in 2014-15 (Cabbage: 8.6 tonnes, Cauliflower: 8 tonnes). Apart from this, it produced 1.2 tonnes of Beans, 1.8 tonnes of Bottle gourd, 1 tonne of Carrot and 2 tonnes of Green Chillies. West Bengal has remained as a major Vegetable growing state in the country for a long time with Uttar Pradesh being the other major Vegetable growing state. Apart from these two states, Bihar, Madhya Pradesh, Andhra Pradesh, Gujarat, Odisha, Tamil Nadu and Karnataka are also important Vegetable growing states in India.

India is the second largest producer of Potato in the world after China. In 2014-15, about 45 million tonnes of Potato was produced in the country according to the 2nd advanced estimates form the Government (Fig 52). In fact, India and China together contributes almost 30% to the global Potato production. States like Uttar Pradesh, West Bengal and Bihar are the major Potato producing states in India. If one crop has seen significant change in production trends between the past and the current times, it is Potato. Until the early 1990s, most Potatoes were grown and consumed in Europe, North America and countries





of the former Soviet Union. However, the demand and production of Potato in the developing countries kept on increasing consistently and in 2005, for the first time, the developing world's Potato production exceeded that of the developed world.

India, the second largest Onion producer in the world, produced about 19 million tonnes of Onion in 2014-15. Apart from Maharashtra, producing almost one third of the total production, States like Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana and Tamil Nadu also contribute towards Onion Production. India exported 1.2 million tonnes of fresh Onion worth Rs. 27474 million during the year 2015-16. Apart from Potato and Onion, India produced about 18 million tonnes and 13 million tonnes of Tomato and Brinjal respectively.

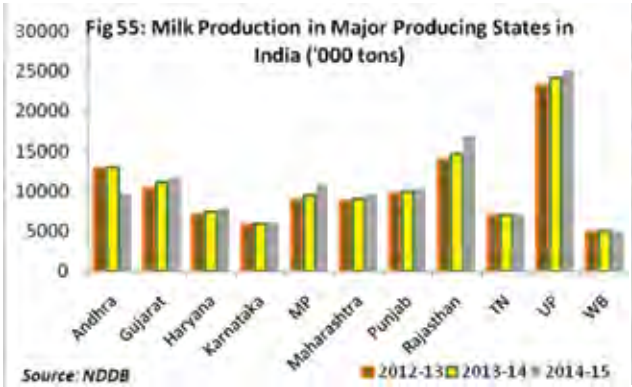
Amongst various Plantation crops, India is the third largest producer of Coconut in the world, following Indonesia in the first place and Phillipines in the second place. According to the second advanced estimates, total production of Coconut in India was about 16 million tonnes. Coconut is an integral component of India, both in terms of economy and also culture and tradition.

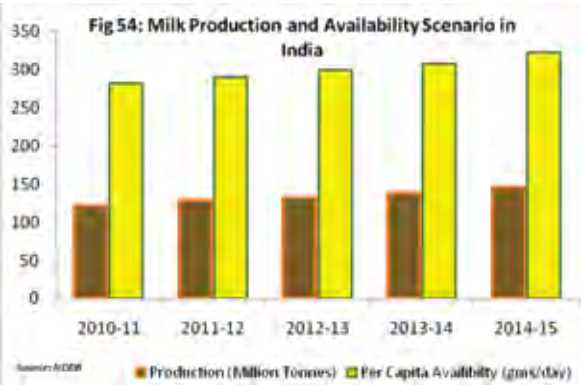
Other than coconut, India also grows Arecanut and Cashew Nut. In 2014-15, about 623000 tonnes and 789000 tonnes of Arecanut and Cashew Nut were grown in the country. India is the largest producer, processor and exporter of Cashew Nut in the world. It is interesting that Cashew was first introduced to India centuries back by the Portuguese, but it found the Indian soil more homely than its homeland.

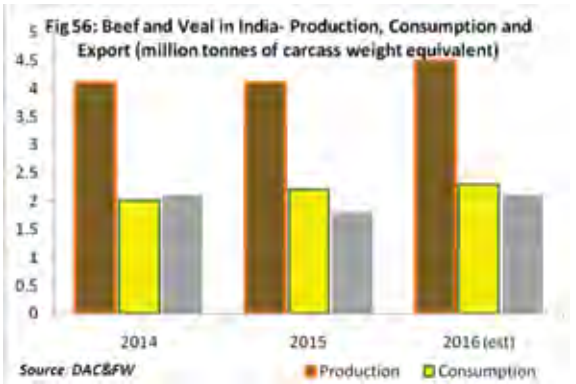
India is home to a number of spices. Indian cooking is characterised by the use of a number of Spices. Various states are home to some type of Spice or the other and as a whole, the country produces and also exports a number of Spices. The production figures of some of the important Spices in India in the recent years are given in Table 5.

Animal Husbandry

India has been reaping the benefit of "Operation Flood" achieved in the dairy sector of the country for quite a long time now. Indian dairy sector is poised for a major growth in the years to follow counting on the major investments including creating farm infrastructure for collection and storage of milk. Currently valued at about Rs 4 lakh-crore, Indian dairy industry has been attracting the attention of many corporate players and is expected to attract investments worth Rs 9,000-





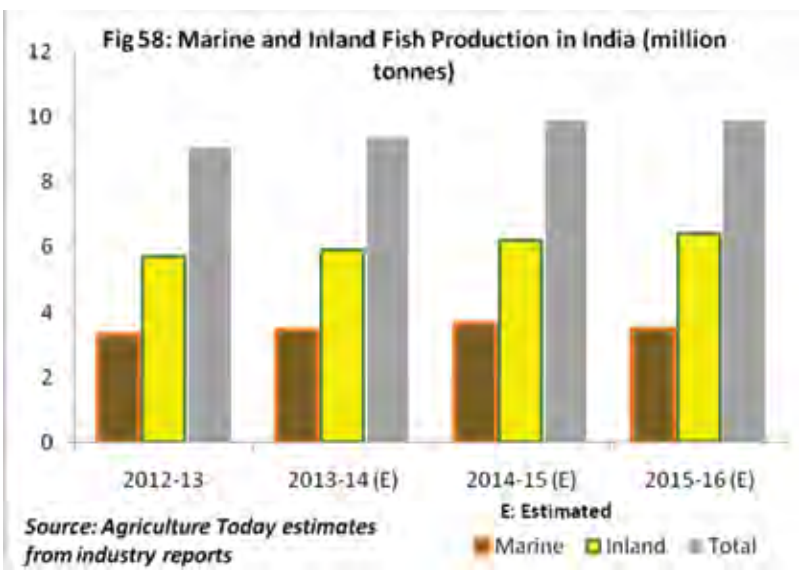


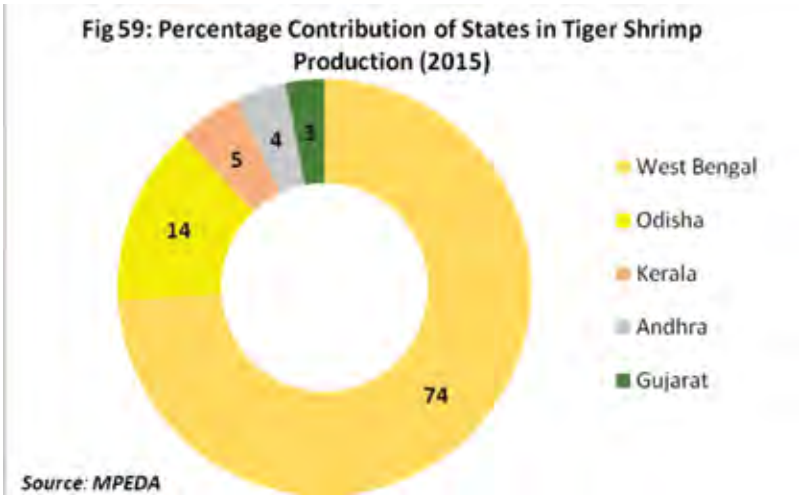
10,000 crore over the next few years till 2020. As seen in Fig 54, milk production in the country has been consistently witnessing growth in the recent several years. Milk production has witnessed growth every year since 2010-11, and in 2014-15, total milk production in the country was 146.5 million tonnes. As a result, per capita availability of milk in the country has also been witnessing growth. Per capita availability of milk in 2014-15 was 322 gms/day. However, given the inequitable distribution of food availability in the country including milk, it is difficult to say how much the poor and the underserved section of our population in the country is able to have access to milk.

A study of milk production by some of the major milk producing states in India reveals some significant trends (Fig 55). Among the leading milk producing states in the country, most of the states have been witnessing growth in milk production. Most significant growth among top milk producing states in India has been posted by states like Rajasthan and Madhya Pradesh in between 2012-13 and 2014-15. Milk production in Rajasthan increased by 21.4% from about 14 million tonnes in 2012-13 to about 17 million tonnes in 2014-15.

Madhya Pradesh posted an increase of almost 22% when its milk production increased from about 9 million tonnes in 2012-13 to almost 11 million tonnes in 2014-15. Uttar Pradesh remains the top milk producing state in India and in 2014-15, it produced 25 million tonnes of milk. Production in Gujarat witnessed over 13% increase from 10.3 million tonnes in 2012-13 to about 11.6 million tonnes in 2014-15. Production in Haryana in 2014-15 was about 8 million tonnes where as in Karnataka, Maharashtra, Punjab, Tamil Nadu and West Bengal, production was respectively 6 million, 9 million, 10 million, 7 million and 5 million tonnes in 2014-15.

India is a major producer and exporter of beef and veal in the world, indicating at the economic importance of beef and veal in the national economy including earning of valuable foreign exchange. Production of beef and veal is estimated to be about 4.5





2012-13, a total of 3.32 million tonnes of marine fishes were captured and traded in the country. The quantity of inland fish produced in the country in 2012-13 was 5.72 million tonnes. The total fish production in the country is estimated to have increased to 9.36 million tonnes in 2013-14 in which 3.44 million tonnes was marine fisheries and 5.92 million tonnes were inland fishery. In 2014-15, the total fish production in the country was estimated to be 9.86 million tonnes (3.66 million tonnes of marine and 6.2 million tonnes of inland fish). In 2015-16, the estimated total fish production was 9.88 million tonnes out of which 3.48 million tonnes was marine and 6.4 million tonnes from inland fisheries.

India is also a major producer of shrimps and prawns. During 2014-15, total production of tiger shrimp was about 73 thousand tonnes, whereas the contribution of Vannamei shrimp was about 353 thousand tonnes.

According to the figures from Marine Products Export Development Authority (MPEDA), West Bengal leads the show in tiger shrimp production, registering 73 per cent, followed by Odisha (13.77 per cent), Kerala (4.98 per cent), Andhra Pradesh (4.04 per cent) and Gujarat (2.98 per cent). In Vannamei shrimps, it was Andhra Pradesh emerging as the leader. ■

million tonnes in 2016. In the last two consecutive years in 2014 and 2015, the total production was 4.1 million tonnes in each year. Consumption of beef and veal in India has increased by small margin in the last three years. From 2 million tonnes in 2014, the production is estimated to increase to 2.3 million tonnes in 2016. The remaining quantity after domestic consumption is exported to various countries. In 2015, beef export recorded a small decline as compared to 2014, from 2.1 million tonnes in 2014 to 1.8 million tonnes in 2015. However, according to estimates of 2016, export of beef and veal in 2016 is going to increase to 2.1 million tonnes.

India is also a significant producer of broiler meat. In 2015, India produced 3.9 million tonnes of broiler meat and is estimated to produce about 4.2 million tonnes in 2016. Average farm gate broiler realizations for 2015-16 at around Rs67/kg were similar to the previous year's. India's per capita consumption of poultry meat is estimated to be around 3.1 kg per year, which is low compared to the world average of around 17 kg per year.India's per capita consumption of eggs is estimated at about 62 eggs per year. States like Andhra Pradesh, Tamil Nadu, Kerala, Goa, Karnataka, Punjab, and West Bengal are the largest chicken meat consuming states. Major growth drivers of Indian poultry industry are rising middle class incomes, more international exposure due to travel and coming up of quick service restaurant chains. All these are keeping up the demand for chicken meat and processed chicken meat. Many consumers prefer poultry meat over other animal protein due to its relatively lower price. Moreover it is the most ubiquitously accepted meat product and acceptable to different ethnic groups having cultural and religious prohibitions for eating pork, water buffalo meat and beef.

Fig 58 provides an overview of marine and inland fish production in India. Inland fish production is more than the marine capture of fish and in

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WESTERN ARID/SEMI ARID ZONE: A BOON OR BURDEN FOR NATION

Productivity potential of any system depends not only on yield but can also be valued for quality.Potential expression is noticed under most favorable resource sufficient system. Resource sufficient/efficient in Agriculture means, ready availability of water, healthy soils having desired nutrients in available form with high carbon, conducive non-fluctuating diurnal temperature and optimum humidity favoring plants unstressed growth to deliver potential yield in general. Indian sub-continent is one of the most diverse agro-ecosystems in the world with climatic conditions varying drastically from North to South and East to West. The *Indo-gangetic* plains considered as one of the most resource rich regions have contributed immensely to green revolution with respect to Wheat and Rice production and made us self-sufficient in food grains.

On the contrary, in the country the western hot arid eco-region designated as zone 2.0 under the national agro-ecological classification, bags hot deserts of sandy and saline soils poor in organic carbon content and low moisture retention capacity resulting in poor productivity potential for yield. The climatic condition of the region is also harsh accounting for highest summer temperature and lowest winter temperature. All these factors cumulatively offer challenging situation for sustainability of agriculture as a whole in the harsh arid/semi-arid zone of the country. But it's a matter of fact that nature offers the best for humanity. Agriculture is more of a regional subject than a national perspective; local crops, cultivation practices, food habits, social environment etc. have evolved over time suiting the best to the need of all living forms in an eco-system. Arid/semi-arid eco-system is characterized by mean annual rainfall less than 400 mm annually; water deficit condition is the most challenging issue to cater to green cover need over the yellow blanket of sandy desert. But to meet the challenge, agro-biodiversity of the zone harbours crops which need less water may it be trees, shrubs/herbs, field crops or horticultural plants of high qualitative value.

Agriculture has become more of an enterprise than mere livelihood means for survival, crops which are cultivated for meeting livelihood need in hot arid zone can deliver high profit for living healthy life. Though commodities like Cumin and Isabgol hold pre-dominant positions in arid zone agriculture, the risk incurred in their cultivation is high for getting a successful harvest. Hence, durable crops having minimum risk of failure which are adapted well to the zone should be focused. The present article is about the status and future of arid/semi-arid zone for sustainability of resource deprived farmers living on lands with one of the harshest environments

Table 1. Area of different crops in arid & semi-arid region

Crop	Area (ha) of different *kharif* crops			Crop	Area (ha) of different *Rabi* crops		
	AUJ jurisdiction	State	% of State		AUJ jurisdiction	State	% of State
Bajra	18,69,230	40,76,909	45.8	Cumin	3,80,767	4,34,783	87.6
Guar	9,73,870	46,25,206	21.1	R & M	2,91,578	24,33,778	12.0
Moong	5,68,850	8,93,947	63.6	Isabgol	2,63,054	3,55,595	74.0
Moth	4,53,627	8,68,914	52.2	Wheat	2,62,287	33,18,248	7.9
Jowar	2,86,699	6,60,969	43.4	Gram	47,174	12,56,323	3.8
Castor	2,20,187	2,26,336	97.3	Henna	41,799	41,809	100.0
Sesame	2,12,962	3,29,905	64.6	Onion	26,753	61,363	43.6
G'nut	1,41,050	5,00,824	28.2	Barley	16,422	3,43,302	4.8
Cotton	1,20,685	4,86,552	24.8	Taramira	17,438	40,604	42.9
Maize	36,764	8,91,457	4.1	Fennel	12,254	15,561	78.7
Chilli	2,297	9,671	23.8	Garlic	3,392	50,156	6.8

for performing agriculture as routine or business.

Focused Approach for Arid & Semi-Arid Zone:

To emphasize the research and development of the arid/semi-arid region,Government of Rajasthan has established an Agriculture University at Jodhpur in the recent past, the jurisdiction area under it covers six districts viz., Jodhpur, Pali, Sirohi, Jalore, Barmer and Nagaur; signifying net representation of the State's geographical area- 28.2 %; *kharif* crops 33.2 %, *rabi* crops 18.7 %; population 21.1 % and livestock 29.3%. Technology needed for the zone is very specific with respect to crop, cultivation practices, post-harvest management and marketing. Agriculture University can play a vital role in delivering situation based packages for sustainable and profitable farming in arid and semi-arid situations. Varietal need of the zone is very specific, early genotypes with low input requirement having high resistance to abiotic and biotic factors should be developed or identified. Arid plants are molecularly wealthy for genes conferring

resistance against salinity, heat, cold, drought etc., therefore, an insight into the genome inventory will provide valuable sequences for generating GM crops of future or climate resilient varieties. Microbial biota of the zone is least exploited for its diversity and use in agriculture.

Leading crops of the zone: Predominantly Rainfed farming is the most important cultural practice in Western India, mainly due to poor availability of quality irrigation water. Hence *Kharif* crops are planted to the maximum potential of cultivable land available in the zone. In terms of ranks marked on basis of highest share in the State, Castor is first (97.30 %) followed by Sesame (64.6 %), Mungbean (63.6 %), Mothbean (52.2 %), Bajra (45.8 %) and Jowar (43.4 %) in *Kharif* season. Whereas, in *Rabi,* Henna stands alone in state with 100 % followed by Cumin (87.6%), Fennel (78.7%), Isabgol (74%), Taramira (42.9%) and Onion (43.6%). Account of few crops like *Nagaurimethi*, Kair (*Capparis decidua*), Khejari (*Prosopis cineraria*), Kumut (*Acasia Senegal*), lasora (*Cordiamyxa*), Kachari (*Cucumiccallosus*), Tumba (*Citrullus colocynthis*) etc. are also major cultivated crops from the zone. These crops are cultivated largely in the

arid/ semi-arid pockets only, which makes the zone prominent over others for dominating at domestic as well as international market.

Potential of Under exploited or Neglected Crops: The specific environment of arid/semi-arid zone harbours crops of high trade value but are neglected due to numerous reasons. Dill (*Anethum* spp.) is cultivated mostly in the zone on conserved moisture.It is an important aromatic seed spice having high medicinal value. Recent studies in India have quoted the active ingredient dilapole in it as an effective insecticide, and Indian *Sowa* is rich in dilapole compared to European species *graveolens*. The share of Chilli in the State from the region is nearly 23.8 %, showing high adaptability of the crop in the zone and among farmers. But the most important land race of the region *Mathania* Chilli, the one which can bag high profit due to its preference for making specific recipes, pickles etc., is extinct. Fenugreek and Fennel are cultivated mostly in Rajasthan state; the zone has tremendous potential to provide quality produce under limited water availability.

New crops for diversification in the zone: Anise (*Pimpenell aanisum*) is a seed spice which can suit well under Semi-arid climate, the water requirement of the crop is less and yield potential is an average 8-10 quintals. It is less susceptible to diseases and pests and being a *Rabi* crop it can be raised in calculative manner with defined ratio along with cumin to compensate the risk factors incurred in cumin cultivation. An assured agriculture farming system is the need of the hour, therefore research on fitness of anise in the zone and along with short stature crops like Cumin and Isabgol should be worked out. Quinoa(*Chenopodium quinoa*) is a species of Chenopodium genus cultivated largely in Western world mainly South America, Africa for its low caloric grains. It has been introduced in the zone and due to low risk and assured return is gaining popularity among farmers.A preliminary evaluation of another new crop, Chia (*Salvia hispanica)*has been found to be promising under arid and semi-arid regions.

Trade Value Unexplored: The products which are derived by the specificity of the region can be marked with a trade name. *Nagauri methi* is a brand name sold in the market by vendors, but no GI (geographical Indication) is claimed for it for the benefit of farmers as a whole. Similarly, other commodities that can come under the registration of GI are *Mathaniya mirchi (chilli)*, Barmer cumin Nagauri Methi etc. A community based approach for delivering traded products directly from farm to table will give maximum profit to basic stakeholders of arid/ semi-arid zone.

New Research Initiatives started by Agricultural University, Jodhpur for Strengthening Agriculture needs of the Zone: Agricultural depends largely on inputs provided on time. Seed is the basic entity for culturing crops for business. Quality seed production is the most crucial element in pursuing healthy and profitable agriculture. The timely availability of quality seeds to the farmers is scanty. Looking at the needs,AU, Jodhpur emphasized upon quality seed production of pre-dominant crops like Cumin, Mungbean, Sesame and all important crops cultivated in the zone for which the farmers have to depend upon other agencies.

Interestingly, hybrid Bajra seed production is taken up in southern parts of the country and farmers depend mostly on private players. Bajra is the main crop of the zone and taking up seed production in cultivated area is not innovative, it needs only focused approach and planning. *Prima-facie* producing Bajra seed in Southern India has been challenged by the AU, Jodhpur Scientist in the summer months of 2016 by successfully producing 65 quintals of hybrid seed of cv. MPMH-17 from an area of only 6 ha. Likewise, all Research Stations and KVKs are directed to produce quality seed at the maximum with available resources to meet the regional demand.A start on the line of meeting the crucial input need of seed will definitely add to enhance the productivity of the zone in the coming times. ■

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Andaman and Nicobar Islands Agriculture
Perspective and Strategies

Dr. S. Dam Roy, Director
Dr. Awnindra K.Singh, Sr.Scientist and
Dr. Divya Parisa, Scientist
ICAR-Central Island Agricultural Research Institute
Port Blair, Andaman & Nicobar Islands

Andaman and Nicobar islands is an archipelago of 572 islands, islets and rocks which extend from landfall in the North to the Great Nicobar in the South. These pristine islands are located 1200 km away from the mainland India and are much closer to some of the South East Asian countries. Being close to the equator these islands enjoy a true maritime climate with very little difference between the maximum and minimum temperatures and about 3100 mm of rainfall is received annually through South-West and North-East monsoon over a period of 8 months. The general topography of the Andaman and Nicobar Islands is undulating with hill ranges enclosing narrow valleys while the Nicobar group of Islands are relatively plain. Though these islands are endowed with rich land resources for agricultural development sensulato smallness and remoteness all along constrained its development on the same scale as in mainland.

The agricultural sector of these Islands as a whole includes, plant, animal and fisheries components. The contribution of primary sector (crops, livestock, fisheries, forest logging) to island GDP is 9.2% and the rest comes from service (mainly) tourism and industry sectors. Agriculture plays crucial role in economic development. Increase in agricultural productivity is not only important for supporting increasing population, but also an essential condition for Island economy to pursue industrialization.

Food security is particularly important for a small, isolated island economy where a stable supply of food is often interrupted by natural disasters such as drought, floods, tsunami and unexpected environmental changes. Quite often, for these small islands, domestic food supply is the last resort for survival when natural disasters occur. Increasing food imports at the expense of traditional food supply have been major issues from food security and nutritional stand points. It may be prudent that the existing research and technologies may be geared up to meet the ever increasing food demand of Island population. There is an urgent need for improving the scientific understanding and the ability of the farming communities for taking further adaptive action that could lessen the economic and environmental impacts of agriculture sector in these islands.

An underutilised legume Vigna marina

Demonstration of pulse cultivation in tribal tracts

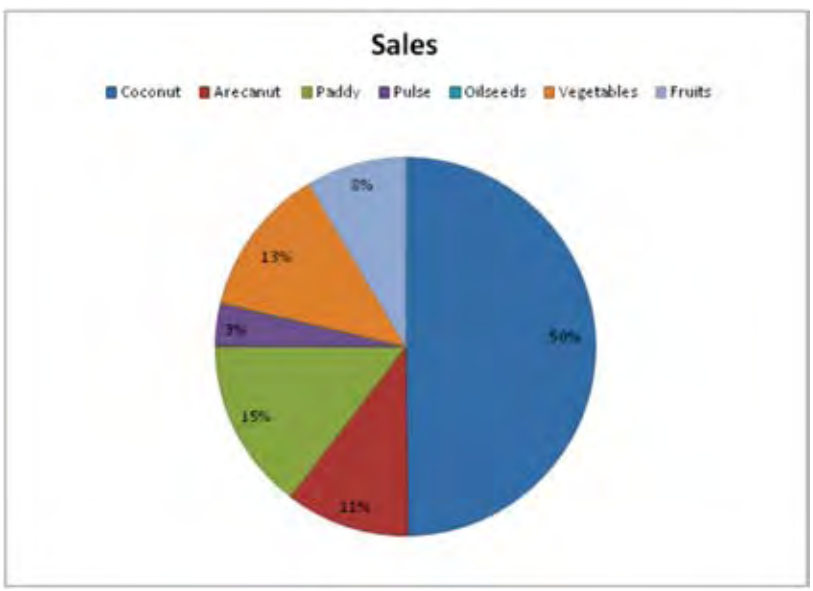
Agricultural sector in the Islands

The major field crops under cultivation include Paddy, Pulses, Maize and Oil seeds which cover an area of 6434.6 ha, 1575 ha, 167 ha and 36 ha respectively. Paddy *(Oryza sativa)* is the staple grain crop of islands. Besides the cultivated species *Oryza indandamanica*, Ellis is another species reported from the islands. ICAR-CIARI has recently documented and characterized and facilitated PPV-FRA registration of six unique rice landraces of Karen community in Middle Andaman. ICAR-CIARI has developed and released several varieties of rice like CARI Dhan-1, CARI Dhan-2, CARI Dhan-3, CARI Dhan-4 (salt tolerant variety), CARI Dhan-5 (salt tolerant variety), CARI Dhan-6, CARI Dhan-7, CARI Dhan-8 and CARI Dhan-9 suitable for cultivation in the rainfed lowland areas of A&N Islands.

Regarding Pulse crops except Pigeon pea, other pulse crops such as Mungbean, Urdbean, Chickpea etc. are grown as rabi crops. The area under pulses is about 1575 ha with an annual production of 844 MT. The native people are intimately associated with the cultivation of Mungbean, Urdbean, Cowpea and Pigeonpea landraces and dune vegetation like *Vigna marina* (possess salt tolerance genes), *V.heritiella, Canavalia rosea etc.* Several varieties of pulse crops like CIARI Mung-1 (ANM-11-12), CIARI Mung-2 (ANM-11-05) and CIARI Mung-3 (ANM-11-07-2) are the varieties of Mungbean identified for cultivation in A&N islands. Few collections from the islands were found to out-yield the regular checks in Mungbean and Urdbean. Oilseed crops grown in the islands include Sesame, Groundnut and Mustard which cover an area of 36 ha and production of 15.4 MT.

Horticulture Scenario of the Islands:

The horticulture based farming system occupies about 70% of total cropped area and is the predominant source of income in island agriculture. It also serves as major source of dietary microelements for settler and tribal communities. Many of the tuberous and leafy vegetable, and wild fruits are among the staple diets of indigenous tribal communities. Local medicinal plants are still part of traditional health system in Islands. Two major cropping systems viz. Coconut and Arecanut based cropping system in the upland areas, and Paddy and Vegetables in the lowland areas are practiced by the island farmers. Most of the horticulture crops being associated



Percent area distribution under different agricultural crops in Andaman and Nicobar Islands

Export and import of Fish in Andaman and Nicobar Islands

S. No	Name of the item	Export(In tonnes)	Import (In tonnes)
1	Tuna chilled and frozen fish	1631	0
2	Prawn	0.15	0
3	Lobster	2.107	0
4	Crabs	58.895	0
5	Shrimps (in Lakhs)	49.5	0
6	Shark fins	0.230	0
7	Shark flesh	10.348	0
8	Dry fish	4.314	0
Total		1756.544	0

with the socio-economic conditions and traditional preferences, their consumption pattern is highly varied amongst the communities. Unfortunately, the productivity of horticultural crops in islands still remains near to stagnant over the years. But the demand has increased manifold due to increased population and tourist inflow. Resultantly, islands are facing scarcity of locally grown horticultural products, and depend for many Fruits and Vegetables from mainland. Transfer of technology by ICAR-CIARI with regard to various interventions like horticulture based cropping system, protected cultivation technology, broad bed furrow system, grafting techniques, coconut based silvi-pasture system, Gliricidia-alley cropping system, micro-propagation and macro-propagation techniques for minor fruits and medicinal plants have strengthened the horticulture sector in these Islands.

Fish farming

Freshwater aquaculture plays a very important role in livelihood of local communities. About 14839 licensed fishermen are engaged in fishing activities. The fishing fleet comprises of 1510 traditional, 1352 motorized traditional crafts and 68 small mechanized boats. Indian major Carps, Catfishes and freshwater Prawn mainly contribute to total fresh water fish production in these islands. On an average, island produces about 100-120 t/ year of fresh water fishes. At present, the Island consists of 1870 minor irrigation ponds with total water spread area of 114.35 ha used for pisciculture purpose and 367 ha of reservoir area (7 numbers). The main fish culture areas are concentrated in Port Blair, South Andaman (488 ponds, 26.13 ha) and in Diglipur, North Andaman (473 ponds, 29.87 ha). Though fresh water aquaculture has been practiced by farmers of Andaman and Nicobar Islands from the days of early settlement, scientific methods of fish farming and the availability of quality seeds (spawn, fry and fingerlings) are the main problems hindering the development of aquaculture in these islands. ICAR-CIARI has successfully demonstrated the composite fish culture technologies in which rearing of group of cultivable fishes with different feeding niches and living in different strata in order to obtain high production per unit of area is a viable option for development of potential entrepreneurs as well as to satisfy the demand of freshwater fishes in Andaman.

Livestock farming:

In Andaman and Nicobar Islands, livestock is one of the mainstays of

Cultivable candidate species for aquaculture in Islands

Marine	Brackish water	Fresh water
Crompileptes altevelis	*Lates calcarifer*	Indian major carps (Catla, rohu and mrigal)
E.malabaricus	*Liza sp.*	Chinese carps (silver carp, common carp and grass carp)
Rachycentron canadus	*Penaeus monodon*	Cat fishes (Magur and singhi)
Lobsters, mussels and shrimps	*Etroplus suratensis*	Fresh water ornamental fishes (Gobies, Channa sp.)

Demonstration of fish seed packaging

Fresh water ornamental fishes (Gobies)

the economy. The livestock farming in Andaman and Nicobar Islands is done on the areas that have been cleared from the forest regions of the islands, which have dense vegetation growth of rain forest. Although the total percentage of lands that are used for livestock is small, in some areas of Andaman and Nicobar Islands, livestock thrives despite harsh conditions. The native breeds of the Islands like Frizzle fowl, Nacked neck, Nicobari fowl, Nicobari pig, Teressa goat, Feral (Barren Island) goat (Feral depends on sea water and prefers 1:4 fresh and sea water for drinking), Andaman local goat, and Trinket cattle are some of the indigenous breeds which were found to have disease tolerance against some of the prevailing diseases in the islands. Apart from the indigenous breeds several introduced breeds of duck like khaki Campbell, Peckin and Chara Campbell and introduced breeds, of poultry like Japanese Quail, Guinea fowl, Broiler, Turkey are performing very well under the island conditions. The introduction of these breeds by ICAR-CIARI and standardisation of technologies for successful poultry farming under Island conditions contributed immensely to the empowerment of tribal and women of these islands.

Statistics of milk and egg production during the year 2014-15

S.No	Item	Production
1	Cow milk (Indigenous) (Ton)	4535
	Exotic & Cross bred (Ton)	8061
2	Buffalo (Ton)	1707
3	Goat (Ton)	1371
4	Egg (No. in Lakh)	918.52

Feral goat of Barren Island

According to the 2012 livestock census, total cattle population is 45,625, buffaloes are 7,863 in number, goat population is around 65,324, pigs are 35,921 in number and total poultry accounts to 11,65,223.The demand for milk and egg is more in the urban areas, therefore plenty of opportunities exist for carrying out intensive dairy development activities in the Islands.

Opportunities for Strengthening Agriculture in the Islands

- Andaman and Nicobar Islands

is bestowed with a highly suitable environment for the development of horticulture and plantation crops.

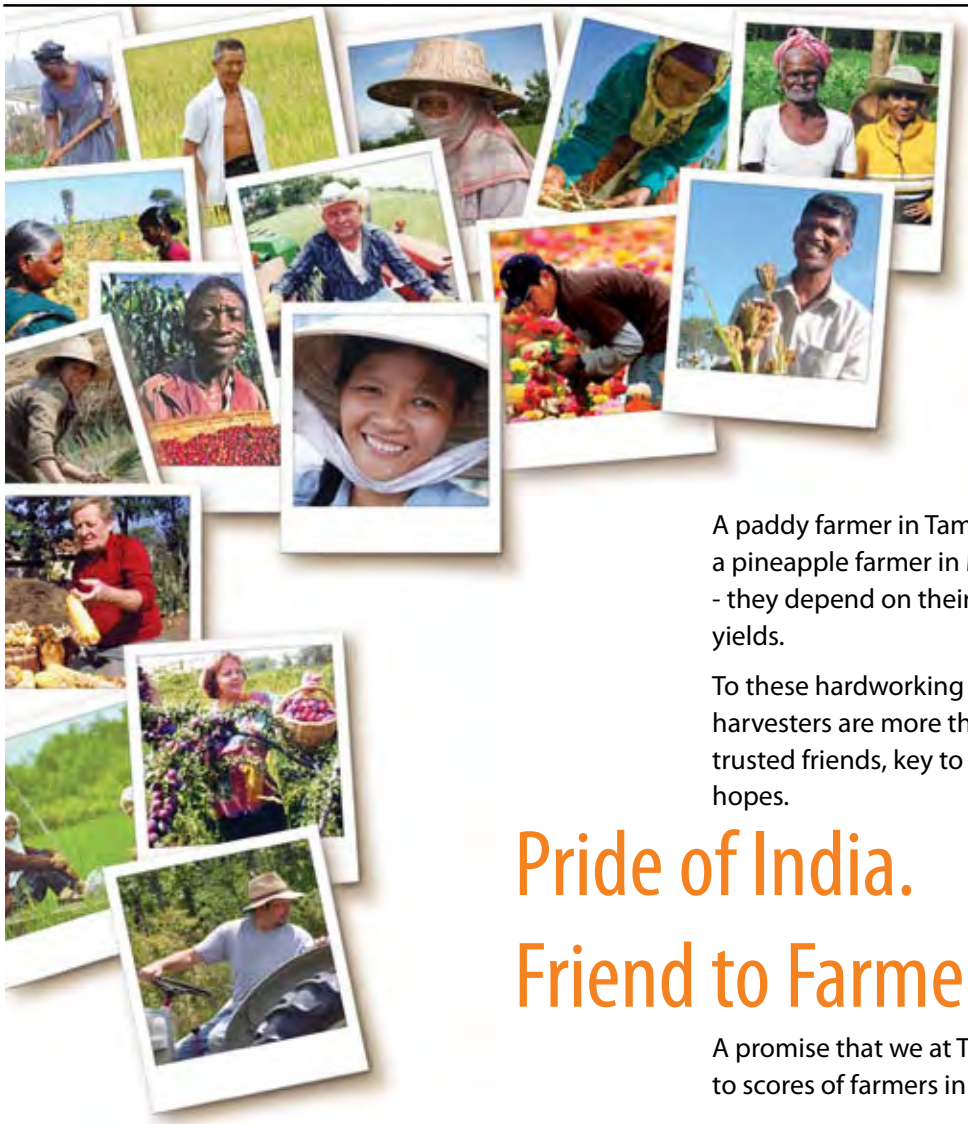
- Tapping the underutilised/under exploited wealth of marine and horticulture resources
- There is a great scope for developing food processing, fish processing and related industries.
- Consumer demands for fresh, local foods have increased markedly. Farmers are finding new and profitable ways to aggregate their farm products and brand and market products as locally grown.
- There is a huge potential for organic cultivation of spices, coconut, tropical fruits, high value vegetables and fine quality rice varieties.
- Farmers can be given access to attractive markets through value added and certified products which enables the Island farming community to get premium price for their produce.

Challenges for Island agriculture

- Geographical isolation of farms and people
- 85% of the land is under reserved forests
- Shrinking agricultural land holdings
- Growing food demand
- Lack of availability of infrastructure facilities like cold storage, refrigerated transport trucks, etc. which are beyond the individual investment of cultivators.
- Marketing intelligence is practically negligible in the islands and hence the present and future trends need for product diversification is realised very late.
- The production units are small and scattered, and have no proper linkages between the producers and marketers.
- Climate change is inevitable and being experienced across the globe but the vulnerability of the Islands is much more severe.

Future Strategies for Development of Agriculture in the Islands

The agricultural development in habituated island requires, proper planning with consideration for the fragile ecosystem. The geographical isolation and import depending phenomena further attract more attention of policy makers to upgrade local population base with suitable technological interventions. The primary concern in these territories is towards proper use of resource base in sustainable manner. Most of islands have climatic conditions favouring rich biodiversity of flora and fauna. Therefore, efforts need to be taken for sustainable exploitation of these resources. Encouraging hi-tech interventions in agriculture with assured supply of inputs and post harvest management is potential area for enhancing island agricultural productivity. For this emphasis on infrastructure development, integrated farming system, crop diversification, pest management and improvement of existing plantation are required. Besides, there is urgency to promote the systems through which input requirements can be met with locally driven materials. The agricultural growth needs to be stepped up to achieve livelihood security for ever increasing population under the changing climate situation. There is a need to evolve sustainable strategies for augmenting production through on farm and off farm activities. Integration of different agricultural activities based on resource endowment and constraints of different islands, it is possible to improve the farm production as well as employment opportunities of the individual households, thus ensuring rural prosperity and agripreneurship to the next generation of the Islands.■



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Agriculture and Horticulture in Indian North-Western Himalayas:

Status, Constraints, Interventions for Upscaling and Future Thrust Areas

The Indian North-Western Himalayan region (INWH) spreads to an approximate area of 33.13 million ha, comprising of Himachal Pradesh (HP), Jammu & Kashmir (J&K) and Uttarakhand (UK), which is 10% of country's total geographical area. Due to hill and mountainous topography, INWH differs from plains in respect to weather and soil parameters, biodiversity, ethnic diversity, land use systems and socio-economic conditions. It exhibits a diverse climate, topography, vegetation, ecology and land use pattern. The region's major natural resources are water, forests, floral and faunal biodiversity. The Ganga river basin, supporting 43% of India's population, originates from the region. INWH itself supports India's 2.4% (29.5 million) human and 3.7% (18.8 million) livestock populations. Region's population mainly (76%) lives in rural area. Agriculture and allied sectors are backbone of INWH and provide direct employment to about 70% of work force and contribute 14% to 17% of total GSDP (agriculture and livestock) of HP and J&K states, respectively. Net sown area constitutes second largest land use in J&K and Uttarakhand. In HP, 25% area is under non-agricultural uses. HP has sizeable area (33%) under permanent pastures and grazing lands. In INWH, the area under permanent pasture is 13%, which is a great support to livestock production system. Out of the net sown area of INWH, 62% is rain dependent, with lowest percentage of irrigated area in HP (19.7%), despite abundance of water, due to limited scope of irrigation. The annual average rainfall in INWH varies from 80 mm (Ladakh) to over 2000 mm (some parts of

HP and Uttarakhand).

The average size of land holding varies from 0.62 ha (J&K) to 0.99 ha (HP), which is less than national average (1.15 ha). Though INWH is thinly populated, actual pressure on agricultural land is high since net cultivated area is low (average 9.5%). Thus, land holdings are small, and also fragmented. Over time, proportion of small and marginal farmers out of total farmers has increased - it ranged from 87% to 94% in 2005-06; it increased to 88% - 99% by 2010-11. As a result, proportion of total cultivated area owned by marginal and small farmers, which ranged from 52% to 70% in 2005-06, became 54% to 73% in 2010-11. However, INWH states are quite ahead of India (138.7%) in terms of cropping intensity, which ranges from 155.6% (J&K) to 176.6% (HP). Agriculture being a livelihood source for majority of people of INWH, land is intensively used. However, due to various natural and human reasons, productivity is below the national average.

The INWH has a niche in horticultural crop cultivation. The area under fruit crops in the region accounts for 10.1% of total area under these crops in India. The agro-climatic conditions of INWH are suitable for growing high quality temperate to sub-tropical fruits, vegetables, spices,flowers and honey, which have commercial significance besides distinct nutraceutical and medicinal properties. The region also has advantage for cultivation of off-season vegetables and flowers. Contribution of INWH to national fruit basket is, however, only 4.1% as cultivation is at a small scale. The productivity of fruits is low, considering range of niche available for their cultivation. INWH accounts for only 3.7% of the total livestock population of India. However,

animal husbandry is an integral part of hill agriculture, as it is required for various purposes – milk, meat, wool, fur, hide, manure and transportation. Livestock rearing is mostly with open grazing system. Dependency on forests and commonly owned grazing lands is very high.

Over-exploitation of natural resources has resulted in severe land degradation problems and paradoxical water scarcity under plenty availability. Soil erosion by water (> 10.0 t ha-1 yr-1) is a major problem in INWH. Uttrakhand has highest area (21.19%) under water erosion followed by HP (17.76%) and J&K (9.14%). Soil loss tolerance limit (T-value) varies 2.5 to 12.5 t ha-1 yr-1 depending on soil depth and soil resistance to erosion. The areas where prevailing erosion rate is more than permissible limits need to be addressed on priority through appropriate conservation measures for bringing the erosion rate within permissible rate. In INWH, highest area under priority class 1 is in Uttrakhand (4.34% of TGA) followed by HP (0.91% of TGA). The highest area under priority class 2 also falls in Uttrakhand (29.30% of TGA) followed by HP (15.21% of TGA) and J&K (7.01% of TGA).Impact of water erosion in terms of production losses in rainfed Cereal, Oilseeds and Pulse crops indicated that UK contributes 44%, 88% and 74%, respectively to total losses in INWH followed by HP and J&K, and 45% to losses from all these crops together. A similar trend exists in monetary losses.

On the whole, the dominant features of farming in INWH are small and fragmented land holdings, poor water management and lack of irrigation, coupled with poor water harvesting, non-availability of proper pesticides, low level of mechanization, non-availability of marketing infrastructure, sloping marginal farmlands, poor socio-economic conditions of farmers, wild animal menace (monkeys, boars etc.) and cultivation under rainfed farming.

Paddy and Wheat are main crops of INWH, besides Maize in HP and J&K, and Millets in Uttrakhand. Vegetables, Pulses and oilseeds are also cultivated. During 2003-04 to 2012-13, the production of Paddy, Wheat, all cereals and all oilseeds increased by 7, 13, 9 and 15 percent, respectively

due to increase in productivity, which more than compensated for decrease in respective area ranging from insignificant to 5%. Production of Maize and coarse cereals declined by 9% and 8%, respectively due to fall in area (5% and 6%, respectively) as well as productivity during the same period. On the other hand, production of Pulses increased by significant 91% due to 22% increase in area along with productivity. However, during following period of 2012-13 to 2013-14, production of all, except Maize (3% increase), decreased ranging from 1% to 8% due to decrease in area and productivity.

Available Interventions that Need to be Up scaled

- Develop and popularization of varieties and augmenting of seed production.
- Biotechnology
- Harnessing full potential of improved varieties.
- Soil fertility maintenance.
- Promotion of organic agriculture.
- Real time Nitrogen management in basmati rice varieties.
- Water Resource Development.
- Promotion of easy to purchase and carry improved and small agricultural tools and machines.
- Implementing Plant Protection.
- Develop technology for fodder production from dual-purpose Wheat.
- Popularization of alternative cropping systems.
- Popularization of integrated technology for eradication/ control of *Lantana camara* and other obnoxious weeds.

Future Thrust Areas for Research and Extension for INWH

- Climate Smart Agriculture
- Molecular profiling and allele mining in major hill crops for marker-assisted selection (MAS) for higher grain yield, bio-fortification of crops for micronutrients, QTL mapping for agronomic traits, disease resistance and quality traits.
- Molecular characterization and registration for Geographical Indicators for niche crops.
- Application of GIS-based digital evaluation models and other tools for precise measurement of resource base.
- Adoption of farm mechanization at larger scale for reducing operation time and higher cropping intensity.
- Refinement of value addition and other post harvest technologies.
- Improving crop productivity of rainfed areas through integrated farming system models and improvement of water productivity.
- Development of IPM models for different crops.
- Developing affordable micro irrigation/fertigation techniques.
- Mechanism for increasing seed replacement rate.
- Establishment of packaging centres and small/large scale value added industrial units for processing of agricultural

produce.

- Techniques/Mechanisms for wild animal menace.
- Development of suitable varieties for inter/mixed/strip cropping, especially pulses.
- Mechanism for inclusion of locally grown traditional cultivars.
- Delineation of GPS based soils major/micro nutrient deficiency and development of area specific soil test based fertilizer recommendations for different crops.
- Micro-organisms efficacy evaluation in different crops.
- Development of agro-techniques for recycling of farm wastes in crop production.

Horticulture Sector

Area under fruits in INWH increased by 10% (2010-11 to 2013-14), but productivity, over the period, fell in all the three states (HP -31%, J&K -14%, Uttrakhand -1%), and consequently production fell by 9% as the states recorded a fall ranging 6%-16%. Area under vegetables increased marginally by 1% during the period as decline in J&K (-9%) was offset by increase (3%-8%) in other two states. In terms of productivity, only HP recorded an increase (3%), while other states suffered decline in productivity ranging 1%-4%. As a result, the region incurred a negligible fall in production

(-0.4%). Flowers recorded tremendous three times area increase in J&K but other two states experienced reduction (7%-9%) during 2011-12 to 2013-14. In J&K, area under flowers increased in INWH by 16%. But the region experienced a decrease of 20% in production. During the same period, area under spices increased ranging from 18% (J&K) to 76% (HP) and in INWH by 38%. But a decrease in productivity ranging from 14% (J&K and Uttrakhand) to 58% (HP) recorded a fall of 5% in production.

Available Interventions that Need to be Upscaled

- Nursery techniques, and production and supply of quality planting materials.
- Introduction of - Pomegranate germplasm (for Jammu); low chilling cultivars of Peach, Plum, Pear, Pomegranate and Strawberry; improved cultivars of Mango, Grapes, Citrus, Guava, Litchi, Aonla, Ber.
- Scientific training/pruning and canopy management of orchards.
- Precision farming in protected cultivation of flower and vegetable crops.
- Popularization of high value exotic vegetables.
- Low-cost walnut propagation.
- Intensive saffron production technology, and production of safranal through SLS.
- For Apple and Almond - rejuvenation of old senile orchards; standardized drip irrigation, fertigation, rainwater harvesting and moisture conservation; and, standardized high and medium density orcharding with suitable varieties.
- Integrated Nutrient Management

in vegetables.
- Herbicidal weed management in garlic and onion.
- Nursery raising technology for high value crops in soil-less media; off-season nursery raising technology for cucurbits and early vegetables on raised beds.
- Management of potato late blight (module); saffron corm rot and chilli wilt (integrated); Fruit fly with Methyl Eugenol and cue-lure based trapping devices / Palam Trap; Yellow Vein Mosaic of okra; diseases, nutrient and water for gladiolus (integrated); wilt in solanaceous crops; downy mildew of cucumber; soil borne diseases of vegetables (through bio-control); mango anthracnose; lepidopterous pests of vegetables (through bio-pesticides).
- Apiculture - honey bee-rearing technologies for honey production and pollination; management practices for honey bee diseases and Varroa mites; pollination requirements of crops.

Future Thrust Areas of Research and Extension for INWH

- Development and refinement of micro and high-tech propagation techniques and establishment of progeny orchards.
- Technology for protected cultivation of high value crops.
- Expansion of Kiwi fruit and flowers cultivation in the region.
- Spurious pesticides and pollination problems in horticultural crops.
- Use of micronutrients in horticultural crops and soil health.
- Development of micro propagation protocols for ornamental, medicinal and aromatic plants.
- Rootstock and pollinizer management for different ecological situations and planting densities.
- Development of efficient system for enhancement of water productivity, water harvesting and moisture conservation.
- Studies on impact of climate change on temperate horticultural crops and development of mitigation technologies and varieties for optimizing production.
- Promoting use of honeybees as an essential agricultural input for pollination.
- Standardization of specific package of practices for high density fruit plantations, biodynamic and organic farming in context to productivity improvement.
- Efficacy trials and recommendations for use of bio-fertilizers and bio-pesticides.
- Remedies against winter frost for mango and litchi plantations in sub tropical areas.
- Adaptability trials for introduction of new fruits like Avocado, white strawberry, golden kiwi and blueberry for diversification.
- Molecular characterization and registration for geographical indicators for R.S. Pura Basmati, rajmash, kalazera, anardana, saffron etc.
- Refinement of micro-irrigation system for undulating topography of fields and fertigation technique as per soil health status.
- Production technologies for rain-fed fruit crops - crop regulation, fruit cracking, foliar nutrition and canopy management.

Way Forward

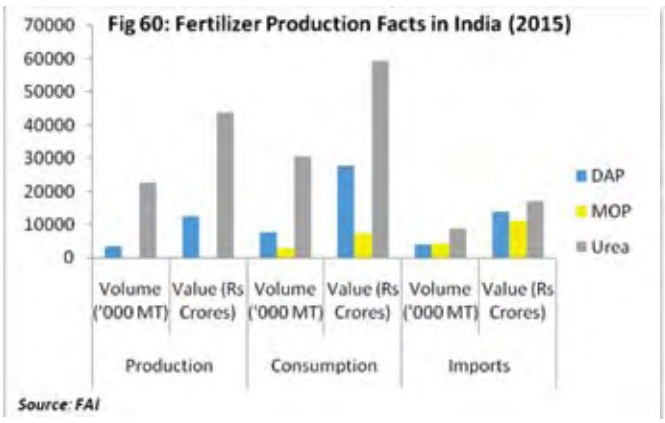
For catering to agricultural research and development of INWH region, there are six state agricultural universities, including two specifically for research, education and extension in the fields of horticulture and forestry. There are also six ICAR institutions and 43 KVKs besides several Regional / Research Centres of ICAR Institutes located in other regions. These Universities and ICAR Institutes are working synergistically under the National Agricultural Research System (NARS) for resolving the regional as well as national issues related to agriculture leading to sustainable production systems, and alleviating poverty among directly and indirectly dependent population of the region on agriculture and allied sectors. ■

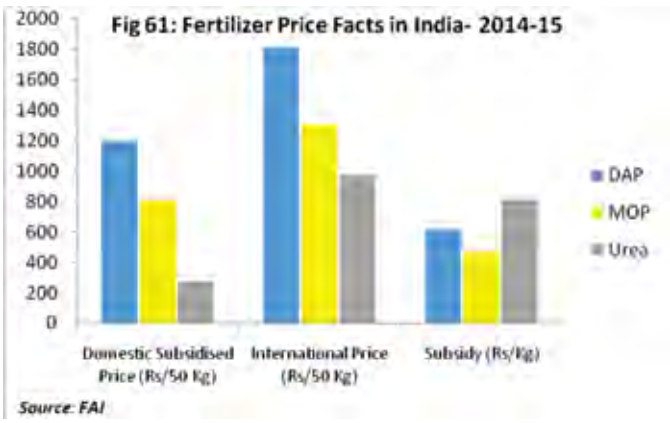
AGRICULTURE & INDUSTRY

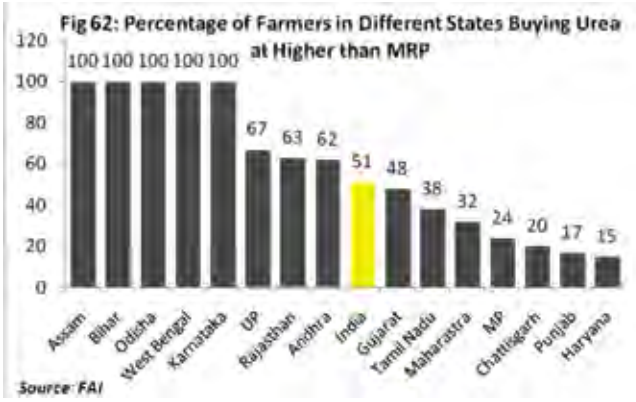
Overview of Indian Fertilizer Sector

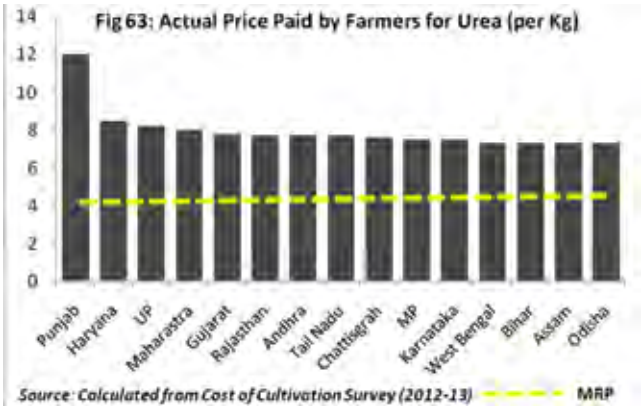
With changing time and changing economic landscape, the fertilizer sector in India has been witnessing reforms, particularly since 2014. In recent years, Government interventions in Urea and DAP/MOP differ not just in scale, but also in kind. DAP and MOP producers and importers receive a Nutrient Based Subsidy (NBS) based on a formula that determines the amount of N, P and K in a given amount of fertiliser. As seen in Fig 60, in 2015, India produced 3.4 million tonnes of DAP and about 22.6 million tonnes of Urea. The corresponding value in rupees was Rs 12471 Crores for DAP and Rs 43830 Crores for Urea. India does not produce any MOP and is solely dependent on imports. However, total domestic consumption of DAP, MOP and Urea in 2015 was much higher at 7.6 million tonnes, about 3 million tonnes and about 31 million tonnes for DAP, MOP and Urea respectively. The corresponding rupee values for the consumed fertilizer categories in the country were Rs 27606 Crores, Rs 2853 Crores and Rs 30610 Crores respectively. The deficit between production and consumption of different fertilizers in India is met every year through imports. While India imported whole of MOP required for consumption to the tune of about 4.2 million tonnes in 2015, it imported 3.8 million tonnes and 8.7 million tonnes of DAP and Urea respectively.

In India, Urea is the most physically controlled fertiliser, with 50 per cent under the Fertiliser Ministry's movement control order. In comparison, DAP and MOP are controlled to the extent of 20 per cent each. Urea also receives the largest subsidies, in outlay terms (accounting for nearly 70 per cent of total fertiliser subsidy) and as proportion of actual cost of production (75 per cent per kg, compared with about 35 per cent for DAP and MOP). As noticed in Fig 61, while the international price of DAP was about Rs 1810 per 50 kg, Indian farmers availed it at a price of Rs 1200 per 50 kg bags. Domestic price of Urea in 2014-15 was Rs 5.40/kg while internationally the price was Rs19.40/kg. Similarly, MOP whose international price was Rs 26/kg in 2014-15, in India it was made available at a price of Rs 16/kg. On account







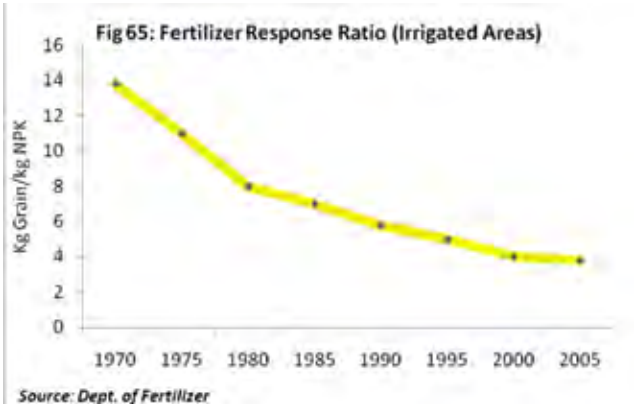


of all these reduced price of major fertilizers in India, total amount of subsidies incurred by the government exchequer in 2014-15 was Rs 618/Kg, 465/Kg and 807/Kg respectively for DAP, MOP and Urea.

Fig 62 is quite revealing in terms of the fact that the large amount of subsidies given to an important fertilizer like Urea is actually mis-utilised to a large extent across the country and remains no secret to the policy makers and the regulators. It is appalling that 75 per cent subsidy on agricultural urea creates a large price wedge which feeds on a thriving black market. According to reports available to government sources, a large chunk of Urea meant for consumption in Indian agriculture is getting diverted to industry and possibly across the border to Bangladesh and Nepal by unscrupulous business men. As seen in the figure, it is unfortunate to note that in states like Assam, Bihar, Odisha, West Bengal and Karnataka, farmers are buying Urea at a price which is twice the MRP. In states like Uttar Pradesh, Rajasthan, Andhra Pradesh, the price at which farmers are buying urea is more than 60% of the MRP. Farmers from almost all the major crop producing states are buying Urea at prices higher than MRP, whereas the government is paying millions as subsidies. Comparing urea allocation

data with estimates of actual use from the Cost of Cultivation Survey, 2012-13, it is estimated by government sources that 41 per cent of Urea is diverted to industry or smuggled across borders.

However, from the cost of cultivation survey conducted in 2012-13 by government agencies across the country, its seen that in Punjab, farmers are buying Urea at almost Rs 12/kg from fertiliser dealers (Fig 63). This clearly indicates the rampant black marketing and various unholy nexus of different market forces playing in the Indian fertilizer market. Black market prices are, on an average, about 61 per cent higher than stipulated prices (i.e. MRP plus local taxes), indicating that black marketing imposes significant pecuniary costs on farmers, in addition to creating supply side uncertainty. In addition to black marketing, "canalisation" or allowing only few companies to import Urea into Indian market is adding to the woes of the farmers and rendering the system ineffective. Only three firms are allowed to import urea into India, and the canalisers are also instructed when to import, what quantities to import, and in which



districts to sell their goods. Estimates of import are given by the fertilizer department in advance to these companies before the commencement of the season. However, making accurate predictions about the demand of fertilisers is a difficult task at hand in a country like India and many a times, the estimates go hugely wrong. This gives rise to a further congenial situation for rampant black marketing of fertilizer, like Urea as any short supply in the market due to inadequate demand estimation and resulting inadequate import drives farmers to purchase Urea at high prices from the black market.

Black marketing of Urea leaves a heavy impact on the economically weak small farmers of the country. Since the number of such farmers in India is more, a larger section of our farming community is subjected to the burden of purchasing essential fertilizer for crop growth at much higher price than MRP. Due to weak social network and weak connections, it is the small and marginal farmers who are constantly being subjected to the regressive effect of any shortage in availability of fertilisers. The large farmers are usually well connected and can easily avail the subsidized fertilizer stock before it finishes. Fig 64 presents a stark reality of the brunt of black marketing being faced by the small and marginal farmers. In states like Punjab, Tamil Nadu, Uttar Pradesh, these farmers need to incur more than 50% additional cost of cultivation because of excess price of urea which further reduces their market competitiveness and profitability.

According to scientists and experts of the sector, time has now come when one needs to seriously think about encouraging the rampant use of chemical fertilisers like Urea in the soil and to the crops. Subsidizing fertiliser prices on one hand, while leading to leakages due to corrupt business practices on the other, is also leading to non judicious and needlessly excessive use of fertilzers. As can be seen in Fig 65, the fertilizer response ration or number of kilograms of grains obtained from per kg of NPK has been consistently and rapidly reducing over the decades. During the seventies, each kilogram of NPK used to yield about 14 kgs of grains, other factors remaining constant. Between 1970 and 1985, a period following after the Green Revolution and a period marked by a newly found penchant for chemical fertilizer application, fertilizer response ratio dropped significantly by as much as almost 50%. In 1985, per kg of NPK yield was just about 7 kgs of grains. This clearly indicates that the soil was continuously getting deteriorated and bereaved of its inherent and essential qualities. Adequate and effective measures should have been perhaps initiated long back. These days, the fertilizer response ratio is just about 4 kg grains/kg of NPK, which is drastically lower by as much as 72%.

The disparity factor in terms of fertilizer availability in India is a kind of a double edged sword. On one hand, while fertilizer availability is an issue with the small and marginal farmers both in terms of cost and quantity, on the other hand, inequitable distribution of fertilizers across the country is an equally serious issue. While regions like North East does not even use about 4 kg/hectare of chemical fertilizers, states like Punjab guzzle almost 250 kg/ha of chemical fertilizers. Regions like the North East use less nitrogenous fertiliser per hectare than the world average. This is also indicative of the fact that in various parts of the country, there are large scale deviations from the optimal N:P ratio. Most states use almost twice more Nitrogen as compared to Phosphorous than what is recommended. This pattern is also observed in the most productive states like Punjab, Haryana, UP and Gujarat. ■

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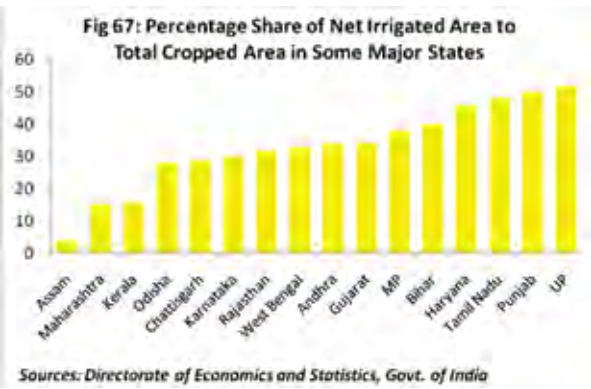
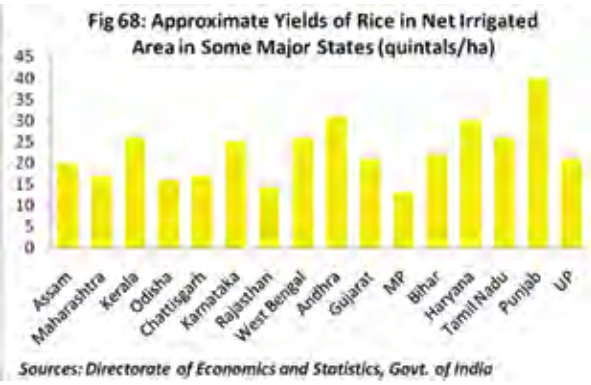
Irrigation

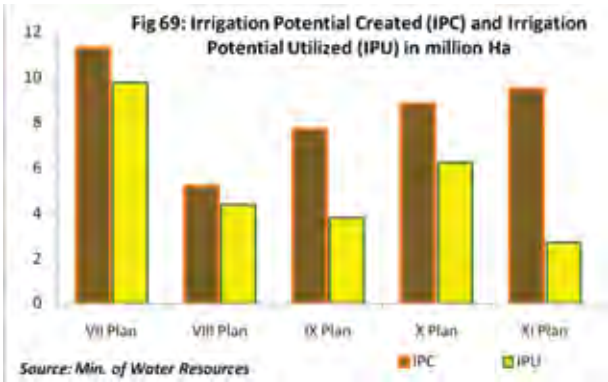
India is still a wholly monsoon dependent country for the success of its agriculture sector. Every year, from farmers to the policy makers equally keep staring at the sky and the weather reports for a favourable monsoon so that agriculture production is not affected. Even after so much of funding and policy initiatives in the agriculture sector, not even 40% of the total cropped area in agriculture has come under the ambit of assured irrigation. Identifying this as an issue to be needing urgent course correction and attention, Government of India has come out with Pradhan Mantri Krishi Sinchayee Yojana or PMKSY. There has already been a sanctioned outlay of Rs. 50,000 crore for a between 2015-16 and 2019-20.The major objective of PMKSY is to achieve convergence of investments in irrigation at the field level, expand cultivable area under irrigation, improve on-farm water use efficiency to reduce wastage of water, enhance the adoption of precision irrigation and other water saving technologies to attain the motto of "More crop per drop". At the same time, the scheme aims to enhance recharge of aquifers and introduce sustainable water conservation practices etc. As seen in Fig 67, still various agriculturally important states do not have their agricultural land under the coverage of assured irrigation. In some states like Assam (just about 4% as net irrigated land), Maharashtra(15% net irrigated land), Kerala (16% as net irrigated land) etc., are states with abysmally low area under assured irrigation. Even a sum of Rs. 5300 Crores, comprising Rs. 1800 Crores for Department of Agriculture & Cooperation, Rs. 1500 Crores for Department of Land Resources and Rs.2000 Crores for Ministry of Water Resources, River Development and Ganga Rejuvenation was allocated already during 2015-16.

Rice is the most widely grown crop in India and India is still amongst the countries with the lowest rice yields. Rice needs water and in India, major source of water for rice cultivation is still monsoon. Figure 68 depicts the yield of rice in some of the major rice producing states in India in net irrigated area. Seventy percent of the 414 rice-growing districts report yields lower than the national average, clearly indicating that well after the advent of high yield technology, a sizable area is categorized as low producing. Sixty percent of the low productivity rice areas are in Bihar, Orissa, Assam, West Bengal, and Uttar Pradesh. Surprisingly, 32 percent of the irrigated rice areas produce low yields. Yield gap analysis further reveals that 30 to 40 percent of the potential yield is yet to be tapped with available high yielding varieties (HYV) sown on highly productive irrigated soils. This gap is likely due to degraded and less fertile soils, pockets of endemic pests and diseases, low input use, defective cropping systems, and a low adoption rate by farmers of high yielding technologies.

In India, there is a huge difference between irrigation potential created and utilized. Irrigation potential created is the total area which can be irrigated from a project on its full utilization. Fig 69 provides the extent of gap still existing between irrigation potential created and irrigation potential utilized. It has to be made sure that once an irrigation potential is created, water is available for the area to be irrigated in each season during a complete irrigation year. Further, it is necessary to have the conveyance system to be available to carry water up to where it is needed and also the projected cropping pattern of the region is satisfactorily adhered to. ■







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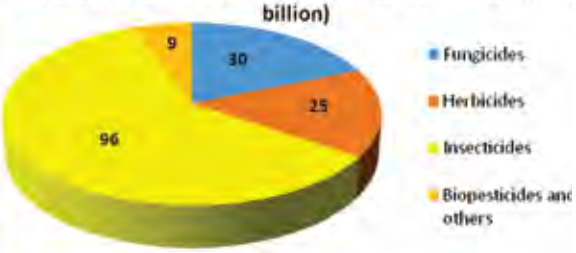
Overview of Agrochemicals Sector

In the last couple of years, Indian agrochemicals sector is abuzz with activities. Various global players are looking at India to increase their market share, add to their product portfolio, and strengthen their supply base in specialty and agrochemicals. Indian agrochemicals sector is showing signs of robust growth at about 12% CAGR. Size of domestic agrochemicals market in India (sans export volume) is about Rs 160 billion of which, insecticides constitute the majority of the sector at about Rs 96 billion (Fig 70). Fungicides, Herbicides and bio-pesticides and others constitute respectively Rs 30 billion, Rs 25 billion and Rs 9 billion respectively. The agrochemicals sector has come a long way ahead from the older generation products that has been largely faulted for their indiscriminate nature of killing and collateral damage to the environment to an era of new generation molecules that are highly potent, but selective in their action. New generation products are now used at levels a few thousand times lower than products of yesteryears, and the quest for even safer products is ongoing with persistent R&D focus and efforts in the leading companies of the world.

The agrochemicals industry is an important component of the speciality chemicals industry and plays a key role in the Indian economy. In the total chemical industry landscape of the country, the pesticides alone constitute 2% of the total share (Fig 71). India's agrochemical industry can be divided into producers of technical agrochemicals and the formulators who transform the technical into form suitable for actual use in crop protection. The industry is highly fragmented at both levels, with around 125 technical producers and more than 800 formulators, serving a few million farmers through a network of almost 1.5 lakh retailers across the country. The business also includes many technical manufacturers who also double up as forward integrators of formulations.

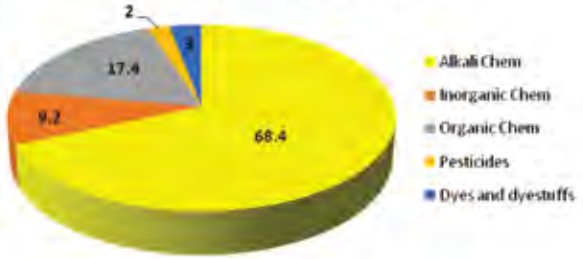
The global agrochemical market which is valued currently at about USD 71 billion (at manufacturer level value), currently believed to be growing at a CAGR of over 5% and is marked by a number of significant changes in the recent years and also is poised for changes in the coming years. A large number of pesticides are coming off-patented and the sales proportion of proprietary patented pesticides has continued to drop. The void is

Fig 70: Share of Different Categories of Plant Protection Chemicals in the Total Agrochemicals Market in India (in R billion)

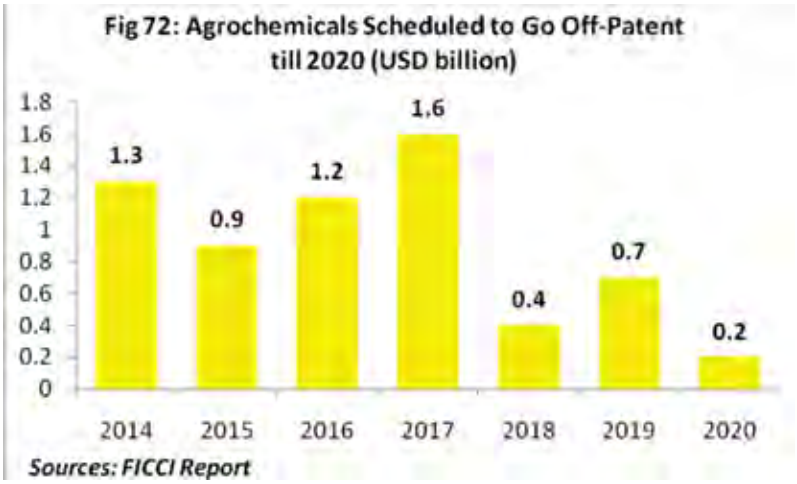


Source: Agriculture Today estimates from various industry sources

Fig 71: Share of Agrochemicals in the Total Chemical Industry of India (in %)



Source: Dept.of Chemical and Petrochemicals



being filled up by new generation molecules. At present the market value of proprietary patented pesticides, proprietary off-patented pesticides and generic pesticides respectively accounts for 25%, 30% and 45% of the total market value. Proprietary off-patent product refers to product whose patented active ingredient expires but the terminal formulated product is still protected due to its patented technology. According to estimates, approximately USD50 billion exists with proprietary off-patent pesticides and generic pesticides provides non-research oriented pesticide enterprises with great opportunities and market potentials. Fig 72 provides the value of agrochemicals scheduled to go off patent every year till 2020.

All these and various other important factors are making the agrochemicals sector an interesting place of business activities. Recently, the agrochemicals sector of the country had witnessed a lot of frenzied business activities, takeovers and divestments. Some of the notable activities are:

• According to industry reports, Japanese conglomerate Sumitomo Chemical is at an advanced stage of negotiations to acquire almost 44% stake in Excel Crop Care, a Mumbai based listed Indian agrochemicals company. The proposed deal involves acquiring the shares of the pesticides and agrochemicals company for a total consideration of Rs 12000-13000 million. Sumitomo plans to buy out stake of the Shroff family who are the promoters along with two financial investors. Shroff family owns 24.7% equity and the financial investors together holds about 19% of the shares.

• US-based DuPont which has substantial operations in India and active in sectors like healthcare, agriculture, electronics, energy and plastics etc. has recently divested its copper fungicide business to Kocide, a wholly owned subsidiary of Japanese major Mitsui. The Competition Commission of India (CCI) approved the deal recently. Kocide established in 2014 for the purpose of the acquisition, sells and markets the acquired copper fungicide globally.

• Insecticides India Limited (IIL) has recently announced that it has tied up with Japan's Nihon Nohyaku Co to launch new products for paddy, pulses and vegetable crops. With a turnover of over Rs 10000 million, IIL will launch a new generation insecticide with the brand name Suzuka and another brand in the name of Hakko, an insecticide for BPH in paddy crop.

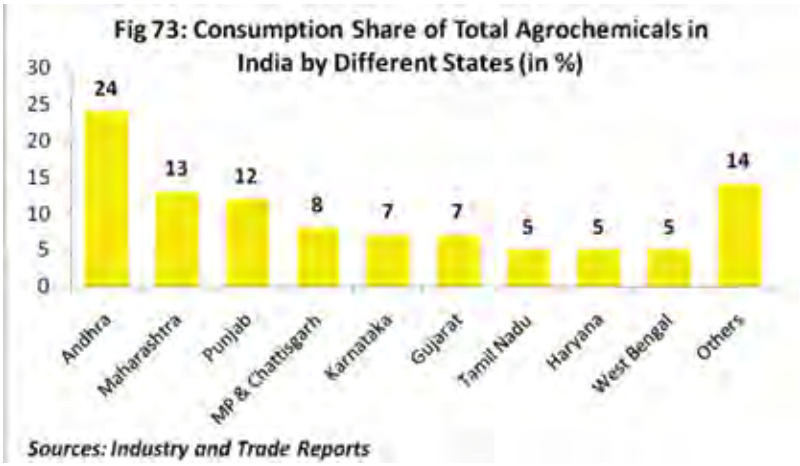
• According to recent industry reports, Amira Nature Foods Ltd., a global provider of branded speciality rice, including basmati and other food products, and United Phosphorus Limited have entered into a strategic alliance to build a productive rice value chain in India and other parts of the world.

• New Delhi based Indian agrochemical company Crystal Crop Protection acquired the fungicide brand 'Bavistin' from BASF. Crystal Crop Protection Pvt Ltd, which posted a turnover of around Rs 1,200 crore

Table 6: 2016-17 Q1 Turnover of Some Major and Listed Indian Agrochemical Companies

Company	Q1 Turnover (in Rs Crores)	% Change over Q1 in Last FY	Net Profit/ (Loss) in Rs Crore
Bayer CropScience India	855.5	7	131.2
Hikal Ltd	221	25	44
Insecticides India	304.85	7	20
UPL	3,51,020	7	40,200
PI Industries	12,690	48	16,600
Coromandel International	2,060	-6.5	8
Rallis India	464	0	33
Dhanuka Agritech	198.40	10	19.35

Source: Agriculture Today from various industry sources



in the previous fiscal, aims to raise its revenue by 7-8 per cent with this acquisition. According to the MD of Crystal Crop Care Mr. Ankur Aggarwal, the market of Bavistin brand in India at farmers' price rate is more than Rs 100 crore with application in around 70 million acres of land. It is used in fruits, vegetables, cereals, oilseeds and pulses.

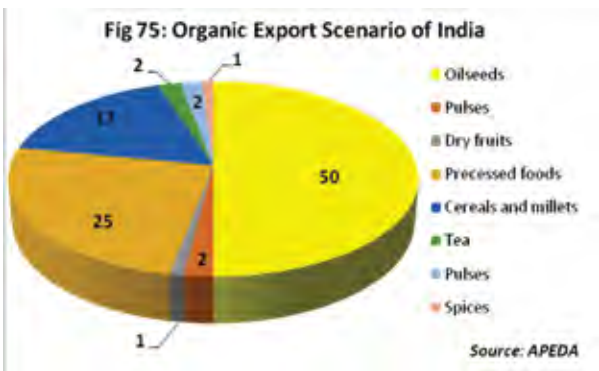
The upbeat mood of the Indian agrochemicals sector in the current fiscal year so far can be understood from the fact that most of the major players of the sector have posted growth during the first quarter of 2016-17. Table 6 provides the first quarter results of some of the listed agrochemicals companies operating in India.

Taking an overview of pesticide use across India, some of the states like Andhra Pradesh, Maharashtra, Punjab etc. are in a way high consumers of agrochemicals (Fig 73). All the major states consume a bulk of the pesticides produced in the country. The production capacity of pesticides in the country is elaborate and well developed. Cotton and paddy are the major crops where pesticides consumption is 50% and 18%, respectively. Fruits and vegetables account for the significant share of agrochemicals. Cotton covers only 5% of the cropped area but accounts for 50% of pesticides. Rice grown over 24% of the cropped area consume 18% of the pesticides. The fruits and vegetables account for 18% cropped areas, while cereals, millets and oilseeds cover 58% areas. Sugarcane uses 2% of the pesticides and other crops grown over 6% of the cropped area account for 1% only. ■

Organic Food Industry

Important organic food producing states in the country are states like Madhya Pradesh, Himachal Pradesh, Rajasthan, Sikkim etc.Domestic organic food market in India is currently estimated to be USD 5 billion and growing at 20% annually. Total export of organic products from India during 2015-16 was 263687 MT. Total foreign currency earnings from organic food export realization were around USD 298 million.

India produces around 1.35 million metric tonnes of

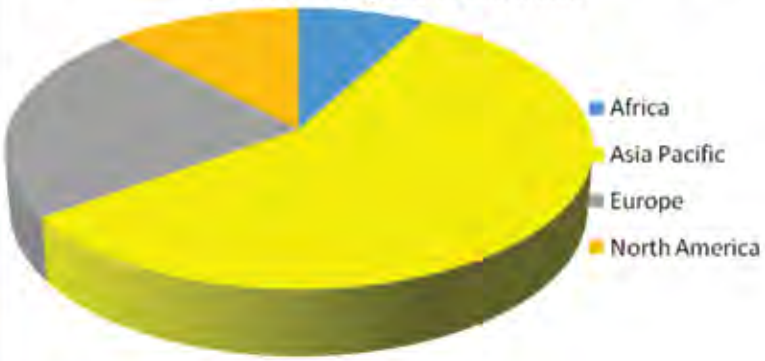


certified organic products which include all varieties of food products like Basmati rice, Pulses, Oilseeds, Honey, Fruits, Tea, Processed Food, Spices, Cereals, Coffee, Herbal Medicines, Value Added Products etc. Indian export of organic food product constitutes 50% of oil seeds (Fig 75). Apart from Edible Products, India also produces and exports organic cotton fibre, garments, cosmetics, functional food products, body care products etc. Important export destinations of organic export products include EU, USA, Canada, Switzerland, Korea, Australia, New Zealand, South Africa, South East Asian countries and Middle East. ■

Seed Industry in a Nutshell

With the Global seed industry pegged at an estimated USD 50 billion, Indian seed industry is ranked 5th in the world in value terms accounting USD 2.5 billion. Indian seed industry is predominantly driven by crops like cotton, rice and vegetable seeds. In the recent years, Indian seed sector has been going through a phase of consolidation. A number of companies have merged to form larger, more competitive entities with a wider product portfolio. Apart from domestic consumption, India exports seeds worth USD 138 Million including field crops valued at around USD 71 million and vegetable crops around USD 68 million. Vegetable seeds are mainly exported to Asia Pacific (about 57%), Europe (23%) and North America (12%) as seen in Fig 74. About 8% of the total vegetable seed export goes to Africa. Among the various crop categories, demand for Indian vegetable seeds is high in many of the international markets for Solanaceous vegetable crops. For example, tomato seeds is the highest exported vegetable seed from India and accounts for approximately USD 12 million. Countries like Netherlands, USA, Thailand are major importers from India for tomato seeds. Other vegetable seeds like okra, hot-pepper, radish, cabbage are mostly exported to countries like Pakistan, Bangladesh etc.

Fig 74: Percentage Share of Vegetable Seed Export from India to Different Regions of the World



Source: APEDA

Seed industry in India is going through a period which is currently witnessing greater government regulatory activities. Some of the major industry players have found a flurry of regulatory steps in recent months a bit difficult to absorb. Monsanto, the US biotechnology giant has withdrawn an application to sell its next-generation genetically modified (GM) cotton seeds in India on concerns over the security of its intellectual property. Government had asked to share its technology with local seed companies. Monsanto, for whom India is the largest source of revenue outside the USA, is already locked in a legal battle with the Government over a cut in the royalty it gets from seed companies for licensing use of its patented technology.

As recently as in August 2016, executives from companies like Monsanto, Bayer, Dow, Dupont Pioneer and Syngenta have formed the Federation of Seed Industry of India (FSII) with a goal to address difficulties in the industry. ■

Mr. Jay Singh,
Managing Director
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Farm Mechanization, Playing a Pivotal Role in Overcoming Challenges in Agriculture

Agriculture, the backbone of the Indian economy and the primary occupation of over 50% citizens, has seen limited improvements in the past few decades. Over the years, the manufacturing and services sectors have flourished, but the agriculture sector has remained stagnant. This indicates that the benefits of development of these sectors have not trickled down to all sections of the society.

In the recent past, the challenges have multiplied. From continuous droughts to increasing incidence of farmer suicides, the list of problems go on to include increasing debts, slow implementation of schemes and increasing demand for food grains. The sector is further pressurized by reduction in available manual labour, as youth migrate to urban areas in search of better opportunities. With the Government's vision of doubling farmer's income by 2020, agriculture has received new impetus through campaigns such as 'Make in India' and 'Skill India'.

As the Government launches many more initiatives, especially keeping technology at the core of it, farmers are also supporting and cooperating in embracing such technologies. E-mandis, online retail stores, soil health cards and e-banking are some of these initiatives. However, as manual labour reduces, farmers must look at investing more in farm mechanization, which is cost and effort effective in the long run. Manual labour is expected to further reduce by 26% in 2050, highlighting the urgent need to invest in various machines that solve specific purposes on the farms.

Farm mechanization is not a new concept. Ministry of Agriculture shares that about 40% of the total agricultural land is mechanized. Although the extent of mechanization at various stages varies, the trend indicates that adoption of mechanized solutions at all stages would slowly gain momentum and hence is expected to bring about a much needed revolution in the country. Conversations around the need for mechanization in the country have seen a rise

because there is a requirement for increase in productivity, which cannot be met through current practices. According to the World Bank, India has the second largest agricultural land in the world with 60.3% of land used in agriculture. However, with the simultaneous increase in population and demand for food, we must utilize this land to feed everyone. Hence, mechanization is the way forward which shall enable farmers to increase productivity of their land, and make it cost effective as well.

Today, the revolution that we are witnessing, is not only going to bring about progress for the farmers but is going to change the face of agriculture. With the introduction of custom hiring centres, farmers are finding ways to afford machines and become progressive. What started off as a one-off centre, has today, become a promising model with the potential to accelerate the growth of a sector which has seen negligible growth till date. The growth of rental operators has been advantageous

as well. On one hand, it has helped reduce dependence on manual labour, thereby ensuring cost and time effectiveness and improvement in yield; on the other hand it is leading to an entrepreneurial wave in the nation, and farmers are seen moving towards not only purchasing machinery to use on their farms but also to rent it out to small and marginal farmers, ensuring maximum utilization, better access, and development for the community as a whole.

While avenues are opening up, some challenges retain. A major challenge in adoption of mechanization in India is the small land holdings. Although with a change in perceptions, farmers are now willing to adopt mechanization, they are apprehensive as the small size of landholdings does not allow them to utilize the machine to its full potential. The custom hiring centres help eliminate this apprehension by providing machinery on a rent-out basis, which reduces the investment required and yet makes technology accessible. Not just small and marginal farmers, but rental operators themselves are exploring new avenues, and reaping benefits, and becoming entrepreneurs in their own way. Just like any new model that is in its initial phase, the custom hiring model is not free from its share of challenges. One of the biggest challenges they face is that of taxation, while migrating from one city or state to another. The implementation of GST might prove to be a solution to this challenge, since it would ensure a uniform tax across cities and states, which will reduce the additional tax burden and make this model even more lucrative.

Another aspect which is expected to give a boost to this exemplary model is the initiatives being taken up by the government to generate awareness amongst farmers about various schemes available at their disposal. With the development of various portals and applications, we must inform and educate the farmers about farm equipment and machinery, other than tractors, which are used in various stages of production. Balers, transplanters, foragers or harvesters are to name a few. At present, the farm equipment sector is dominated by tractors, the annual market size of which is currently, 600,000 to 700,000 units. Though threshers are the second largest equipment sold, it lags behind at only 100,000 units a year. Each machine has its own role to play in the field, and these numbers highlight the urgency to educate the farmers about the options they can choose from.

Contrary to normal perception, tractor is not a multipurpose solution to all farming needs. To ensure efficiency and optimum time utilization, other machines must be used for specific activities. For instance, a forager can help increase the yield of cattle by 1-2 kg per day per cow, thus improving productivity and income for a dairy farmer. But, unfortunately, a large number of dairy farmers are not aware of this. This shows lack of awareness is detrimental and must be addressed.

It is encouraging to note that we are embracing technology, and mechanization in agriculture is expected to enjoy a growth rate of 10% by 2018. It would be interesting to see if efforts towards educating farmers, and custom hiring centers can encourage adoption of more machines than just tractors. With the 'Make in India' initiative, research and development in the sector is being prioritized and innovative solutions such as precision farming are being explored. This can play a pivotal role in changing the way we look at the Indian agricultural scenario. These initiatives can provide a boost to the Indian farmer and can result in positive outcomes for the economy as a whole.

The farm economy holds a lot of untapped potential which, if explored, would lead to the development of the most crucial sector in the economy. With over 50% of the population dependent on agricultural sector, we need to expedite these efforts.

To conclude, there is a need to spread awareness amongst farmers about the innovative, mechanized solutions available today, benefits of adopting sustainable practices and the initiatives that are being undertaken to ensure accessibility. Once we are able to achieve this, the Government's vision of doubling farmers' income would become a reality, India would become a self-reliant nation, in terms of food production and a large section of the society which has been neglected would prosper. ■

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Seed Africa-India:

On A Way to Sustainable Growth & Partnership

Indian Seed Sector

The Indian Seed Sector is a vast sector with more than 700 seed companies operating in the organised Seed Segment. From being a food grain deficit country a few decades back, today India is a food grain surplus country. This has become possible due to constant focus of research based innovations.

A major re-structuring of the seed industry by Government of India through the National Seed Project Phase-I (1977-78), Phase-II (1978-79) and Phase-III (1990-1991), was carried out, which strengthened the seed infrastructure that was most needed and relevant around those times. This could be termed as a first turning point in shaping of an organized seed industry. Introduction of New Seed Development Policy (1988 – 1989) was yet another significant mile stone in the Indian Seed Industry, which transformed the very character of the seed industry. The policy gave access to Indian farmers of the best of seeds and planting materials available anywhere on the world. The policy stimulated appreciable investments by private individuals, Indian Corporate and MNCs in the Indian seed sector with strong R&D base for product development in each of the seed companies with more emphasis on high value hybrids of cereals and vegetables and hi-tech products such as Bt. Cotton.

According to the International Seed Federation (ISF), India is 6th largest domestic seed marketin the world, which was estimated to be USD 2000 Million in 2013.

African Seed Sector

Like India, in Africa too most of the farmers practise small scale farming. This sustains millions of livelihoods in Africa. The World

Bank estimates that agriculture in sub-Saharan Africa (including upstream and downstream value chains or 'agribusiness') is the continent's largest economic sector, which is currently worth more than US$300 bn per year and has the potential to grow to over one trillion dollars by 2030. According to the World Bank,an important slice of this potential stems from the low productivity of African agriculture compared to other regions of the world, and this may be attributed in part to the continent's low uptake of modern agricultural technologies including quality seeds, improved crop varieties and hybrids. Improved crop varieties were planted on only 27 percent of Africa's food crop area in 2000 (World Bank 2013).

At present, the commercial seed industry is underdeveloped in most parts of Africa, with the use of commercial seed being relatively more common in East and Southern Africa than in West and Central Africa, according to the Bank. In several African countries, the formal seed sector is still dominated by public sector enterprises and private investment is limited (World Bank2013).

India & Africa- Natural Partners

African continent and Indian sub-continent have been natural partners in view of their origins, agro-climates, socio-economic conditions and natural diversity. India has a lucrative seed industry but its current export to Africa is not abundant.In 2014,the country occupied only 14th place in the list of nations exporting seeds to Africa, with less than two percent of the trade. As in terms of agro-climatic conditions and natural diversity India and Africa shares similarity, so there is a scope to collaborate research projects and seed business.

Challenges in African Seed Sector

According to the World Bank, the seed industry in Africa faces many obstacles and challenges.

A recent survey of registered seed companiesin Eastern and Southern Africa identified a numberof generic constraints, such as:

- Access to Finance
- Poor Infrastructure
- Weak Extension
- A Shortage of Skilled Technicians
- Lack of access to germplasm
- High start-up costs
- Outdated and rigid seed policies

A top priority is to reform seed policies andregulations. Policy and

regulatory barriers-including import restrictions and rigid, lengthy processes for releasing new varieties — are slowing the adoption of agricultural inputs. Priorities are to reform seed policies, ensure a level playing field for the private sector, and liberalize varietal release procedures. As emphasized time and again by investors, these reforms must be accompanied by policies to allow free exchange of varieties and seeds within a region to create markets of sufficient size. Despite general agreement on the value of such reforms, their implementation has been painfully slow. The vested interests of government agencies responsible for certifying, producing, and distributing improved varieties and seed are hard to overcome.

Opportunities in African Seed Sector

Based on data from Agricultural and Processed Food Products Export Development Authority (APEDA), it is indicated that India exports seeds to 24 African countries. Kenya is ranked first in the list followed by Egypt, Sudan etc.

There are huge opportunities in terms of hybrid maize and cotton. Avenues of direct investments in seed production in African countries is available. Also companies can develop joint partnerships with local seed producing companies. Indian public and private seed producing organisations have expertise in development of food crops as well as cash crops. The Indian seed companies are looking at expandingto emerging African agri-input markets. From exporting seeds to partnering with local seed companies/NGOs to investing in overseas R&D to acquiring local

companies/Joint-ventures/opening WOS (wholly-owned subsidiary), several Indian seed companies are leveraging on this scope of harnessing the opportunity to capture African markets. Indianseed companies are using these measures indesirable combination to have effective in roads into African markets.

Way Forward

The way forward has to be strengthen ongoing efforts and also stress on constant innovation. Efforts should be directed at identifying new avenues for partnership, in both public and private sector. This can be propelled by exchange of ideas between researchers, breeders and seed producers. Today India has achieved food sufficiency and has the experience of dealing with harsh realities of drought, flood etc. Also India with its large pool of researchers and breeders has vast experience in development and application of various agricultural technologies, varying from traditional to modern. Both India and Africa can learn a lot from each other and bring prosperity and change for their masses.

Recommendations

- Greater flow of Technology from India to Africa through Partnerships and collaborations
- Export of seeds from India to Africa
- Development of skilled Technicians in Agriculture
- Development of technology, infrastructure and R&D capacity
- Reformation of outdated Seed Policies for improvement in African Seed System.
- Facility to access germplasm to develop new varieties and Hybrids for increased production and productivity
- Launch of projects and programmes to stimulate agricultural and agribusiness development. ■

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TECHNOLOGICAL EXCELLENCE IN INTEGRATED CROP HEALTH MANAGEMENT:

AN AFFORDABLE OPTION IN INDIA

Increasing awareness of environmental hazards and development of resistant pest population due to enormous dependence on inorganic inputs in agriculture urged for search of alternative strategies in the domain of crop pest management during last few decades. Crop health managers target prevention of crop damage from reaching pest status by utilizing a combination of suitable methods. Adoption of biological methods in pest management have been established as an appropriate substitute for chemical-based management system although, certain limitations are there to realize full potential of it. Biocontrol agents are reported to be slow in action and sensitive to the environment, which lead to the inconsistent and poor success rate in the field. To overcome these problems, attempts have been made to identify highly efficient and aggressive strains to improve the field efficacy and to develop suitable formulation technologies for increased field persistence and to withstand harsh environmental factors of radiations and dry weather conditions. Though the biological control agents are slow to act, they provide environmental protection and do not harm the nature. Biological control agents are high-technology products; including a wider acceptance of the concept and a well-defined process to production through use of state-of-the -art technology.

Biological control of crop diseases using antagonistic organisms gained momentum in India in late 1980s. The research findings clearly demonstrated the cost-effective, environmentally safe seed treatment technology with *Trichoderma viride* and *Pseudomonas fluorescence* for management of root rots of pulses in the country. As a result, several commercial products of *Trichoderma* spp., *P. fluorescence* and *Bacillus subtilis* have been developed and marketed in India for management of soil-borne diseases in cereals, vegetables, plantation, pulses and oil seed crops viz., *Kalisena* (product of ICAR: IARI marketed by M/s Cadila Pharmaceuticals Limited), *Trichostar* (Super Agro India), etc. Success has been achieved with these antagonists for management of soil borne diseases mainly because they are aggressive saprophytes capable of replacing the pathogen inoculum by competition for food, able to produce antimicrobial compounds against plant pathogens, able to induce systemic resistance in crop plants, mobilize the nutrients in soil for crop plants thereby promoting the growth in the young plants to resist the invasion of dreaded soil-borne pathogens like *Fusarium*, *Pythium*, *Phytophthora*, *Rhizoctonia*, *Macrophomina*, *Sclerotium*, *Sclerotina,* etc. Similarly, some excellent strains of *Beauveria bassiana, Metarhizium anisopliae, Bacillus thuringiensis* have been very effective in integrated

management of some fruit flies more so with off-season interventions. Some private commercial agencies are developing and exporting these products to various countries. However, the quality of the majority of the products marketed in India is inferior as regulations are not strictly implemented.

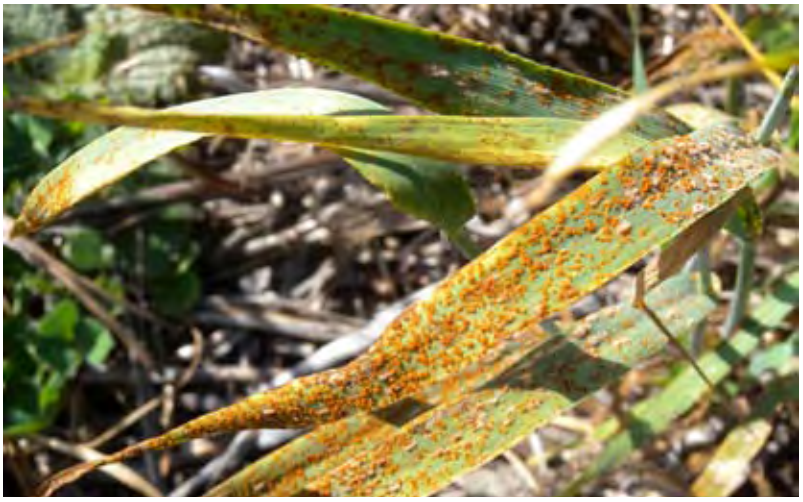
Research on biological control of foliar plant pathogens in India is yet to take momentum. In countries like USA and Israel some commercial formulations are already available for management of some foliar diseases. *Trichoderma harzianum* strain T-22 available under trade names TopShield, Bio-Trek 22G, T22 Hopper Box in USA is effective against *Botrytis cinerea*, powdery and downy mildews of various crops. An example of a novel approach to the biocontrol of *B. cinerea* is the development of the product, which consists of a mixture of the fungi *T. hamatum* and *Rhodotorula glutinis* and the bacterium *Bacillus megaterium* in USA. In Israel, a commercial product "Trichodex" based on *T. harzianum* Strain 39 is available for managing *B. cinerea* grey mould and other foliar diseases in various crops. Currently, no commercial product is available for foliar disease management in India. However, a few reports have shown possibility of using bioagents for foliar disease management (*Alternaria*, *Colletotrichum,* etc). The research in this area needs to be intensified.

Biocontrol is only an important part of paradigm shift towards integrated plant health management (IPHM) where besides direct action on plant pathogens and plant growth promotion, their indirect role in reclamation of toxic substances in soil, improving soil fertility

status by solubilizing minerals, decomposition of organic substrates, reduction of soil erosion are some important advantages which cannot be ignored. IPHM also includes biofertilizers encompassing nitrogen fixers, phosphate and potassium solubilizers, mycorrhizal fungi, etc. which are directly involved in boosting nutrient uptake in plant and in doing so they also contribute to biological control by occupying the rhizosphere throughout crop growth. Hence, there is no clear demarcation in action of biocontrol agents and biofertilizers in the sphere of IPHM, rather the term plant growth promoting microorganisms (PGPM) is appropriately coined by several scientists.

A single microbial agent may not perform well at all times in all kinds of soil environment to improve plant and soil health. Plant pathogens in disease suppressive soil are biologically controlled due to the existence of mixture of microbial antagonists. Strain mixtures of Pseudomonads in combination with other bacteria were more effective than the application of individual strains. Application of mixed PGPM formulations to field might ensure at least one of the mechanisms to operate under variable environment that exist under field conditions. So it is always wise to use consortium of microbial inoculants although some variation may also be observed probably due to the differences in the functionality of tested microbial strains, variation in survivability and colonization efficiency of inoculated cultures in soil, or strong competition from the natural microbiota of field soils, leading possibility to exclusion of inoculated cultures from rhizospheres. Selection of compatible microbes is therefore, the most important aspect of formulating a consortium.

The plant growth promoters can be integrated in agro-ecosystems either by inoculation of commercial products or by encouraging the



growthofnativepopulation.However, the success of introduced PGPMs depends on timely and appropriate application. The PGPMs, especially if are inoculated on the seed before planting or are introduced to the soil during final land preparation are able to establish themselves efficiently on the crop roots. Selection of region and crop specific appropriate PGPM consortium is the foremost and crucial criteria for capitalizing the gain from it. Few cultural interventions aiming to improve soil carbon status, equilibrate the soil pH near neutral, physical treatments to eliminate saprophytes are prerequisite to the success of introduced microbial consortia. Most types of soil disinfection, including solarisation, steaming and chemical fumigation adversely affect both target and non-target soil microorganisms, while biofumigation is less harmful to the soil biota in general. However, in situations where it is necessary to apply soil disinfection, the possibility of introducing PGPMs should be considered ideally in combination with organic matter amendment in the form of animal manure, green manure, compost, etc.

New developments in agricultural biotechnology are being used to increase crop productivity, mainly by reducing the production costs by decreasing the needs for inputs of chemical pesticides. Plant biotechnology tools also facilitate cultivating crops with multiple resistances to pests (including pathogens). Similarly, transgenes or marker-assisted selection may assist in the development of high yielding crops, which will be needed for food security and save land for the conservation of plant biodiversity in natural habitats. Therefore, crops should be engineered to meet the demands and needs of consumers. The genetic base of crop production can be preserved and widened by an integration of biotechnology tools in conventional breeding. Genetically modified microbial pesticides are bacteria, fungi, viruses, protozoa, or algae, who's DNA has been modified to express pesticidal properties. The modified microorganism normally performs as a pesticide. For example, certain fungi can manage the growth of specific types of weeds, while other types of fungi can kill certain insect-pests. Weed management is one of the farmers' biggest challenges in crop production, because poorly managed weeds drastically reduce crop yield and quality. To manage weeds, farmers often use broad-spectrum herbicides, which kill nearly all kinds of plants. For this reason, scientists have also applied biotechnology to create crops that are resistant to certain herbicides. The biotechnological mode of incorporating genes into plants to get the desired traits makes a big contribution to IPM. It enables plants to fight insect-pests and pathogens by making them produce toxins. Although there are apprehensions about the use of this technology, days are not far when the use of chemical pesticide would become very less with the use of transgenic plants. *Bt* cotton against the lepidopteran pests, has already made a dent in cotton production in our country. Recent advances in the study of molecular genetics of PGPMs have provided powerful tool in unravelling basic mechanisms and for evaluating their performance in various agro-ecosystems. Monitoring of introduced PGPMs in crop rhizosphere is only possible through biotechnological intervention. Biotechnology in plant health management plays, of course, an important role in achieving research and development success in these areas for sustainable productivity and livelihood security.

All the above aspects lead to ecologically safe and economically affordable organic crop cultivation that no doubt combats harshness of climate changes and makes the production system sustainable for the future. Although the average yield in organic farming system is 10-15% less than conventional practice, the lower yields are balanced by lower input costs and higher margins.

During the last decade, organic production has recorded 20% annual growth rate, accounting for over 31 million hectares and generating over 26 billion US dollars in annual trade worldwide. India, although comes at second place with respect to total number of certified organic farms, occupies 13th position as far as the area under organic agriculture concerns. The importance of PGPMs in the harmony of technological intervention in organic agriculture has also been realized by both public and private players and necessary policies are being churned out by the Indian Government to promote utilization of various natural resources through research and extension activities. Farmers of India are not so well proficient to readily accept any technology that requires time to prove its potential. Hence, strategic utilization of natural bioresource and continuous generation of awareness within the farming community should be the prima face in Indian agriculture in this 21st Century. In view of addressing the demand, following agenda should be considered as prime plan of action to be undertaken by appropriate authority.

- Consolidating support to research institutions in identifying and developing region-specific PGPM bank along with mandating research programmes that fulfil echo-compatible demand in agriculture.
- Infrastructure development to produce these microbial inoculants in Public-Private Partnership mode can meet the need of grower. Quality products are to be assured rigorously at certain points before reaching end users in viable form.
- Strengthening the ability to exchange information and to set-up organic agriculture networks, in order to ensure that producers, operators and government have access to reliable and quality information needed for informed decision-making, for directing research and extension, and for making investments.
- Developing and disseminating knowledge and tools that support organic plant protection, soil and nutrient management and post-harvest operations, especially in developing countries and market-marginalized areas.
- Assisting governments in designing the types of legal and policy frameworks that provide support to farmers by facilitating the marketing and trade of certified organic products that meet international inspection and certification standards.

Crop health managers work with the mission of maximizing crop yields through minimization of losses due to pests across major agricultural and horticultural crops in tune with the emerging problems of varied geographical locations of the country. Assimilation of knowledge base on pests, crop protection practices, products and personnel of the country, linking public (institutes of the Indian Council of Agricultural Research, State Agricultural Universities, *Krishi Vigyan Kendras* and State Department of Agriculture) and private institutions (non-governmental organizations and industries) for an effective large-scale IPM implementation have been in vogue in India. Pre-season pest management practices, guidance in selection of crops and cultivars suited to soils, timely planting, continuous monitoring of crop health, pest status, conservation of natural enemies, timely use of quality biological control agents integrated with location-specific crop production practices formed the foundation of several successes in integrated crop health management. Thus, a change at the grassroots could be enabled through a marriage between technological excellence and affordability that could enable inclusivity on wider scale. Recent technological breakthroughs have mostly achieved such level that has enabled their larger adoption. Biological control agents and biotechnological tools do provide the affordable option for integrated crop health management with assured safety to the environment coupled with improved livelihood security. ■

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Group Axereal

SUSTAINABILITY OF INDIAN AGRICULTURE & FARM MECHANIZATION BY CUSTOM HIRING

With domestic growing population and increasing disposable incomes, there is robust demand for food grains including cereals, fruits and vegetables. Increasing crop yield is the only solution to this problem since there is very limited prospect to increase land under agriculture. Among the methods of increasing farm productivity domestically, farm mechanisation is also essential in augmenting the earning capacity of rural farmers and consequent progress of Indian agriculture.

Future of Indian Agriculture: Adoption of mechanization through Custom Hiring

The Custom Hiring Centre(CHCs) is place where farmers can get farm machinery on rental basis especially when they cannot afford to purchase agricultural machinery and equipment. The centres play critical role in introducing high technology agriculture machinery to even poor farmers with the objective of increasing yield and improving quality of agriculture operations. Because of India's Land Ceiling Act and increasing population, the total land under agriculture is decreasing and at present it is only 1.5 acre per farmer. With such small land holdings, for farmers it become difficult to justify ownership of any kind of agri-machinery. Hence, renting out farm machines becomes more viable.

Out of 120 million strong farmer population in India, majority of them are incapable of buying machines. Moreover, the reality of labour shortage is making farmers more inclined towards mechanization to ensure faster work at a lower cost. Custom hiring makes available various farm machinery/equipments to expand mechanized activities during cropping seasons in large areas especially for small and marginal farmers and improve mechanization in places with low farm power availability. It balances the adverse economies of scale due to high cost of individual ownership. With the concept of custom hiring, various agricultural machinery/implements and high value crop specific machines applied for different operations will be available for farmers. It has also helped develop centres under contract Farming, for example "Axereal's entrepreneur center" , which are Centers of Excellence for farm Machinery, agri-Inputs and expert' s advice. These centers promote development of entrepreneurs among farmers. These centers also help companies like Axereal to add qualitative and quantitative value in contract farming program.

Models of Custom Hiring

There are two prevailing models of Custom Hiring, namely

- **Tractor Centric Model:** Tractor Centric Model emphasizes on tractor along with range of equipments. This model offers only basic services like leveling, ploughing, harrowing, planting etc. Mostly local entrepreneurs who are mainly farmers with limited financial capability implement this model in focused territories.
- **Operation based model:** Operation based model involves one type of high value machinery (single/ fleet) with operations in larger territory, even in multiple states for better utilization of the machine. This model offers services for all the major agriculture operations from soil preparation to sowing, transplanting to harvesting and is relatively better organized and professionally managed.

Case study: Axereal Entrepreneurship centres

Following the policy of developing effective, sustainable supply chain, Axereal India has been working in contract farming in Northern states i.e., Rajasthan and Haryana which are also major grain producing regions of India. Farmers are supplied with better quality seeds, motivated to adopt good packages of practices and mechanisation. In return, company procures premium quality malt barley at competitive rates. Axereal has developed unique model of entrepreneurship, to convert farmers into breed of entrepreneurs. Axereal has helped farmers to setup 'Axereal Entrepreneurship centres', which sells seeds, agri inputs and fertilisers as well as provides agri-extension services. These centres also

own some agriculture machinery and implements, which are taken on lease by other farmers. Axereal also helps these entrepreneurs to communicate with bank to have loan with better terms & conditions. Axereal has tied up with leading European machinery companies such as Kuhn & Berthoud from France to upgrade these centres to business unit, to provide farmers all facilities under one roof from agri-inputs, hi-end machines as well extension services. Output of this model is observed by several state governments and business associations very positively.

Social, Economic and Environmental benefits of Custom Hiring

There are multiple social and economic benefits for custom hiring such as reduction of harvest and post-harvest losses, reduction of workloads particularly for women, improved safety, efficient labour, saving in cost of production, increased cultivation area, timely production, better quality cultivation, increased yields, crop diversification, retention of farmers in rural areas along with improved livelihood. The use of combined harvesters has led to increment in quality, reducing harvesting cost and saving time. The use of the harvester has helped farmers to reduce risk of pre germination of grain during drying period of plants after manual cutting. Custom hiring provides employment and entrepreneurship opportunity among Villagers. Progressive farmers also takes it as business opportunities to develop CHCs.

Supporting Schemes by the Government

- **National Mission on Agricultural Mechanization (NMAM)**

NMAM has been envisaged for implementation from XII plan onwards. The Mission will aim at catalyzing and accelerating inclusive growth of agricultural mechanization in India. The proposed outlay for this mission during 12th plan shall be Rs.3500 crores.

- **Sub-Mission on Agricultural Mechanization (SMAM)**

Among the states, farm power availability in Punjab, Haryana,

Western Uttar Pradesh and western part of Rajasthan is higher than the national average of 1.73 kW/ha. In rest of the country, especially in eastern and north-east regions, it is significantly lower which requires the promotion of farm mechanization as a special mission. SMAM scheme will be implemented in all the states, to promote the usage of farm mechanization and increase the ratio of farm power to cultivable unit area up to 2 kW/ha. The mission comes under the ambit of National Mission on Agricultural Extension & Technology. SMAM provides subsidies for customer hiring centres into different components.

Constraints and Challenges

The constraints in Custom Hiring of improved machinery are following:

- High preliminarycost
- Lack of knowledge in the aspects of operation, maintenance and repair of equipment High cost of land/space for storage.
- Tractor is prime source of transportation in the countryside which makes tractor unavailable for farm usage
- Limited interested of Private sector into PPP model, because of agriculture is state subject. Red tapism and lack of policies are other factors for lack of will for investment.
- Social, cultural and diversity issues still have strong influence in village culture, for example it may be possible that one farmer from specific caste or religion may not wish to avail services from owner of custom hiring centre, if he/she belongs to another caste.
- Because of illiteracy lack of awareness amongst farmers about the benefits of custom hiring
- Research, development and testing of India specific farm machinery and equipment: Companies need to develop farm machinery suitable for small land holding and dry conditions.
- Price sensitivity also disables local low cost manufacturers to develop to the levels of standard designs of equipment with quality.
- Lack of interest by commercial banks and financial institutions. They also need to develop hasslefree loan disbursement process for tractors and farm machinery on individual ownership basis or Custom Hiring basis.

Custom Hiring has lot of challenges today, but this is the only practical way to introduce capital intensive, high quality mechanization to the small farming units in India. The Custom Hiring model enables new machinery and implements to be used at their maximum capacity and enables farmers to gain access to technology they would otherwise have not been able to utilise.

Custom Hiring can facilitate diversification in agriculture specifically from wheat and paddy to other crops. Machinery required

For Establishment of farm Machinery Banks for Custom Hiring

Item	Maximum Permissible limit	Pattern of assistance
Procurement Subsidy for Establishment of Custom Hiring Centre upto 10 lakh	4 lakh	40 %
Procurement Subsidy for Establishment of Custom Hiring Centre upto 25 lakh	10 lakh	40 %
Procurement Subsidy for Establishment of Custom Hiring Centre upto 40 lakh	16 lakh	40 %
Procurement Subsidy for Establishment of Custom Hiring Centre upto 60 lakh	24 lakh	40 %

For Establishment of Hi-Tech, High Productive Equipment Hub for Custom Hiring

Sr No	Item	Maximum Permissible limit	Pattern of assistance
1	Procurement Subsidy for Establishment of Custom Hiring Centre upto 100 lakh	40 lakh	40 %
2	Procurement Subsidy for Establishment of Custom HiringCentre upto 150 lakh	60 lakh	40 %
3	Procurement Subsidy for Establishment of Custom Hiring Centre upto 200 lakh	80 lakh	40 %
4	Procurement Subsidy for Establishment of Custom Hiring Centre upto 250 lakh		
	100 lakh	40 %	

Financial Assistance for promotion of Mechanized operations/hectare carried out through Custom hiring centre: Government of India is also providing financial Assistance for promoting mechanized operations/hectare carried out through CHCs, which is as follows:

Sr No	Item	Maximum Permissible Project Cost	Pattern of Assistance
1	(a) Hiring Charges to farmer members of Farm Machinery	₹2000/ha/farmers/year	50% of the cost of operation/ha
2	(b) Field Demo by CHCs	Minimum 120 ha/season per CHC	₹ 4000/ha

for operations like sowing, planting, transplanting, plant protection, harvesting and machinery or implement is highly crop specific. Thus, diversification would require lot of additional equipment for these operations on limited area in the initial stages, making it uneconomical on ownership basis. However, Custom Hiring through private entrepreneurs or co-operatives will help to increase annual use of these equipments thereby making them viable.

India is global player in production of cereals such as wheat, rice but because of poor quality Indian cereal lose competiveness with respect to other countries. Through adoption of mechanization by CHSs, significant quality will increase, which will lead to better price and market linkage to farmers.

Soil health is major issue in the country. CHSs can help farmers for efficient usage of agrochemicals, which can also help to reduce cost of inputs.

If government involves in an arrangement to provide custom hiring service facility for farm machinery to farmers by engaging unemployed agricultural graduate, there will be better scope for machinery utilization round the year, better productivity and income generation per unit of manpower deployment. It will create sustainable entrepreneurship opportunities for the agricultural graduates even if other job opportunities are available. ■

Anjana Nair
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Food Processing for Increasing Food Potential

India endowed with varied agro ecological conditions and vast swathes of arable land, which happens to be the largest in the world, is home to many food crops. Primarily an agrarian country, India had to fight its way through famine, poverty and skewed political equations to arise out of utter helplessness in food availability to total food security. Overflowing granaries and truck loads of fruits and vegetables have become synonymous with India's agriculture. However, it would be a complete misconception to believe that these surpluses are turning into real time profit for farmers. India is becoming incapable to deal with excesses and this ineptitude deeply undermines the efforts, the resources and the time that has gone into the farming operations.

Even as India celebrates its success in agriculture pronounced by heaps and mounds of food grains scattered in the grossly inadequate premises of FCI godowns, one cannot but feel remorse for the quantity of food that is lost owing to a complete lack of logistics or lack of infrastructure. India being the top producer of many agricultural commodities, holds undue advantage in turning this spectacle into actual profit. Despite five decades post green revolution, we still have wastages that have rocketed to the tune of Rs.90,000 crore.

Food Wastage to Food Processing

India, although has successfully emerged from the abysmal pits of food shortage and today boasts of serial production bonanzas, the Asia's third largest economy has a totally shameful record of food wastages.

The food wastage is rampant across a wide section of agricultural products. While the perishable nature of fruits and vegetables may be one reason, it is the lack of proper storage infrastructure in the case of cereals. The food loss statistics associated with India's agriculture is a concern of mammoth proportions – a fact that was corroborated by the previous Agriculture Minister, Sharad Pawar when he informed the Parliament that India bears losses worth Rs. 44,000 Crore due to loss of fruits, grains and vegetables.

While the lack of storage infrastructure appears to be the primary reason, another possible factor is the underutilized potential of processing sector. India, despite being a major food producer, is unable to convert the surplus into value added products. The level of food processing in India is only 6% (2.2% of Fruits and Vegetables, 8% of Marine products, 6% for Poultry and 20% for Buffalo Meat) where as it accounts to more than 70% in Countries like USA, China, Malaysia, Philippines.

The food wastage that currently India is staring at significantly reduces the food available for consumption. At a time when there is a constant effort to enhance food production, these kind of losses severely restrains our goal of food for all. The losses should be converted into gains by involving the right technology and industry. This year's budget has placed tremendous emphasis on doubling farmers' income. A well-developed food processing sector with higher level of processing helps in the reduction of wastage, improves value addition, promotes crop diversification, ensures better return to the farmers, promotes employment as well as increases export earnings. This sector

is also capable of addressing critical issues of food security, food inflation and providing wholesome and nutritious food to the masses.

The distance from food wastage to food processing is fairly short if we are invested financially and politically. India offers tremendous opportunities for food processing. There is abundant supply of raw materials, a constantly increasing demand for food from a dynamic population and emphasis by the government on increasing the food processing capabilities of the country.

Food Processing – The Rising Star

Food processing sector is one of the largest in India in terms of production, growth, consumption, and export. India's food processing sector covers a variety of agricultural products including fruit and vegetables; spices; meat and poultry; milk and milk products, alcoholic beverages, fisheries, plantation, grain processing and other consumer product groups like confectionery, chocolates and cocoa products, soya-based products, mineral water, high protein foods etc.

In the last few years, the food processing sector has been growing at a faster rate than agriculture sector. Food Processing Sector has emerged as an important segment of the Indian economy in terms of its contribution to GDP, employment and investment. The sector constitutes as much as 9.0 and 11.0 per cent of GDP in Manufacturing and Agriculture sector respectively. Food Processing Industries sector has been growing at an Average Annual Growth Rate (AAGR) of around 8.4 per cent as compared to around 3.3 per cent in Agriculture and 6.6 per cent in Manufacturing. Performance of this sector has improved significantly in the recent years.

Besides contribution to the economy, the relevance of food processing in increasing employment opportunities are immense. Food Processing Industry is one of the major employment intensive segments constituting 13.04 per cent of employment generated in all Registered Factory sector in 2012-13. According to the Annual Survey of Industries (ASI) for 2012-13, the total number of persons engaged in registered food processing sector is 16.89 lakhs. Unregistered food processing sector supports employment to 47.9 lakh workers as per the NSSO 67thRound, 2010-11.

Processed foods also find markets abroad. The value of exports in the sector has been showing an increasing trend with Average Annual Growth Rate (AAGR) of 20.53 per cent for five years ending 2013-14. The value of processed food exports during 2013-14 (Provisional results) was of the order of US $ 37.79 Billion (total exports US $ 312 Billion) constituting 12.1 per cent of India's total exports. India's exports of Processed Food was Rs. 31563.43 Crores in 2014-15, which including the share of products like Mango Pulp (Rs. 841.39 Crores), Dried and Preserved Vegetable (Rs. 847.11 Crores), Other Processed Fruits and Vegetables (Rs. 2,569.93 Crores), Pulses (Rs. 1,209.51 Crores), Groundnuts (Rs. 4,675.35 Crores), Guargum (Rs. 9,480.00 Crores), Jaggery& Confectionary (Rs. 1,161.81 Crores), Cocoa Products (Rs. 848.62 Crores), Cereal Preparations (Rs. 3,038.79 Crores), Alcoholic and Non-Alcoholic Beverages (Rs. 2,231.58 Crores) and Miscellaneous Preparations (Rs. 2,437.77 Crores).

Since liberalization in Aug'91 several proposals for projects of have been suggested in various segments of the food and agro-processing industry. Besides this, Govt. has also approved proposals for joint ventures; foreign collaboration, industrial licenses and 100% export oriented units envisaging an investment. Out of this, foreign investment is over Rs.10,000 crores. Considering the tremendous opportunities existing in the Indian market, foreign companies are keen on investing in Indian processing sector. Foreign Direct Investment (FDI) is permissible for all the processed food products up to 100 per cent on automatic route except for items reserved for Micro and Small Enterprises (MSEs) subject to applicable laws/ regulatories, securities and other conditions. For manufacture of items reserved for Micro Small Medium enterprises, FDI is permissible under automatic route up to 24 per cent of the capital. If foreign investment is more than 24 per cent, Industrial License under Industries (Development & Regulation), Act 1951 is required. In terms of fixed capital, FP sector is growing at an AAGR of 20.35 per cent during five years ending 2011-12. As per the latest, ASI 2011-12, the Fixed Capital in FP Industry stood at Rs. 1,45,038 crore.

Despite being a global giant in agriculture, we in India have only explored a miniscule fraction of the food processing sector. Supply chain mismanagement, infrastructure gaps, APMC restrictions on raw materials procurement, complex FSSAI restrictions and inadequate organized retail has bottled up our food processing aspirations. With several schemes and programmes, we are on the right track to increase our food potential through food processing. ■

Indian Success in Seed Sector - Result of Government And Technology Support

Agriculture in India has travelled through different levels and have taken many historic turns. Each phase in the Indian agriculture took different paths and yielded exceptional results. Notably, each of these phase was engendered by 'a set of seeds' that changed the course of history of Indian agriculture. Seeds in fact were responsible for many revolutions and transformations that this country had witnessed. The famed' Green Revolution' that took India's agriculture to new heights was also based upon the seeds of High yielding varieties of wheat that produced good yields. Similarly, 'Bt cotton' transformed India's cotton economics. Good yields coupled with resistance to pest attack gave the cotton farmers in India better returns. Invariably good seeds produced good results.

But arriving upon a good seed is a herculean task. It involves years of research and standardization procedures before it reaches the farmers. Today, most of the farming in India depends upon these seeds that are released by research bodies or private companies. These seeds have become the staple of Indian agriculture.

Favourable Government Policies

Seeds form a crucial and unavoidable component of agriculture. They convert the resources and labour into fruitful harvest. In fact the response of all other inputs depend on the seed. Studies have pointed that quality seeds can alone contribute to about 15 – 20% to the total production depending upon the crop and it can be further raised up to 45% with efficient management of other inputs.

The growth of seed industry has been commensurate with that of Indian agriculture. At each step, the Indian agriculture was amply supported by the seed sector. Sixties were particularly a crucial time in Indian seed sector and several impactful changes happened during this time. In 1963, National Seed Corporation (NSC) was established. The objective was to undertake production of foundation and certified seeds. Now it has grown into a Schedule 'B'-Miniratna Category-I company wholly owned by Government of India under the administrative control of Ministry of Agriculture and Farmers Welfare. At present, NSC is undertaking production of certified seeds of nearly 600 varieties of 60 crops through its registered

seed growers. There are about 8000 registered seed growers all over the country who are undertaking the seed production programmes in different agro-climatic conditions. The turnover of the Corporation for the F.Y. 2014-15 was Rs. 890.03 Crores. The Government of India enacted the Seeds Act in 1966 to regulate the growing seed industry. The Seeds Act stipulated that seeds should conform to a minimum stipulated level of physical and genetic purity and assured percentage germination either by compulsory labelling or voluntary certification. Further, the Act provided a system for seed quality control through independent State Seed Certification Agencies which were placed under the control of State Departments of Agriculture.

The eighties were also impressive for seed sector as it witnessed two more important policy developments for the seed industry, viz. granting of permission to MRTP/FERA companies for investment in the seed sector in 1987 and the introduction of 'New Policy' on seed development in 1988. Besides this, the time saw launching of the World Bank aided National Seeds Programme (1975-85) in three phases leading to the creation of State Seeds Corporations, State Seed Certification Agencies, State Seed Testing Laboratories, Breeder Seed Programmes etc. Seed Control Order (1983), Creation of the Technology Mission on Oilseeds & Pulses (TMOP) in 1986 now called The Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM), Production and Distribution Subsidy, Distribution of Seed Mini-kits and Seed Transport Subsidy Scheme were also enacted during the same period.

Seed sector garnered further support in the beginning of nineties. Under the 1991 Industrial Policy,

seed production was identified as a 'high priority industry'. In line with India's larger liberalization and privatization policies during the same period, the new policy on Seed Development opened the doors for import of vegetable and flower seeds in general and seeds of other commodities in a restricted manner and also encouraged multinational seed companies to enter the seed business. As a result more than 24 companies initiated research and development activities.

Further to strengthen the seed sector and to address certain unattended areas in Seeds order, National Seed Policy 2002 was initiated. The aim was to provide intellectual property protection to new varieties; usher this sector into planned development; protect the interest of farmers and encourage conservation of agro-biodiversity. This policy had 10 thrust areas - Varietal Development and Plant Varieties Protection, Seed Production, Quality Assurance, Seed Distribution and Marketing, Infrastructure facilities, Transgenic Plant Varieties, Import of seeds and planting materials, Export of seeds, Promotion of Domestic Seed and Strengthening of monitoring system. Under the policy a Plant Varieties & Farmers' Rights Protection (PVP) Authority was established to undertake registration of extant and new plant varieties. A National Gene Fund was also established for implementation of the benefit sharing arrangement, and payment of compensation to village communities for their contribution to the development and conservation of plant genetic resources and also to promote conservation and sustainable use of genetic resources. The National Seeds Board (NSB) was established in place of existing Central Seed Committee and Central Seed Certification Board which was entrusted with the responsibility of executing and implementing the provisions of the Seeds Act and advising the Government on all matters relating to seed planning and development.

The Seeds Bill seeks to regulate the production, distribution and sale of seeds. It requires every seller of seeds (including farmers) to meet certain minimum standards. The Standing Committee has recommended that farmers selling or exchanging seeds

from other farmers be exempt from this requirement. The Bill has been pending since December 2004.

With ample support from the government, India's seed industry flourished. Currently, ranked as the fifth in the world, the domestic seed industry will continue to grow at a double-digit growth rate in the medium-term driven by improved seed replacement ratio (SRR) and rising adoption of improved hybrid seeds, according to ratings agency ICRA. The studies suggest the favourable policy environment generated through National Seeds Plan and National Food Security Mission (NFSM) has augured well for the industry.

The Indian seeds industry grew at a Compound Growth Rate (CAGR) of 8.4 percent in volume terms from FY 2009 to FY 2015 to reach 3.5 million tonnes in consumption. On an average, private sector companies saw operating margin of about 15.5 percent between Financial Year 2011 - FY 14 vis-a-vis 9.3 percent for state run companies. Private sector companies have a longer cash conversion cycle of about 160 days versus 75 days for state run players as observed by ICRA during the period FY 11 - FY 14.

Technology Help

While India's green revolution owed its results to the carefully selected and multiplied High Yielding Varieties, another major development was brewing in the hybrid seed sector which also marked yet another milestone in Indian agriculture. Followed by the hybrid seed production, India also made rapid advances in cotton production via GM technology.

India's first phase that owed considerable credit to seeds in sixties. India was struggling with low yields and was staring at a gaping void between demand and supply of food grains in the country. It was a struggle that was put to rest by the visionaries who decided to seek help from Norman Borlaug who was invited to India by the adviser to the Indian minister of agriculture, C. Subramaniam. Wheat seeds with striking yield advantages were imported to India and trials began in Punjab. The results propelled India's wheat production capabilities. In rice too, India adopted a revolutionary stand by adopting IR8 – a semi-dwarf rice variety developed by the International Rice Research Institute (IRRI) that could produce more grains of rice per plant when grown with certain fertilizers and irrigation. IR8 was also developed into Semi-dwarf IR36. The change in rice yields made India self sufficient and a reliable exporter of rice. The advances were also extended to other field crops.

Another major breakthrough took place when hybrids were introduced and widely accepted into the India's agriculture system.

Hybrids are now becoming the new favourites of the Indian farmers. Although the adoption of hybrids have not been uniform across all crop categories, the deepest impact had been on the cotton production segment. India became a pioneer country for commercial cultivation of cotton hybrids, which covered more than 50% of the cotton area. Cotton hybrids gave fifty percent higher productivity than conventional varieties. Their wider adaptability, high degree of resistance to biotic and abiotic stresses and better fibre quality made them a favourite of the Indian farmers. The first intra-hirsutum hybrid cotton Hybrid - 4(H-4) was released in 1970 from Main Cotton Research Station, Surat of G.A.U. by Dr. C.T. Patel. This was followed by the development of world's first inter-specific hybrid Varalaxmi in 1972 from U.A.S., Dharwad by Dr. B.H. Katarki. Hybridization also gripped the rice fields in India, albeit at a slower pace. Research programme was initiated during 1970 to develop hybrid rice variety in the country. There was no success in this programme during the subsequent two decades. However, the research programme was accelerated and intensified from 1989 with a mission mode project. With this concerted research efforts, a remarkable success was achieved within a short span of 5 years and half a dozen hybrid rice varieties were developed from public and private sectors. The first four hybrid rice varieties were released in the country during 1994. Subsequently, two more hybrid rice varieties were also released. By the end of 2001, a total of 19 hybrid rice varieties were released. During the year 2007, around 1.1 million hectares were estimated to be planted under hybrid rice. The

"National Food Security Mission" has specifically placed significant thrust on hybrid rice. However, Indian farmers have been reluctant to fully exploit the potential of hybrid rice as the cooking qualities of hybrid rice were not acceptable by the Indian palate. Another benefactor of hybrid seed technology was the vegetable segment in India. With the entry of private segment in the seed sector, hybrid technology in vegetable received a major boost.

Genetic engineering also made a formal entry into India's commercial agriculture scene. At a time, when cotton production in India was facing a major threat from boll worm – a pest that severely interferes with the boll quality and quantity, Btvarieites of cotton were introduced. The genetically engineered variety with borrowed genes from a bacteria *Bacillus thuringienisis* produced a protein in the plant itself that killed the pest – boll worm. The technology reduced the expenses incurred upon pest management and also increased the yield manifold. India's cotton yield was 225 kg per hectare in 1990-91. It fell to 190 kg per hectare in 2000-01, a bad monsoon year. Bt cotton cultivation began in 2002, and its acreage shot up from 0.29 million hectares in 2002 to 9.4 million hectares in 2011-12. By this time, the Bt variety accounted for 90% of cotton acreage. Cotton yield rose to 362 kg per hectare in 2005-06, and then increased further with fluctuations to 510 kg per hectare in 2010-11.In 2001, India was a large importer of cotton. But within seven years of Bollgard's introduction, India became the world's second-largest producer and exporter of cotton. Today, India's share of world cotton production is up 68%, and exports are at an all-time high.

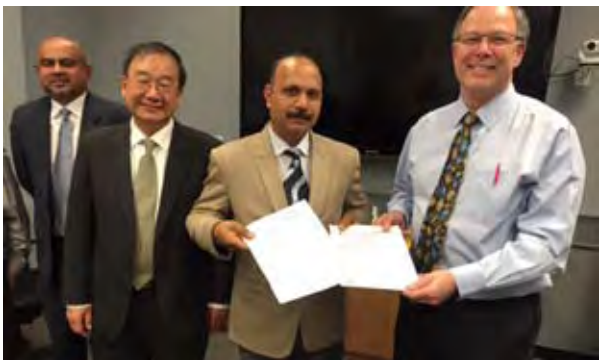
Seeds are central to our food security. They sow the seeds of prosperity in the lives of farmers and nation. India should take bold measures to address the inefficiencies or gaps in the system. ■

Agriculture Today Team

ICFA- The Journey Begins...

It was September 2015, during the 8th Agriculture Leadership Summit that ICFA was born. It came into existence in presence of a host of eminent dignitaries when Hon'ble Home Minister of India, Sri Rajnath Singh launched the website of ICFA and also announced its formation officially. The discussions and deliberations for its formation stretched over 12 years with its 1st meeting taking place at the residence of the then Power Minister, Suresh Prabhu (now Minister of Railways) in 2012. It has been one complete year since its launch on 18 Sept, 2015 and ICFA has already started taking its early baby steps. During the very first couple of months of its formation, ICFA conducted its first board meeting and following that, it undertook a number of engagement activities.

After having drawn an elaborate Board of Directors consisting of people of eminence, experts, policy makers, parliamentarians, bureaucrats, industrialists and corporate CEOs, international experts and progressive farmers, ICFA also constituted a number of Working Groups to have focussed approach towards policy issues concerning those sectors. Working Groups were formed with utmost consideration for representing all and every facet of the agriculture sector that involves a complex network of social, economic, cultural and scientific aspect. ICFA recognizes that one of the major issues facing Indian food and agriculture and its trade is the issue of food safety, traceability and certification. Aspects like adherence to Good Agricultural Practices (GAP) and quality standards of food in India, including awareness in this regard in the producers and consumers, are impacting Indian exports and trade. ICFA has taken up agriculture stewardship program and national certification program for farm produce and GAP, especially the agriculture produce meant for nutrition and health sectors, industrial use or for exports. ICFA is also promoting investments and technologies in farm sector by forging global partnerships with right institutions and by taking up



ICFA Signing up MoU with the University of Maryland

ICFA Signing up MoU with The Energy and Resources Institute

projects, training and entrepreneurship development to accelerate growth in productivity, agribusinesses and exports.

ICFA has already signed up MoUs with a host of very important organizations spread across India and the world, working in the field of agriculture. The colourful bouquet of the MoUs that ICFA has already signed up includes organizations like the International Trade Council (Brussels), Michigan State University (USA), University of Maryland (USA), University of Western Australia (Perth), MSSRF (Chennai), India Agriculture Group International (Washington DC), Asia Africa Rural Development Organisation, Borlaug Institute for South Asia and University of California and The Energy and Resources Institute (New Delhi) to name few. Talks of similar MoUs are on with various other organizations too. All these mutual agreements provide a viable and effective climate for fostering meaningful dialogue and activities towards the betterment of Indian agriculture, in particular and the national economy, in general. In addition, agreements on a number of Joint Business Councils (JBCs) have been forged and progress made. ICFA is closely working on formation of business platforms like India-Africa JBC, India-US JBC, JBCs between France, the Netherlands, China, Australia, Brazil and a host of other countries. All preparations have been made for launching State Chapters of ICFA, starting with Uttar Pradesh, Maharashtra, Punjab and North Eastern Region to follow.

ICFA announced the launch of Working Group on African Agriculture, Chaired by India and Co-chaired by US

In short, between Agriculture Summit 2015 and the Summit this year on 8 Sept, 2016, ICFA has been able to create the necessary critical mass and gain the required traction for undertaking activities and achieve the objectives with which it has come into existence. However, ICFA recognizes that the coming months and the future will not be easy for the agriculture sector due to rapidly growing incomes in India and other developing countries; and as a result the increasing pressure on demands for pulses, oilseeds, fruits, vegetables, fish, dairy and meat products. Thus, the work for bodies like ICFA becomes further more important and challenging in promoting trade and mobilising global investments and technologies for improving productivity and availability of food towards ensuring national and global food and nutrition security. However, with the support that ICFA is getting from its Board and all the stakeholders, it hopes to further gain momentum and contribute meaningfully for the overall development of the sector with welfare of the farmers being the ultimate focus. Launch of ICFA promoted All India Farmers Alliance at the 9th Agriculture Leadership Summit will go long way in giving voice to the farmers at the states, national and global levels and towards empowering them. ■

INTERNATIONAL AGRICULTURE CONSULTING GROUP

Indian initiative towards food and agriculture solutions

Vision

Our vision is to be a leading provider of Indian regional expertise in food and agriculture and to outstand as key advisory partners on food security concerns, policy planning and strategy framework for sustainable development through agriculture.

Mission

Our mission is to initiate and support micro and macro level changes in agriculture by providing Indian expertise and solutions for research, extension, education, training, institutional frame, policy planning, agribusiness and project consulting so as to address their major agricultural concerns relating to farm production, food security, environment sustainability, rural employment, economic growth and human resource development.




Objectives

1. Provide Indian expertise to deliver solutions to agricultural issues and concerns through formulation of agro and rural development projects, farming solutions, micro and macro level national agriculture planning, policy support, organized research, extension infrastructure and institutional set-ups, value addition and market linkage services.
2. Manage short terms management programs, training and entrepreneurship course for farmers, research & extension personnel, officials and professionals of various countries while recognizing and understanding ecological, technological, social and economic concerns related to their food and agriculture sector.
3. Facilitating students from different countries in enrolling in food and agricultural degree programs; management and entrepreneurship courses offered by various institutes and recognized universities of India, so as to help various countries in developing human resource for creative and productive change at ground level.
4. Organizing delegation level visits from India to various countries and of different countries to India for participation in agri and business summits, learning and exposure at technology institutions, agri universities, model farms etc., and discussing possibilities for joint ventures, collaborations and promoting better understanding in agriculture and agribusiness.
5. Facilitating Governments, Corporates or Institutions to venture globally and act as total solutions providers in implementation of foreign agriculture projects by providing research structure, technical assistance and investment planning in food, farming, agribusiness or agriculture development programs.

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