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The National Agriculture Magazine

AGRICULTURE YEAR BOOK 2018





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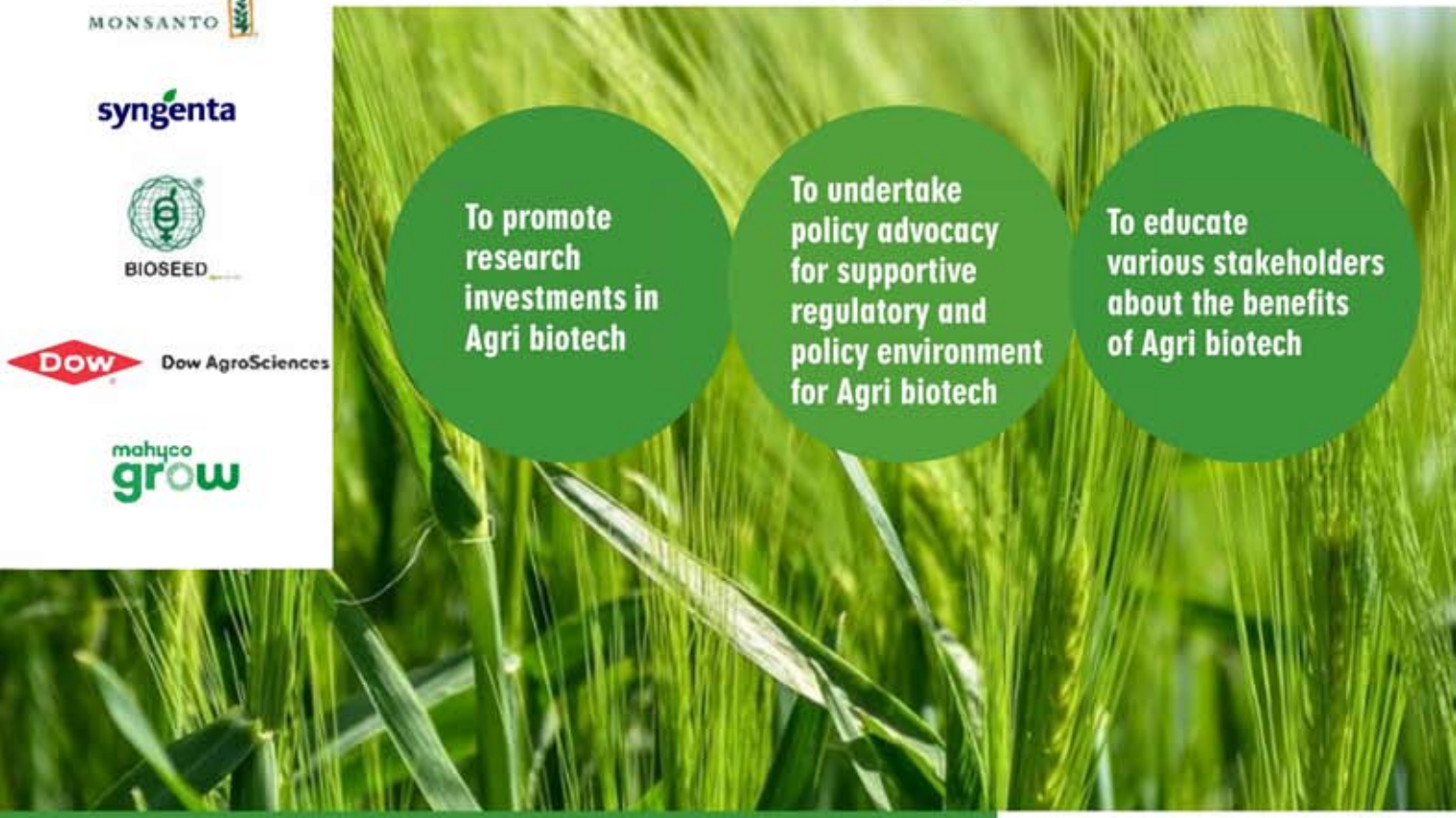

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EDITORIAL NOTE

Dear Readers,

It gives me immense pleasure to introduce to you the recent edition of the Agriculture Today Year Book. The 11th edition is the result of hours of hard work, months of preparation and dedicated efforts put together by a remarkable team. The readers, our source of motivation, have also played their role in bringing out the best in us.

Agriculture Today has emerged as a strong force in the Indian agricultural scene for close to two decades. Faring the test of time, the magazine has earned the trust of its readers over the years and has become the ideal platform to discuss and debate topics of agricultural relevance.

Agriculture Today Year Book of 2018 features articles penned down by the some of the brightest minds in Indian agriculture. These articles evolved from years of experience are a powerhouse of knowledge for the stakeholders of agriculture. The articles address the most contemporary as well as the most significant issues faced by agriculture and carry glimpses of hope, and plans of action. The year book 2018, besides featuring some of the best articles written in agriculture strikes a right balance with data, analysis and information.

I would like to thank all the eminent writers for their valuable contributions for the Year Book 2018. 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, including government officials, policy makers, scientists, agribusiness companies, NGOs, institutions, agri researchers, professionals, planners, students etc. 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 11th Global Agriculture Leadership Summit 2018 for their valuable guidance. I am thankful to Dr. MJ Khan for guiding us throughout the entire process of compilation. My colleagues specifically, Fariha Ahmed and Mr. Abdul Rehman deserve special mention whose untiring efforts in compiling the Agriculture Year Book 2018 were exemplary.

Anjana Nair

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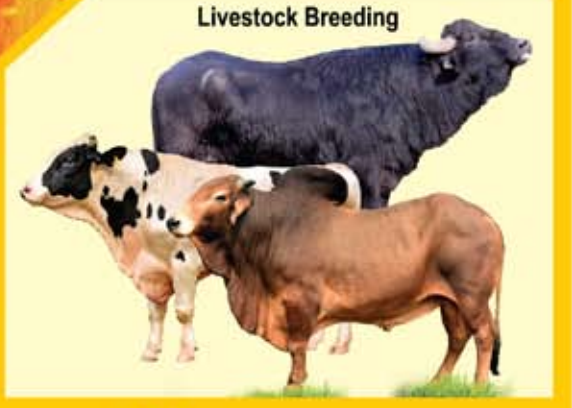

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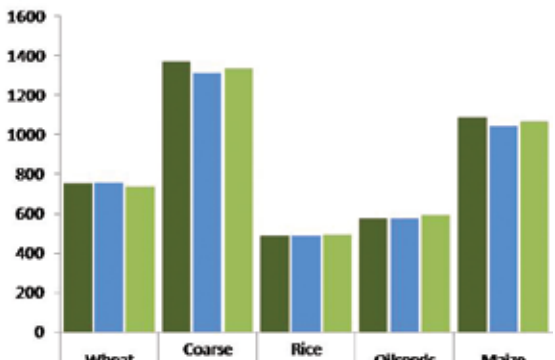
GLOBAL AGRICULTURE

GLOBAL FOOD PRODUCTION

Global production of the important agri commodities in the last three years exhibited more or less the same level of production. Wheat recorded 758 million tonnes in 2017-18 which was a little above the production of 752 million tonnes the previous year. The global production of wheat is projected at 736.3 million tonnes for the current year, till August 2018. However, the global production of total coarse grains witnessed a marginal decline in 2017-18 at 1314.5 million tonnes from that of about 1370 million tonnes in the previous year.

Fig 1: Global Food production



	Wheat	Coarse Grains	Rice (Milled)	Oilseeds	Maize
2016-17	752	1,369.90	486.7	574.2	1087
2017-18	758	1,314.50	488.5	573.4	1045
2018-19 (Proj till Aug '18)	736.3	1,336.90	491	592.6	1064

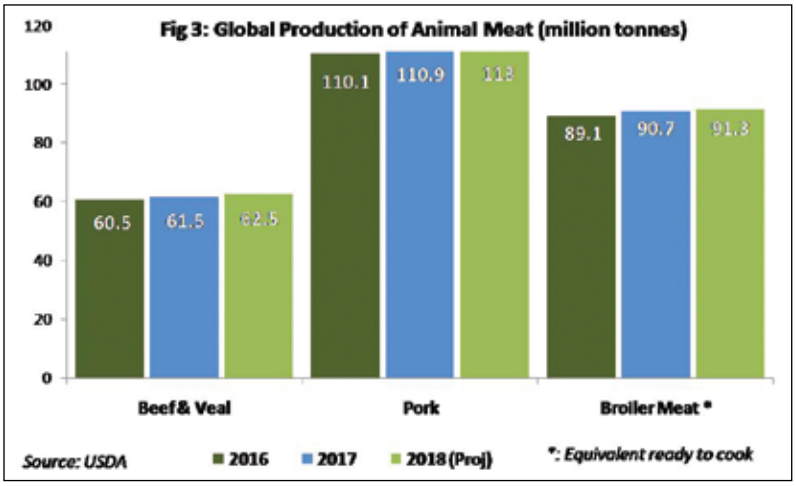
Source: USDA

■ 2016-17 ■ 2017-18 ■ 2018-19 (Proj till Aug '18)

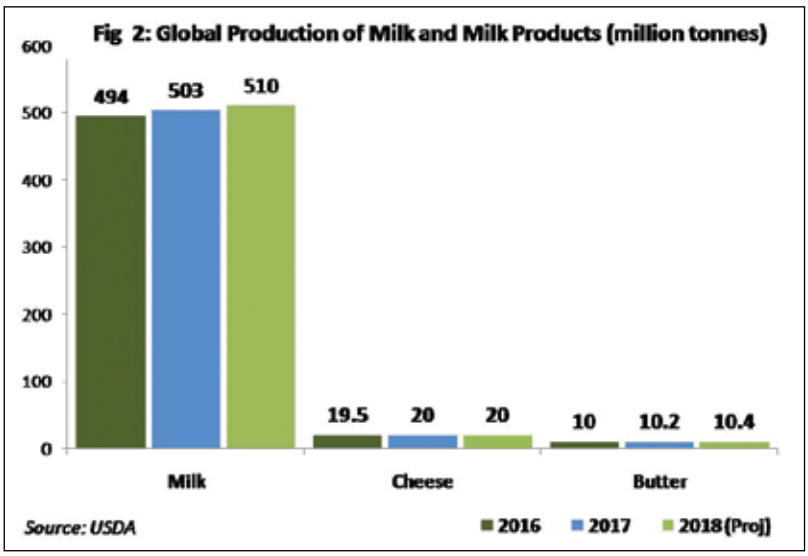
It is expected to recover and a slight increase in total production of global coarse grains is projected in 2018-19. Rice which is the staple food of almost half of the world population is showing consistency in production. In 2016-17, the total global production of rice was about 487 million tonnes followed by a production of 488.5 million tonnes in 2017-18. This year, it is projected to further increase and till August 2018, the rice production worldwide recorded 491 million tonnes (Fig 1).

Oilseeds too exhibited a similar trend of consistent production. While the total global oilseeds production in 2017-18 (573.4 million tonnes) was about a million tonne less than that of the year 2016-17, the global production is expected to rise this year (about 593 million tonnes as projected till August 2018). Global maize production decreased significantly from 1087 million tonnes in 2016-17 to 1045 million tonnes in 2017-18. It is expected to recover this year with the projection till August being 1064 million tonnes.

Fig 2 depicts the global production scenario of milk and milk products. The production of milk has been exhibiting a nominal increasing trend with 494 and 503 million tonnes in 2016 and 2018 respectively. This year, the projected milk production is 510 million tonnes. Similarly, the total global production of cheese and butter will remain almost same as the previous years.

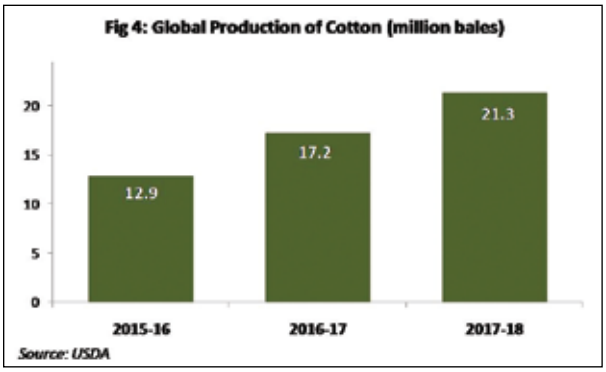


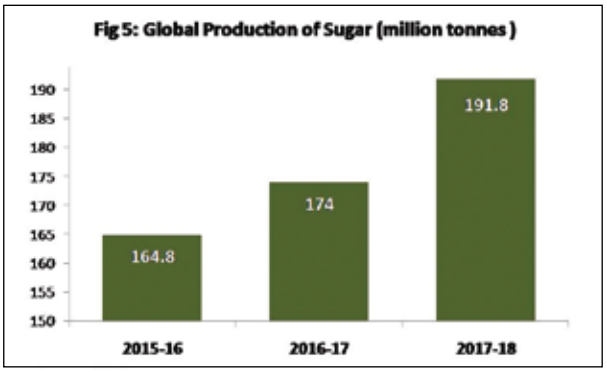
Statistics reveal that pork followed by broiler meat has always been consumed more than beef and veal worldwide. Production of beef and veal was 60.5 million tonnes and 61.5 million tonnes in 2016 and 2017 respectively. This year, it is expected to be about 62.5 million tonnes. In contrast, the global production of pork this year is expected to be about 113 million tonnes, a marginal increase from 110.9 million tonnes in 2017 and 110.1 million tonnes in 2016. Production of broiler meat, in terms of equivalent amount of ready to cook meat was recorded as 89.1 and 90.7 million tonnes in 2016 and 2017 respectively with a projection of 91.3 million tonnes this year.



Cotton and Sugarcane are two important cash crops globally. The global cotton industry is buoyed by factors like increasing consumer preferences, rapidly increasing polyester prices and increasing concern for pollution issues arising from synthetic fibres. This has opened up new opportunities for the cotton sector. Production of cotton exhibited considerable increase in the last few years. Global cotton production increased by 65% in between the period from 2015-16 to 2017-18; increasing from 12.9 million bales in 2015-16 to 21.3 million bales in 2017-18 (Fig 4).

Global sugar production has also exhibited a considerable increase in the past few years. In 2016-17, it increased to 174 million tonnes which further increased to 191.8 million tons in 2017-18, thus posted a net increase of 16% from 2015-16 to 2017-18. This increased production of sugar has in turn resulted in soaring global surplus of sugar of about 20 million

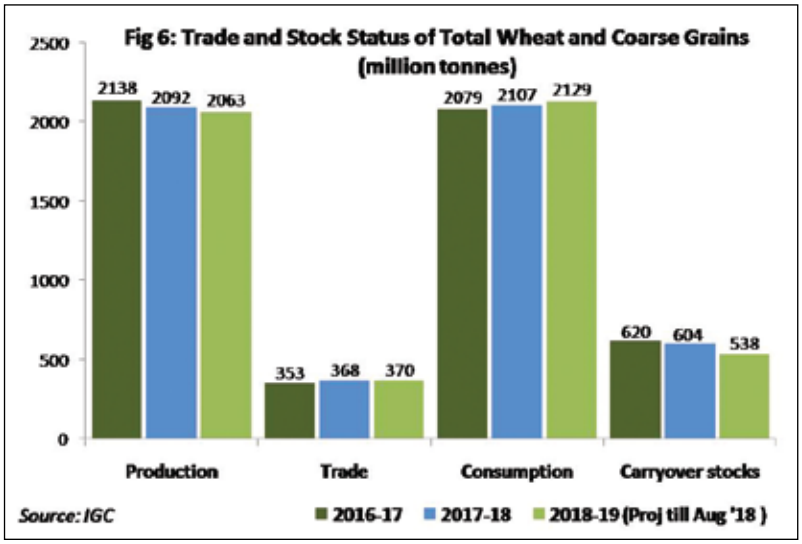


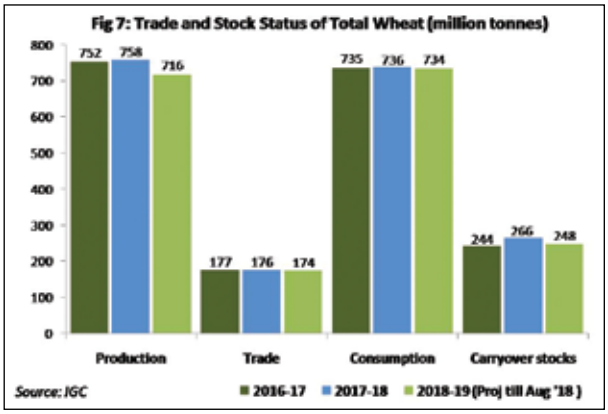


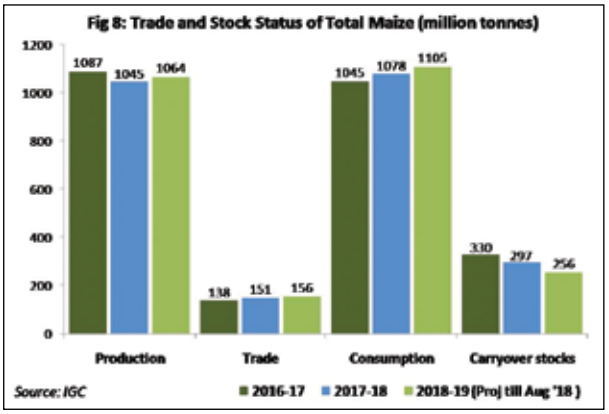
tonnes in 2017-18 and in 2018-19, the surplus is projected to be about 16 million tonnes. The surge in global sugar production in the last couple of years was mainly as a result of huge production in countries like India. As a result of the increasing sugar stock, the prices of sugar worldwide will see a downward trend.

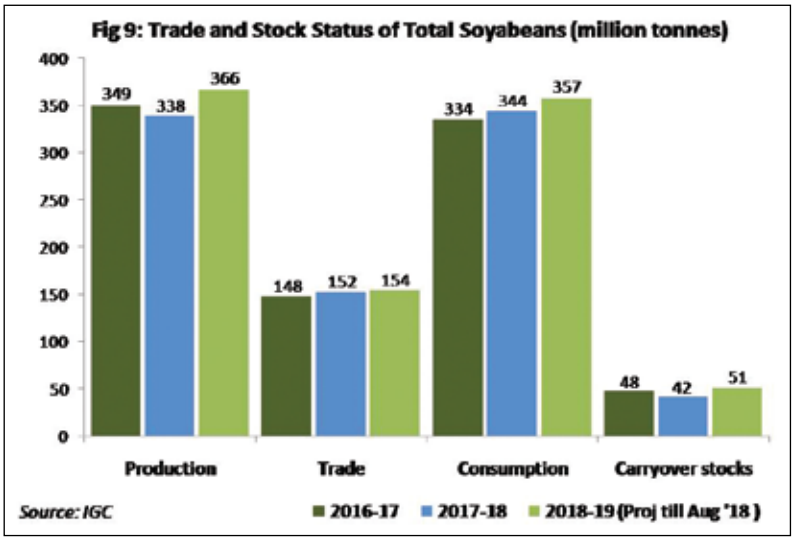
Trade and stock status of wheat and other coarse grain production on a global level reveals that consumption has been increasing in the recent years along with marginal decrease in carryover stocks. Carryover stocks are important in terms of maintaining a global buffer stock but might also hide an inequitable distribution of stocks across different countries with some countries left with considerable surplus while some stare at food insecurity due to meagre surplus (Fig 6). Carryover stocks of wheat and other coarse grains at a global level was 620 million tonnes and 604 million tonnes in 2016-17 and 2017-18 respectively while in the current year as projected till August, the carry over stock is expected to further decrease to 538 million tonnes. The trade on the other hand was 353 million tonnes and 368 million tonnes respectively in 2016-17 and 2017-18 respectively and this year, its projected to be about 370 million tonnes till August.

Fig 7 shows the trade, consumption and carryover stocks scenario of wheat alone. Total trade of wheat globally has remained consistent in terms of quantity along with consumption and carryover stocks. However, the carryover stocks this year are projected to show some decline from the previous year's quantity of 266 million tonnes.









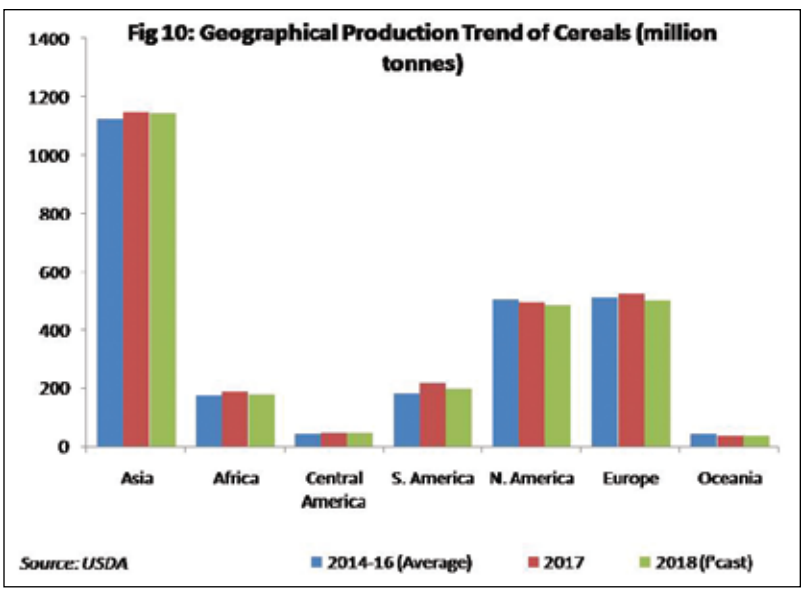
stock scenario in case of maize reveals a different story though. While the total global production of maize is showing fluctuating trends in the recent past years, its trade and consumption has shown upward trend, perhaps due to its increasing use in bio fuel production. At 151 million tonnes in 2017-18, trade of maize increased from its previous year's quantity of 138 million tonnes. This year till August, the projected trade is 156 million tonnes. Consumption increased from 1045 million tonnes in 2016-17 to 1078 million tonnes in 2017-18 and this year, the consumption is projected to increase further to 1105 million tonnes. However, the global stocks of maize has been depleting constantly in the recent years. From 330 million tonnes in 2016-17, it dropped to 297 million tonnes in the following year and is further projected to drop this year to 256 million tonnes.

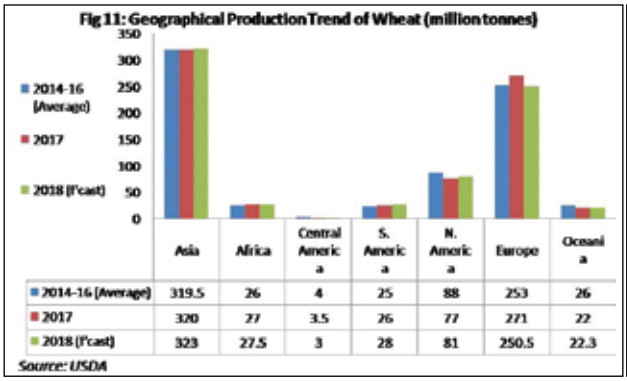
The global soybean trade and the market for soybean in the recent years have been witnessing interesting twists and developments. Recently, China had imposed tariffs against U.S. soybeans and in the process heralded a major trade shift for a crop that has soared to prominence in recent decades. This has also caused a dent in soybean prices as US tries to find new markets for its produce. The biggest impact of this trade war has been on the farmers of Louisiana in US who are forced to sell their crops at a very low price. The overall global trade however has been on a slightly increasing trend, as can be seen in Fig 9. From 148 million tonnes in 2016-17, it increased to 152 million tonnes in 2017-18 and this year, it has projected to increase further to 154 million tonnes. The consumption has been increasing too. However, the carryover stocks are showing a fluctuating trend, largely due to a decrease in production in 2017-18.

GEOGRAPHIC DISTRIBUTION OF GLOBAL FOOD PRODUCTION

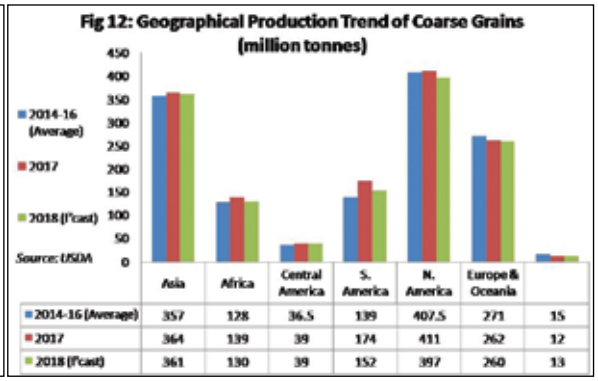
Asia has always been the leader in production of cereals across the world. The average total cereal production in Asia was 1124 million tonnes during 2014 to 2016. It increased to 1150 million tonnes in 2017 and this year, it has been forecasted to be 1147 million tonnes (Fig 10). The highest growth in cereal production has been registered in the South American region, growing at a CAGR of 3% from 180 million tonnes (2014-2016 average) to197 million tonnes in 2018 (forecast). North America, Europe and Oceania regions witnessed fall in production with the steepest fall in Oceania. The production of cereals in Oceania witnessed a negative CAGR of 5%, decreasing from 42 million tonnes (2014-2016 average) to36 million tonnes in 2018 (forecast).

Among cereals, Asia is the highest producer of wheat closely followed by Europe. The highest growth in wheat production is seen in the South Ameri-





	Asia	Africa	Central America	S. America	N. America	Europe	Oceania
2014-16 (Average)	319.5	26	4	25	88	253	26
2017	320	27	3.5	26	77	271	22
2018 (F'cast)	323	27.5	3	28	81	250.5	22.3



	Asia	Africa	Central America	S. America	N. America	Europe & Oceania	
2014-16 (Average)	357	128	36.5	139	407.5	271	15
2017	364	139	39	174	411	262	12
2018 (F'cast)	361	130	39	152	397	260	13

can region, where the production increased from 25 million tonnes (2014-2016 average) to 28 million tonnes in 2018 (forecast). With the forecastproduction of about 22.3 million tonnes this year, Oceania region will witness the steepest fall in production of wheat in the world with a negative CAGR of almost 5% (Fig 11).

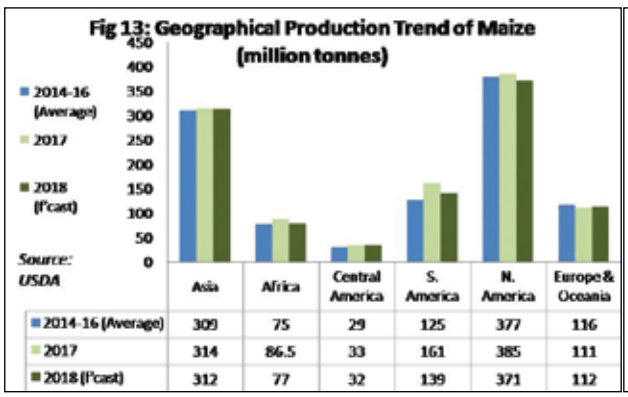
North American region is the leading producer of coarse grains closely followed by the Asian region. However, North America registered a negative growth in coarse grain production in the recent years with a negative CAGR of about 1%. Here, with a forecast production of 397 million tonnes of coarse grains in 2018, the production will witness a decrease from the average production figure of 407.5 from 2014 to 2016. The production forecast for Asian region this year is 361 million tonnes (Fig 12).

In terms of maize production, North America is the leading region but this year, the production forecast indicates a decrease in production at 371 million tonnes. The average production from 2014 to 2016 was 377 million tonnes in this region (Fig 13). The second largest producing region for maize is Asia which is forecast to witness a slight increase in production this year at 312 million tonnes from the average production of 309 million tonnes (2014-2016).

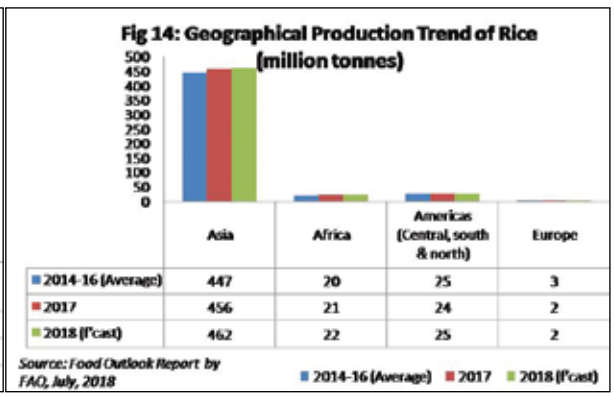
As usual, Asia continues to lead the global rice production sharing almost 87% of the global production. Driven by favourable weather conditions this year, the total rice production in Asia is forecast to be about 462 million tonnes, growing at a CAGR of about 1% from 447 million tonnes of average rice production from 2014 to 2016 (Fig 14). Among major producers in the region, the outlook is especially positive for India, which has already received normal monsoon this year. Moreover, government has announced revised minimum support prices (MSP) for Kharif crops at 1.5 times their cost of production. This will also be a positive factor for increased production of rice this year in India.

Global oilseeds production will be contributed almost equally by Asia, South America and North America, with South American region slated to produce 179 million tonnes of oilseeds in 2018. However, owing to unfavourable weather conditions, South America will witness a considerable decline in production of oilseeds. The production forecast of 179 million tonnes marks an annual 8% decrease when compared to the figure of 195 million tonnes in 2017 (Fig 15).

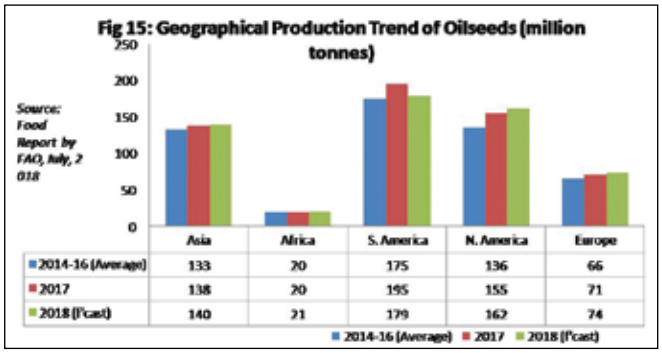
Production of sugar has always been dominated by South America and the Asian region. However, production of sugar witnessed an annual decline of 8.5% in South America from 47 million tonnes in 2016-17 to 43 million tonnes in 2017-18. To the contrary, sugar production increased by almost 3% from 58 million tonnes

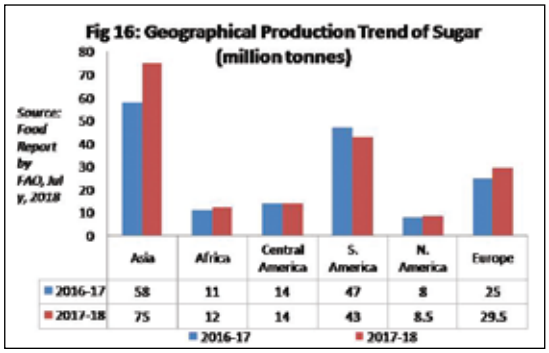


	Asia	Africa	Central America	S. America	N. America	Europe & Oceania
2014-16 (Average)	309	75	29	125	377	116
2017	314	86.5	33	161	385	111
2018 (F'cast)	312	77	32	139	371	112



	Asia	Africa	Americas (Central, south & north)	Europe
2014-16 (Average)	447	20	25	3
2017	456	21	24	2
2018 (F'cast)	462	22	25	2





in 2016-17 to 75 million tonnes in 2017-18. Globally, sugar production has witnessed an all time high of a record level of 187.6 million tonnes in 2017-18. This marks an increase of 11.1 percent over the 2016-17 season, and most likely as a consequence of this, the global sugar price will continue to remain low in the coming months (Fig 16).

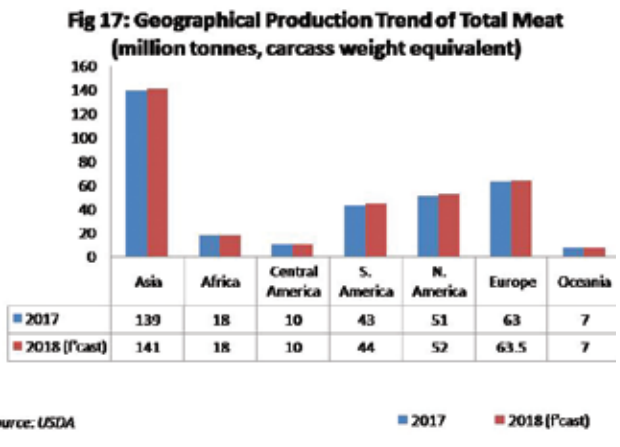
DISTRIBUTION OF GLOBAL ANIMAL HUSBANDRY AND DAIRY PRODUCTS PRODUCTION

Asia contributes almost 42% of the total global meat production constituting bovine, ovine, pig and poultry meat. The production forecast of total meat in Asia in 2018 is 141 million tonnes. Europe contributed almost 19% of the global total meat production with 63.5 million tonnes in 2018 (forecast). South and North American region constitute 13% and 15% respectively and according to the forecasted production in 2018, these two regions will respectively produce 44 million tonnes and 52 million tonnes of total meat.

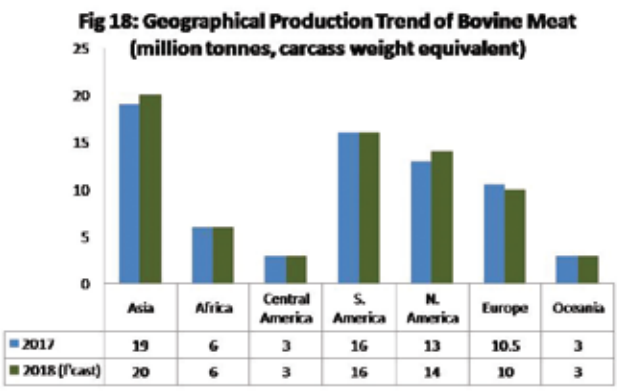
As a part of the total meat production, bovine meat constitutes the major and important segment globally. Asia is the largest producer of bovine meat and in 2018, it is forecasted to produce 20 million tonnes, a marginal increase from 19 million tonnes the previous year. South America, North America and Europe is expected to produce 16 million tonnes, 14 million tonnes and 10 million tonnes of bovine meat respectively.

In terms of ovine meat production, Asia produces about 9 million tonnes and Africa produces 3 million tonnes. Much of the ovine meat production in the Asian region is driven by China which has witnessed a recent demand growth in sheep meat. China is the largest producer, consumer and also the importer of sheep meat globally. In the Oceania region, Australia and New Zealand are the important producers, which are also the two important exporters of sheep meat globally. As a matter of fact, the recent growth import demand for sheep meat in China is largely being met by Australia and New Zealand (Fig 19).

Pig meat production in Asia in 2017 was 66 million tonnes which is going to marginally increase to 67.5 million tonnes according to 2018 forecast. This accounts for about 55% of the total pig meat production globally. The other important pig meat producing countries are North America and Europe producing 14 million tonnes and 29 million tonnes respectively (Fig 20). Countries like China, United States, the EU, the Russian Federation and Vietnam will help maintain the production momentum with increased production in these respective countries. In China, production will

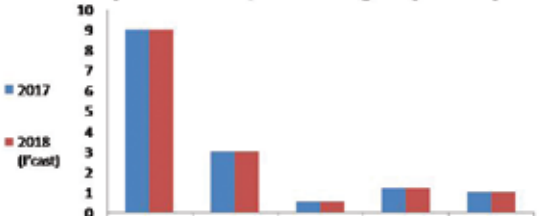


Source: USDA



Source: Food Outlook Report by FAO, July, 2018

Fig 19: Geographical Production Trend of Ovine Meat (million tonnes, carcass weight equivalent)



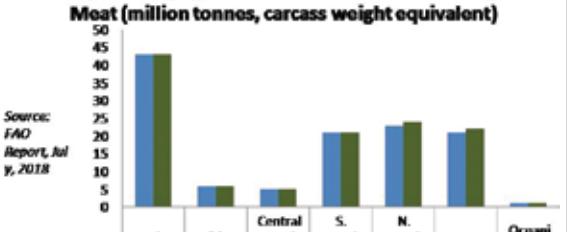
	Asia	Africa	Americas	Europe	Oceania
2017	9	3	0.5	1.2	1
2018 (F'cast)	9	3	0.5	1.2	1

Source: Food Outlook Report by FAO, July, 2018

Fig 20: Geographical Production Trend of Pig Meat (million tonnes, carcass weight equivalent)

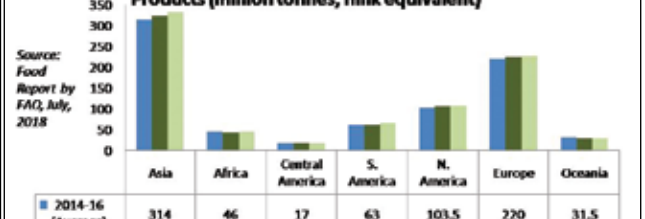
	Asia	Africa	Central America	S. America	N. America	Europe	Oceania
2017	66	1.5	2	6	14	29	0.5
2018 (F'cast)	67.5	1.5	2	6	14	29	0.6

Fig 21: Geographical Production Trend of Poultry Meat (million tonnes, carcass weight equivalent)



	Asia	Africa	Central America	S. America	N. America	Europe	Oceania
2017	43	6	5	21	23	21	1
2018 (F'cast)	43	6	5	21	24	22	1

Fig 22: Geographical Production Trend of Milk and Milk Products (million tonnes, milk equivalent)



	Asia	Africa	Central America	S. America	N. America	Europe	Oceania
2014-16 (Average)	314	46	17	63	103.5	220	31.5
2017	323	45	17.5	63	107	224	31
2018 (F'cast)	333	45.5	18	65	109	227	31

increase as a result of the restructuring and modernization of the sector undertaken in the recent times.

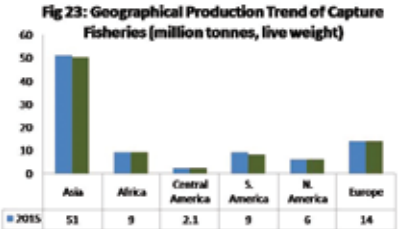
Global poultry meat production is led by Asia producing about 43 million tonnes and accounting for 35% of the total world production of poultry meat. South America, North America and Europe are the other major producing regions with 21 million tonnes, 24 million tonnes and 22 million tonnes respectively. With the threat of Avian Influenza largely under control, the global poultry meat production will witness a sustained growth in the coming time (Fig 21).

Global milk and milk products market is led by China followed by Europe, North America and South America in that order. This year, the total production milk and milk products in Asia is forecast to be about 333 million tonnes. The production forecast for Europe is 227 million tonnes while for North America and South America, the production figures (forecast) for 2018 are 227 million tonnes, 109 million tonnes and 65 million tonnes respectively.

On an overall basis, the global market for milk and milk products in 2018 is expected to attain its fastest growth since 2014, with expansion in almost all the major markets. Forecast to reach 829 million tonnes this year, the global milk production will be expanding by 16.7 million tonnes, or 2.1 percent, from 2017 (Fig 22).

Asian region, the leader in global capture fisheries witnessed a marginal fall in production from 51 million tonnes in 2015 to 50 million tonnes in 2016. The major constituents of capture fisheries are species like tuna, shrimp, ground fish, cephalopods etc. India has been a major contributor of shrimp varieties but over the last few years, the production of shrimp in India has been on the lower side. In the tuna fish category, countries like USA has remained a major exporting country (Fig 23).

Fig 23: Geographical Production Trend of Capture Fisheries (million tonnes, live weight)



	Asia	Africa	Central America	S. America	N. America	Europe
2015	51	9	2.1	9	6	14
2016	50	9	2.1	8	6	14

Source: Food Outlook Report by FAO, July, 2018

Other than the capture fisheries, the inland or the aquaculture fisheries is also a major constituent of global fish production. Asian region has always remained an overwhelming contributor to global inland fisheries production and much of the growth in this segment has been from countries like India. As a matter of fact, India was able to reverse its total fisheries sector production trend in favour of inland or aquaculture fisheries than capture fisheries. In 2016, total production of aquaculture fisheries was about 71 million tonnes, a small increase from the production of 68 million tonnes in the previous year. ■

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H.E. Ms. Judith Kangoma Kapijimpanga
Hon'ble High Commissioner,
High Commission of the Republic of Zambia,
New Delhi

ZAMBIA AGRICULTURAL INVESTMENT OPPORTUNITIES

Zambia is a Country centrally located in Southern Africa bordering 8 Countries namely; Tanzania, Malawi, Mozambique, Zimbabwe, Botswana, Namibia, Angola and Congo D.R.

Though it is geographically landlocked, Zambia is now landlinked because of the massive investment in infrastructure such as roads. Zambia can easily be accessed from India as it is only 6 hours from Dubai, 4 hours from Ethiopia, 2 hours 45 minutes from Kenya, 2 hours from South Africa, 2 hours from Tanzania and 45 minutes from Harare.

With only a population of 15 Million, Zambia is endowed with abundant land of 752 614 kilometres squared. It should be noted that the Indian companies at present, constitute a huge proportion of Zambia's FDI estimated to be in excess of USD4 billion.

Investing in Zambia's agriculture sector is attractive because it is a gateway to three regional markets - Southern African Development Community (SADC), Common Market for Eastern and Southern Africa (COMESA) and East Africa Community (EAC). SADC alone has a population of 401 people, EAC 153 million people and COMESA 582 million people. These provide enough base for sell any agricultural produce or implement.

Since independence in 1964, Zambia has only known peace with a flourishing democracy and strong legal frameworks that protect private sector investment. Zambia's GDP growth rate is 3% as at 2016 with inflation under a single digit of 7% as at 2016. Investing in Zambia's agriculture sector is attractive because of a favourable business

environment. The World Bank "Ease of Doing Business" ranked Zambia 5th in COMESA. The World Economic Forum "Global Competitiveness Index also ranked Zambia as the 11th most competitive country in Africa. Forbes annual ranking "Doing Business" also ranked Zambia as the 9th best country among 54 African countries to do business. The World Bank's forecast on Zambia's GDP in 2018 is 4.2%.

Agriculture is among the five priority sectors in Zambia alongside energy, tourism, manufacturing and infrastructure development. There therefore, are great investment opportunities in agriculture.

The Zambian Government has set aside over 100, 000 hectares of land in each of the 10 provinces in Zambia for commercial agriculture coupled with small holder farmer integration. Luena Farm Block in Luapula Province on the northern side of Zambia has 150, 000 hectares of land reserved for investment in agriculture. Chikumbilo Farm Block in Eastern Province has 47, 000 hectares while Nansanga Farm Block in Central Province has 100, 000 hectares of land. Chongwe Farm Block in Lusaka Province has 100, 000 hectares.Simango Farm Block in Southern Province has 100, 000 hectares same as Kalumwange in Western Province.Lufwanyama in the mining Province,Copperbelt,has 120, 000 hectares while North Western Province has 100, 000 hectares of land under the Solwezi Farm Block. The farm block development allows investors to easily find suitable land for investment in agriculture with serviced roads, water and electricity.

Zambia is further encouraging investors to target agro processing for value addition.Vast investment opportunities for food processing

exist in the Country, covering both large and small scale industries in each of the 10 Provinces.Agro processing and value addition opportunities exist in the following areas:

- Eastern Province has opportunities in maize, cotton, beans, tobacco and groundnuts processing while Luapula Province is rich aquaculture, cassava, maize and sugarcane plantation.
- Southern Province is endowed with abundant beef, dairy, meat processing and maize, while North Western Province has opportunities in pineapple canning, honey production, agro forestry and coffee.
- Muchinga Province is rich in rice and maize (cereals and mill) processing.

- Western Province has adequate tobacco, rice, and cashew nuts as well as cassava which can be an opportunity for processing.
- Central Province has wheat, soya, sunflower and maize awaiting value addition through processing.

Zambia has fertile land where anything grows and the Country is divided into three agro ecological regions (based on rainfall, soil and crop suitability).

- Region one (down south) receives rainfall of about 800 mm per annum. This region has loamy to clay soils that support the growth of cotton, sorghum, millet, sesame, cashew nuts, livestock and fisheries.
- Region two which is the central half of the Country has a rainfall range of 800 to 1,000 mm per annum. The central region has inherent fertile plateau soils. These support the growth of maize, cotton, tobacco, sunflower, soya beans, irrigated wheat, groundnuts, flowers, paprika, vegetables, cassava, millet, horticulture and livestock.
- The third region covering Muchinga, Northern, Luapula,

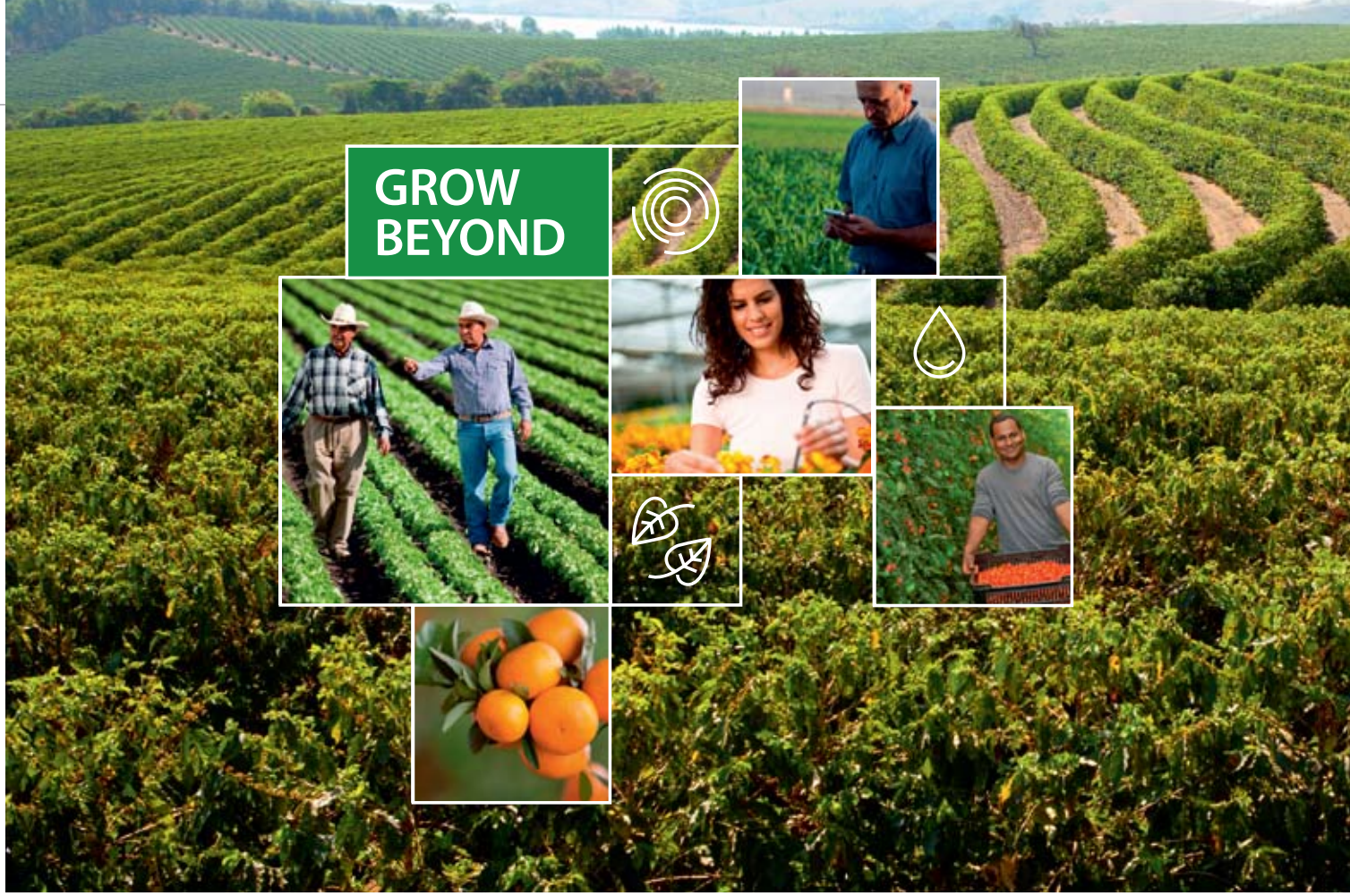
Copperbelt and North Western Provinces receives 1,000 mm of rainfall per annum. It has very deep soils and sandy clay loam. This region is rich in the growth of cassava, millet, sorghum, beans, groundnuts, rice, coffee, tea, pineapples, fish farming and livestock.

A lot of investment incentives are available in Zambia. Tax incentives include zero percent tax on rate on dividends for five years and no import duty on machinery for five years. Non tax incentives are investment guarantees and protection as well as free facilitation for application of permits, licenses, land acquisition and utilities. Another great incentive is that an investor will receive free location support services to farm blocks, Multi Facility Economic Zones, industrial parks and rural areas.

The Government of Zambia has mandated Zambia Development Agency (ZDA) to be a gateway to Zambia. The Zambia Development Agency was established in 2006 by an Act of Parliament to foster economic growth and development by promoting trade and investment through an efficient, effective and coordinated private sector led economic development strategy. ZDA gives an investor free comprehensive support in land acquisition for investment, seeking business partners, immigration and administrative support services, arranging meetings with government ministries, advise on investment incentives and provides information on markets and industries.

Investors in agriculture and any other sector have many reasons to invest in Zambia. This is because Zambia has seen political stability, peace and democracy since independence in 1964. Zambia also has adherence to rule of law, positive and investor friendly environment giving you investment guarantees and security. The Country has abundant natural resources presenting excellent investment and trade opportunities. Zambia already has in place a private sector driven government Economic Development Policy. The Country has no exchange controls and has progressive banking, legal and insurance services of international standards.

Zambia is just a good place to and live, favourable atmospheric temperatures, friendly people with a rich diverse culture and English as the official language. ■



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H.E. Milan Hovorka
Czech Ambassador to India

CZECH REPUBLIC: Reliable Partner with Considerable Potential

The Czech Republic and India enjoy a thriving relationship in a number of areas including trade, investment, education, research, development and people to people contacts. They are like minded on a number of international issues and work together to find proper answers to key challenges of today's increasingly globalized world.

There is, however, one area where the two countries have not yet been able to find the way to explore fully the existing potential despite all the complementarities that exist between them. It is the world of agriculture, farming and food processing.

Numbers speak for themselves. Nearly USD 1.5 billion bilateral trade flew between the two friendly countries in 2017 in which agricultural products accounted for mere 5 per cent. It is only fair to say that Indian exporters are doing much better on one of the fastest growing markets in Europe compared to their Czech counterparts in 1.25 billion India.

The rationale behind not necessarily shining performance of Czechia, which is a one-word name of the Czech Republic, in India and may be explained by the fact that it is being considered here as a primarily highly industrial, knowledge-based and technologically-advanced economy.

And truly so! The Czech Republic finds place among countries with highest industry-to-GDP ratio which exceeds a 30 percent mark. It is the country which has gifted the world with so many industrial inventions and solutions.

On its part, the agricultural sector accounts for 2.5 percent of the Czech economy. However, as in any other developed nation, the role of agriculture in the society is much higher than any quantifiable parameter may indicate. It is also about multifunctional character of the agriculture, its efficiency, rural areas development, food security, increasingly popular organic farming, not to forget the quality of products.

The Czech Republic does not rank high among major world agricultural exporters. However, the country is world-wide known for a number of brand products and distinguishes itself for high quality execution and impressive consumer satisfaction record.

The purpose of this article is to increase awareness of the potential of the Czech

agricultural and food processing sectors and make them more attractive for bilateral cooperation with Indian partners through the introduction of some of the big brands or products offered including dairy products, beverages (beer and wine), malt, hops, livestock, grain and sugar. It has to be recalled that we do not talk only about relations built on a buyer-supplier basis but also about the genuine interest in search for true partnerships in which both countries can gain a lot.

It is only logical that such a partnership has to be built as a two-way avenue. From this perspective, the Czech Republic can offer one of the most liberal and open markets globally in which consumers decide on their choices and preferences. As a Member of the European Union, it is ideally suited to serve as a gateway to more than a 500 million consumers market applying the same set of rules including sanitary and phytosanitary measures. And it is yet another area in which the two countries could and should work together with a view to benefiting fully from their respective potentials, each other's expertise and comparative advantages.

I. DAIRY PRODUCTS – WHEY, MILK POWDER AND CREAM

The combination of a long-lasting tradition of milk powder, cream and whey production in the Czech Republic and long shelf life of these products in dehydrated form make them very attractive for overseas distant markets such as India. The range of these dairy products can be extended with diverse fat content, manifold flavours or package sizes. Milk powder and cream are used in the food processing industry for

example in biscuits or confectionery production.

In recent years, the dry whey exports from Czechia have increased, namely to the non-EU countries such as Malaysia, Thailand, Bangladesh or Philippines. It is an excellent raw material for industrial food processing. In beverage industry, its gel-forming and water-retention properties (the so called "juice effect") are exploited. In baking industry, it improves dough proofing. In wafer and chocolate production, it prevents drying out, replaces the more expensive powdered milk, and improves the taste. In ice-cream production it enhances the whipping ability. It also plays an important role in healthy diet. In dry whey production, water evaporates and milk sugar, proteins and mineral substances remain concentrated. The other important constituents are essential amino acids that the human body cannot produce.

II. BEVERAGES – BEER AND WINE

Beer is one of the most iconic products of the Czech Republic. With the highest average consumption of 142.6 litres per year per capita, the Czech Republic is well known for its beer culture all over the world. The first reference to brewing beer in Czechia is linked to the Břevnov Monastery in Prague and it dates back to the year 993.

Nowadays 90% of beer production in the Czech Republic belongs to the lager beer category, which is often named in the world as "pilsner". The history of the best known Czech lager beer, Pilsner Urquell, starts in 1842, when the first lager beer was ever

produced. The word "pilsner" refers to the place of birth of lager beer which was the city of Pilsen in western part of the Czech Republic. Pilsner Urquell is the world's first blond or pale lager, and due to its popularity it was copied around the world. Many of these copies are named pils, pilsner or pilsener.

Czech Beer ("České pivo" in Czech language) was listed by the European Union in the Register of Protected Geographic Indications. The Geographic Indication "Czech Beer" is at the same time the symbol of quality and the proof use of local Czech ingredients and traditional technological procedures. Only top quality domestic varieties of hops are used for beer production under the Geographic Indication "Czech Beer". Czech beer is typically brewed with Czech malt and hops. All of these ingredients originating from the Czech Republic, with their exceptional quality, are essential for brewing one of the best beers in the world.

The Czech Republic exports 2,000,000 hectolitres of beer per month which places the country among the 20 largest world beer exporters. For a country with only 10 million inhabitants, this is an extraordinary success. In recent years, the beer assortment in the Czech Republic has been expanded by non-traditional types of beer – e.g. wheat, pale, unfiltered, etc. Beer production in the Czech Republic is concentrated to 48 major breweries with a high production capacity. However variety of beer offered in the country increased with approximately 280 mini breweries which often form integrated part of larger Czech pubs.

Not only excellent and famous beer but also very delightful and world-wide respected wine is produced in the Czech Republic. Czech wine growers and makers regularly receive prominent international awards for the quality of wine and also Czech Republic ranks among the top European producers. There are two main wine growing areas in the Czech Republic – Bohemia wine region and Moravia wine region. The vineyards in the Czech Republic cover 19 thousand hectares, mostly in Moravia. That is why you may often hear about 'Moravian wines' in relation to the Czech Republic wine production. White wines produced in the Czech Republic are typical for their fresh acids, while the red wines, conversely, are full bodied and distinctive, but smooth and velvety and with an excellent pleasant fruity smell.

III. HOPS

Hops growing has over a thousand-year long tradition in our country. The first references to hops growing in the Czech territory date back to the year 859. Hops growing in the Czech Lands substantially expanded, thanks to the Emperor and Czech King Charles IV.

The Czech Republic belongs amongst the world's largest hops producers. As far as the place of origin of the hops is concerned nothing beats the Saaz hops, which is cultivated in the region near the city of Saaz (Žatec in Czech language). The Czech Republic was the first European Union Member State to succeed in listing the Protected Geographical Indication in the sector of hops cultivation, namely the aforementioned "Saaz hops". In 2016, Czech companies exported approximately 3 668 tonnes of hops for a total value of 263 crores Indian rupees. Hops belong to traditional items of Czech agrarian export, with the biggest trading partners such as China (963 tonnes), Japan (873 tonnes) and Germany (829 tonnes).

Hop is a perennial plant that can live up to 30 years. Extraordinary combination of climate and soil conditions contribute to the unique aroma of Czech hops. Hops provide beer with a typical bitter taste and characteristic aroma. For a half-litre of beer, you need 3-4 hops cones. Saaz semi-early red-bine hops grown in the Saaz area, is the dominant variety grown in our country. More than 120 farming companies are involved in Hops production in the Czech Republic.

IV. WHITE POPPY SEED

The cultivation of poppy seed in the Czech Republic is on steady rise. The Czech Republic became one of the biggest producers of poppy seed in

the world. It is cultivated for medical and for food production purposes. Poppy is cultivated on 70,000 hectares of land and it is a traditional part of the Czech cuisine.

The Czech Republic is the world's largest producer and exporter of poppy seed for food processing. The tradition of poppy seed growing in the Czech Lands is longer than one thousand years!

Farmers focus mainly on traditional blue poppy which is appreciated for extraordinary tasteful and aromatic oily seed. Apart from this variety, also white and ochre poppy seed with a mild nutty flavour are grown. The white poppy seed is exported mainly to India.

V. MALT

The long tradition and popularity of malt production is based on favourable soil and weather conditions of barley growing areas. The most advanced production technologies guarantee the minimum environmental impact. The Czech malt is one of the main pillars of the Czech beer brewing.

The vastest areas under malting barley are located in the eastern part of the country, in Moravia, where cultivation of special malting barley began in 1870s. The basic raw material for the brewing malt production is spring barley. The Czech production fully covers the consumption. As far as the types of malt are concerned, over 95 % of the malt produced by Czech companies belongs to the group "Czech malt" (also called "light Czech malt" or "Pilsen malt"). A total of 28 domestic malt houses produce more than 500 thousand tonnes of malt every year, of which almost half goes for exports abroad.

The malt constitutes important share of Czech agrarian exports. It is exported to 47 countries of the world. The Czech Republic ranks among the top 5 largest exporters of malt in the European Union.

VI. FRUITS – APPLES AND CHERRIES

Apples are the most common fruit present throughout the central Europe. Although, apples are not the first thing that comes to mind when someone mentions the Czech Republic, apples are present almost everywhere in our country. Apples can be considered as a fruit with the longest history of cultivation in the Czech Republic.

There are approximately 14,500 ha of orchards in the Czech Republic today and yearly production of fruits stems between 150,000 – 200,000 tonnes. The share of apples on the total fruit production accounts for 140,000 tonnes. Golden Delicious is one of the most popular varieties together with Jonagold, Idared and Gala. Cherries belong to another very popular fruit grown in the Czech Republic. Czech apple and cherry growers express keen interest to work with Indian business partners. ■

SERBIA'S FRUIT OFFERING

Vladimir Maric
Serbian Ambassador to India

Due to its geographical position, favorable agro-ecological and climatic conditions, coupled with the introduction of the latest technologies used in the most developed countries, and a broadbase of fruit varieties that are competitive in foreign markets,Serbia has become one of the leading apple and raspberry producers in Europe.

The intensification and modernization of agricultural production, construction of irrigation systems and investments in anti-hail nets represent a winning strategy that has led to significant growth yields and excellent fruit quality.

With its high natural potential resulting from the physical, chemical and biological properties of the land, the Republic of Serbia is also among countries where organic production is successfully expanding. Recognizing the economic and export potential, the Serbian Ministry of Agriculture will focus its future activities on intensifying and strengthening this type of agricultural production.

On the global level, Serbia ranks 12th in the world based on the total land area (25,134 hectares) under apple production.

Apple production in Serbia is expanding. The average annual apple production is approximately 426,000 tonnes. More and more advanced apple orchards are using modern cultivation technologies, with irrigation and anti-grid systems, to harvest apple varieties that are competitive on foreign markets. New cultivation systems employing a greater concentration of seedlings per unit area have led to an intensification of production and an increase in production volumes on smaller land areas.

The average apple yield in the last five years has been approximately 17.3 t/ha. In newly-developed high-intensity plantations that have introduced compact seedlings, anti-hail nets and new irrigation systems, yields range from 50 to 70 t/ha, depending on the apple variety. Apples are one of the few fruit species where

extent are Red Delicious, Gloucester, Mucu, Gala and others. Additionally, club varieties have also been introduced: Pink Lady, Modi, Fuji Kiku.

Last year, 197,602 tonnes of apples were exported in total value of $122.4 million dollars. Of the total export of apples, a large majority (84%) was exported to the Russian Federation. Other countries include Italy, Germany, Hungary and others. Aside from fresh apple exports, we also seek to increase exports of apple concentrate as well as other apple-based processed products.

producers have introduced the latest technologies that are comparable to the most advanced fruit plantations seen around the world.

In line with the intensification and modernization of apple production, the typical manufacturer structure has changed over the years. Ten years ago, apple producers were individual producers who traditionally cultivated apples on a surface of 2 to 5 hectares. In recent years, apple producers run operations on more than 10 ha of orchards and use ULO refrigerators. These are mostly comprised of commercial agricultural holdings that gradually increase cultivated area and modernize production, introduce new technologies and are ready to engage professional consultants. Furthermore, there is an increasing number of large-scale companies that own plantations ranging in size from 30 to 250 ha. These growers operate modern intensive plantations that employ the most modern cultivation practices and technology. Their average yield is about 50-70 t/ha with a high concentration of first-class apples.

The leading apple variety in Serbia is still the Idared, with a share of 20-25% of the total production. In the past few years, there has been a change in the assortment. As such, Idared is slowly losing its primacy, and is currently being replaced by new varieties belonging to a group of autumn varieties, with an earlier maturation period, which helps extend the harvest window.

There is a pronounced industry trend to introduce other varieties depending on end-market demands. The presence of Granny Smith, Golden Delicious and Jonagold is growing. Also present to a lesser

The most important apple products include apple juice and apple concentrate. More and more people are consuming dried apples in the form of apple chips. Apples are used in marmalades, sweet preserves, jams, jellies, purees, vinegars, syrups, juices, etc. The juice can also be fermented to make apple brandy or so-called Calvados. There is also an increasing trend in low-alcoholic beverages, such as cider and other apple-based variations.

The raspberry has a significant place and role in the fruit and agricultural production of the Republic of Serbia. The agro-

ecological conditions of Serbia enable growth of raspberries of top quality and provide higher production yields per unit area compared to other countries where raspberries are produced. Serbian raspberries are generally more aromatic and contain a higher percentage of sugar, due to the country's unique climate conditions.

Raspberries, cultivated on 21, 862 hectares of land,represent the leading position in Serbia's total value of exports. According to the Food and Agricultural Organization (FAO), if you add the total area under blackberry cultivation (5,076ha), Serbia ranks third in Europe for the total area under cultivation of these two fruits.

In Serbia, the average annual raspberry production is about 75,000 tonnes, even though over 100,000 tonnes were produced in the past year. According to the International Raspberry Organization (IRO), an industry body overseeing 13 countries that collectively represent 90% of total raspberry production globally, world-wide raspberry production stands at approximately 450,000 tonnes. In 2016, raspberry production reached a global record of 475,200 tonnes. Serbia was in second place with its 70,000+ tonnes.

Producers that introduce production improvements through field expansions, proper application of agrotechnical measures and new irrigation systems, generally yield 20 tonnes per hectare of raspberries, which is significantly higher compared to traditional cultivation methods, where yields are approximately 5 t/ha.

In terms of raspberry varieties in Serbia, Willamette dominates with about 95%, followed by Meeker with 3-4%, and all the other varieties account for 1-2%. These represent high-quality varieties that are competitive in the global market. As for other varieties, the most abundant are fall-bearing raspberries, such as Polka, Polana, Heritage, Tulameen and others.

Raspberry represents a key strategic fruit in Serbia as it has been among the first three exported agricultural products (along with corn and sugar) in the past ten years. It also achieves the highest export value compared to other fruits. The value of raspberry exports compared to total fruit exports stands at over 40%.

In 2017, Serbia exported 99,664 tonnes of raspberries in total value of 214 million Euros. Raspberries are primarily exported in frozen form (approximately 95%), with the largest quantities exported to countries of the European Union (Germany, France, Belgium, The Netherlands, UK, Austria, Sweden, Poland, Slovenia, Italy), the US and others. Germany and France are the largest buyers of Serbian raspberries, with exports to these two countries accounting for approximately 52% of total exports.

Raspberries have the highest economic significance within the group of berry fruits and represent an extraordinary raw material for the food processing industry. They have a wide range of processing possibilities, and frozen raspberries

can be used year-round. In the Republic of Serbia, most raspberry production (about 85%) is frozen, while the rest is generally used for various forms of processing. They represent an important fruit in both domestic and foreign markets. Raspberries can be processed into juices, syrups, compotes, sweets, jams, wine, dehydrated, etc.

In addition to apple and raspberry exports which have proved to be very successful to date, organic production also shows significant potential to further increase the total value of exports, as organic products are in high demand world-wide, as well as in Serbia, and overall demand for organic products continues to grow on a constant basis.

Regions ideal for development of organic production in Serbia include areas located within Serbia's protected natural areas (approximately 7% of Serbia's territory) where agricultural production is allowed in Level 2 and 3 protected areas.

The advantages of these conservation areas include high-quality air, water, and soil resources as well as the overall stability of the ecosystems. Additionally, from a rural development aspect, underdeveloped villages are usually found close or nearby these protected areas. Special production offers the possibility of supporting sustainable development of these villages in combination with ecotourism that further generates value.

The goal of the Serbian Ministry of Agriculture is to increase the total area under organic production, as well as the number of animals that are bred using organic production methods. It is encouraging that these parameters are increasing with each passing year, and that a growing

number of organic producers have opted to engage in this type of agricultural production.

In Serbia, organic production regulations are prepared in accordance with EU legislation. In an effort to fully harmonize regulations in this field, the Ministry of Agriculture commenced implementation of the Twinning project, funded through the EU's Instrument for Pre-Accession (IPA), which supports capacity building and further development of the legislative framework in the field of organic production and food quality.

Since the global market for organic products continues to grow, and organic products represent a significant export potential for Serbia, a comprehensive plan for the development of organic production has been prepared that sets out strategic goals and measures. This plan is part of the National Rural Development Program from 2018 to 2020.

Within the framework of its agrarian policy, the Ministry of Agriculture has created a special program of measures aimed at supporting the development of organic production in Serbia. In addition to financial support, a system of control and certification has been established that enables Serbian organic products to be placed on both domestic and foreign markets.

The largest share of Serbian organic products are exported to Germany, Italy, USA, Poland, Belgium and Austria. These primarily include frozen organic raspberries, blackberries, plums and apple concentrates. ■

Blairo Maggi
Minister of Agriculture, Livestock and Food Suply, Government of Brazil

INDIA-BRAZIL – Immense Scope for Agribusiness Cooperation

As Brazil and India celebrate the 70th anniversary of bilateral relations, there are certainly many reasons to celebrate. We have strong democratic institutions and increasingly active civil societies. Our countries have come a long way over the last seven decades in terms of socio economic development, placing Brazil and India among the ten largest economies in the world. Wisely, we made sure the growth which transformed our economies, was coupled with significant poverty reduction. We are also developing countries of great territorial and demographic dimensions, with an extraordinary ethnic, cultural and religious diversity. However, we have no intention of limiting ourselves to the appraisal of past achievements.

As we now look to take this successful and long lasting partnership further, agribusiness is bound to play a key role in the development of our countries and in the strengthening of our relationship. In both our countries, agriculture is a crucial part of our economies and essential for providing income to a large share of the population. It is also a field in which most of today's pressing challenges are at play.

Turmoil in global trade, the importance of food security, climate change and the quest for sustainable development are only a few of the many difficulties we must face. In this context, it is important for Brazil and India to reflect upon such challenges and harness bilateral cooperation to benefit from opportunities that lie ahead.

It is our strong belief that Brazilian agribusiness will play a major role in providing food security and promoting sustainability in agriculture worldwide. Brazil is currently one of the countries with the most effective

conditions to significantly raise its agricultural production capacity while preserving the environment. According to OECD data, Brazil is projected to be the leading food producer in the world by 2050. Considering protected areas,soil fertility and climate limitations, Brazil may add in the future 115 million hectares of arable land to the current area of production using sustainable intensification and more precisely integration of crops, livestock and forestry in the same area.

It is important to highlight that the growth of agricultural production in Brazil will continue to rely on productivity increase, coupled with high standards of environmental responsibility. Our agribusiness has contributed greatly to Brazil having one of the highest rates of renewable energy in our energy mix. Our massive deployment of hydropower plants and a very successful biofuels program qualify Brazil as a low carbon economy and set us in a relatively comfortable situation with respect to our contribution to fighting climate change.

As both Brazil and India aim to develop their rural economies while observing the highest patterns of sustainability, both countries should learn from each other's experiences in applying technology to agribusiness and productivity growth. In this context, technical cooperation and business to business interactions will certainly play an essential role.

Meaningful technical cooperation between Brazil and India is already taking place. The Brazilian Agricultural Research Corporation (Embrapa), which has a network of 47 Research Centres and over 10,000 employees, has been cooperating with Indian institutes for decades. During the 2016 BRICS Summit in

Goa, two MoUs were signed between Embrapa and the Department of Animal Husbandry and Dairying (DADF, Ministry of Agriculture and Farmers Welfare) and with the Indian Council of Agriculture Research (ICAR), and both instruments will surely contribute to increase technical cooperation between our countries in several fields.

Bovine genomics is one area in which India can significantly benefit from Brazilian expertise. Brazil has one of the largest livestock of Zebu cattle, a breed of Indian origin. This livestock has undergone considerable genetic improvement over the decades, to the point where Gyr cattle in Brazil has one of the highest productivity in the world in terms of milk output.

The MoU with DADF can provide support to India in the areas of genomics and Assistant Reproductive Technologies (ARTs) in cattle through joint projects for productivity improvement of cattle and buffaloes, broadening the existing knowledge base on sustainable dairy development and institutional strengthening. We are certain that cooperation with Brazil can help India increase its productivity in dairy production, and this will substantially contribute to India's goal of doubling farmer's income in the near future.

Cooperation between Embrapa and ICAR has taken place in several areas, such as germplasm exchange, agro-energy (biofuel; sugarcane-based ethanol), soybean (cultivation and processing for biomaterials) and animal reproduction. At the current stage, Embrapa and ICAR are finalizing an action plan that will pave the way for joint research in relevant fields to our farmers, such as genetic markers for resistance to heat, diseases and ticks.

Closer ties between Indian and Brazilian entities have the potential to spur ground-breaking ideas and businesses, thus contributing significantly to greater social inclusion, food security and income generation.

Brazil and India must also benefit from advanced knowledge produced by the private sector in both countries and realize the manifold opportunities for agribusinesses in both markets. Many Indian companies have a remarkable presence in the Brazilian agribusiness, such as UPL, which has been providing important solutions to Brazilian farmers for years. There are many investment opportunities on both sides which are increasingly attractive, in areas such as logistics, cold chain, agricultural inputs, food processing and retail networks.

Furthermore, as the largest sugar producers in the world, Brazil and India should also strengthen cooperation in the field of sugarcane, especially for biofuels. Brazil has been producing biofuels since the early-1970's, and the mandatory mixing of it with regular gasoline, since 1993, helped the reduction of fossil fuel consumption, and rendered Brazil less vulnerable to volatility in global oil prices.

Ethanol can be an important source of income for sugarcane growers and represents a new paradigm for energy security and conservation. According to a study sponsored by the São Paulo Research Foundation (FAPESP) and published in the journal Nature Climate Change, in 2017, ethanol has potential to replace up to 13.7% of oil consumption worldwide and reduce emissions of carbon dioxide by up to 5.6% by 2045. We commend the Indian government for its push towards biofuels and commit ourselves to further strengthen our partnership in this realm, both bilaterally and in the context of the Biofuture Platform.

As Brazil and India strive to increase productivity while promoting sustainability in agribusiness, we must look into the increasingly important role of technology application.There are a number of opportunities for technological know-how exchange in precision farming, including "smart farming" solutions, artificial intelligence applied to satellite image analysis, irrigation control, and field-applied IoT, among others.

Cooperation in this field is already under way. Brazil had its own pavilion in this year's edition of Agri-TechIndia, in Bengaluru, in September. In that opportunity, four Brazilian agriculture start-ups were showcasing cutting-edge technology and solutions in smart farming, artificial intelligence, remote sensing, management of silos, pest control and much more. There are many complementarities between Indian and Brazilian agricultural innovation ecosystems to be explored, and the exchange of information related to new technologies will surely benefit the agro sector in both countries.

The strategic value attributed to science, technology and innovation was emphasized with enthusiasm during the last bilateral meeting of Heads of Governments from Brazil and India, in Goa, in October 2016. It is a result, on the one hand, of the solid relation established during the past years and, on the other, of the plentiful opportunities for mutual benefits envisaged by both countries in this domain.

While technical cooperation and increasing interaction between business and scientific communities will play a key role in ensuring productivity growth and sustainable patterns in agribusiness, access to global markets is essential for the growth of rural economies in Brazil and India. As India strives to double farmers' income, it will have to seek to increase its role in global agricultural trade, both for export markets and for import of essential goods as well. In order to augment its participation in global agriculture exports, a major goal in India's evolving agriculture export debate will be how to establish a more open and predictable environment,both for agricultural exports and imports, as trade is a two-way street.

As India becomes the world's most populous country, with a growing urban population,food security, water shortage and soil erosion are challenges to be faced with urgency. Brazil can help India to overcome these challenges in a sustainable manner, not only through exchanging the latest food processing and agriculture technology, but also increasing the bilateral commerce of agricultural products.

In their capacity as two of the world's largest developing countries, Brazil and India have built a strong and auspicious partnership over the last seven decades. However, we must endeavor to go further. Increasing our cooperation in agriculture will certainly help us navigate through today's rough seas. In this sense, it is of the utmost importance to place agriculture and innovation at the forefront of our collaboration agenda. Once we become acquainted with each other's agribusiness environment and capabilities, the untapped potential for cooperation will become clear. The closer the contact between our business and scientific communities, the more our partnership in agribusiness will live up to its full potential. ■

ANAND AGRICULTURAL UNIVERSITY

ANAND - 388 110 GUJARAT, INDIA
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Envisioning Challenges & Opportunities - Strategically empowering Agriculture for Nation building

Agriculture is our wisest pursuit, because it will in the end contribute most to real wealth, healthy environment, sustainable development and good morals. The strategy for revitalizing agricultural education and research agenda to provide technology, policy and institutional support should be based on leveraging knowledge and core strengths of the agricultural universities for creating hubs of scientific excellence and attract the best talents to agricultural sector. The important focus should be to create and accelerate sustainable increases in the productivity and production; conserve, enhance, and sustainability use natural resources and biodiversity; and promote excellence in agricultural research, education and extension for sustained food and nutritional security. Productivity paradigm of the past years will give way to a new paradigm of multidimensional approach to agricultural education and research with emphasis on environment, health, nutrition, consumer preferences and farmer livelihoods in addition to productivity. Anand Agricultural University offers you an opportunity to be a part of this endeavor. Come and join our mission for nation building through agricultural interventions and innovations.

Dr. N.C. Patel
Vice Chancellor, AAU

"We are committed to make our country agriculturally prosperous."

VISION

Agriculturally Prosperous Gujarat and India

MISSION

Search of new frontiers of Agricultural Sciences
Development of excellence in human resources and innovative technologies
Service to farming community

Foreign Collaboration

- MoU with Lund University, Sweden for exchange of students and joint teaching & research activities.
- University of Alberta, Canada for student and faculty exchange
- University of Copenhagen, Denmark for student and faculty exchange]
- Florida Agricultural and Mechanical University, USA for co-operative research and student and faculty exchange.

COURSES OFFERED

UNDER GRADUATE

- B.Sc.(Hons.) Agri. - 8 Semesters
- B.Sc.(Hons.) Horti. - 8 Semesters
- B.Tech.(DT) - 8 Semesters
- B.Tech.(Agri.Engg.) - 8 Semesters
- B.Tech. (FT) - 8 Semesters
- B.Tech.(AIT) - 8 Semesters
- B.V.Sc. & A.H.- $5^{1/2}$ Years

POST GRADUATE

- M.Sc.(Agri.) - 4 Semesters
- M.Sc.(Horti.) - 4 Semesters
- M.Tech. - 4 Semesters
- M.Tech. (Agri.Engg.) - 4 Semesters
- M.Tech. (FT)- 4 Semesters
- M.Tech.(AIT) - 4 Semesters
- M.V.Sc. - 4 Semesters
- M.B.A.- 4 Semesters
- Ph.D. - 6 Semesters
- M.Sc.(Agri. Mkt./Agri. Jour)- 4 Semesters (Distance Mode)

POLYTECHNIC COURSES

- Polytechnic in Agri., Anand and Vaso
- Polytechnic in Agri.Engg., Dahod
- Polytechnic in Food Science & Home Economics, Anand
- Polytechnic in Horticulture, Vadodara.

INFRASTRUCTURAL FACILITIES AVAILABLE

- Lush Green Sprawling Campus with e-library cum cybrary
- Hostels • Information Technology Centre • Crop Museum
- Well Equipped Laboratories
- Students' Welfare Services • Guest House
- Auditorium • Well Equipped Gymkhana
- 24x7 Internet Connectivity Canteen • Anubhav Dairy
- Sports Facilities • Health Centres • Shopping Centre
- Post Office • Bank ATM Centres

Ambassador Melba Pria
Ambassador of Mexico to India,
Embasssy of Mexico

AVOCADO: THE 'GREEN GOLD' OF MEXICO

Take a glance at any restaurant menu worldwide or any trending food website, and you will notice that the popularity of avocado has skyrocketed. World imports of avocado have increased worldwide at an impressive rate of 172 per cent over the last decade. People from California to New Zealand have discovered avocadoes and cannot seem to get enough of its creamy, delicious flavor.

Labeled as a 'super-food' for its nutritious contents, avocado has managed to transcend its 'guacamole' form and find a place in every table, from breakfast to dessert,within all kinds of cuisines. Avocadoes are rich in monounsaturated, or "good", fats. They contain a lot of fiber and are rich in vitamins and minerals, such as B-vitamins, vitamin K, vitamin E, vitamin C, potassium and copper. One avocado consists of 73% water, 15% fat, 8.5% carbohydrates and 2% protein, and 100 grams contain approximately 170 calories.

MEXICAN AVOCADO: A JEWEL FROM MEXICO TO THE WORLD

In Mexico, avocadoes are far from being a fad. The *Persea americana* has its origins in the highlands of Eastern and Central Mexico and had been a staple of the Pre-Hispanic cultures for thousands of years. The first evidence of its use as food is from a cave in Tehuacan, Puebla, dating back 7,000 to 8,000 years. Avocado has always been a sought-after crop in Mexico; its leaves were used to fight parasites and for natural healing preparations in ancient times, and they are still used as seasoning for hearty dishes.

Despite its long-standing history, avocado became popular outside of Mexico recently. In 1994, Mexico, the United States and Canada entered the North American Free Trade Agreement (NAFTA) and shortly after that, the United States started lifting its ban on the product. During the Super Bowl weekend

in the United States, it is normal that fans consume around 100,000 tonnes of avocadoes. Consumption has soared in the neighboring country and keeps growing in the rest of the world.

Mexico is the indisputable world leader in production and exports, and harvested nearly 2 million tonnes of avocadoes in 2017. Today, 1 of every 3 avocadoes in the world is Mexican. The national demand for avocadoes in Mexico is currently covered in 100 per cent, and there is still enough to export. The most important market for Mexican avocado is the United States, but avocadoes are increasingly exported to China, the European Union, and many other countries. Moreover, 91 per cent of all avocadoes consumed by Americans come from Mexico; in Canada the share is 95 per cent and in Japan 93 per cent.

The export market for Mexican avocado is growing and diversifying, thanks to the quality of its product but also to the creative strategies adopted for its promotion. Recently, the Mexican trade promotion agency, Pro

Mexico, entered into a partnership with the Chinese company Tmall Fresh, the online retail platform of Alibaba Group. The digital campaign launched to promote Mexican avocado managed to sell half a million Mexican avocadoes online in two days to Chinese consumers. This is a significant market to conquer, considering that the Chinese demand for avocado has an annual growth rate of over 200 per cent.

WHAT MAKES MEXICAN AVOCADO THE BEST IN THE WORLD?

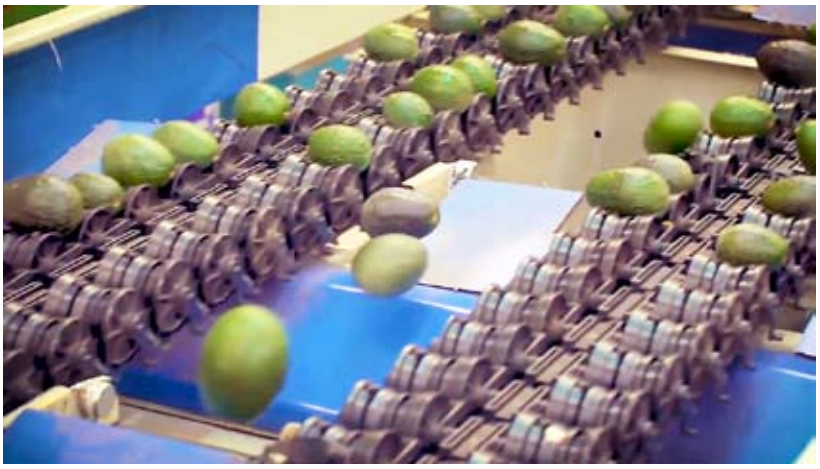
Avocadoes are one of the most important crops in Mexico, comprising over 4 per cent of the agricultural GDP. Besides abundance, there is a great variety.There are over 20 different species related to *Persea americana* in Mexico, including the most demanded Hass, as well as favourites Criollo and Fuerte. The richness and fertility of the volcanic soil, combined with perfect climatic conditions, make it possible to harvest avocado all year round, in 26 of 32 states.

The quality of Mexican avocadoes is recognized worldwide for its characteristics such as the skin, the size of its seed(which has been found to be smaller than other Latin American avocadoes), the texture, and the quality of its pulp and oils.

Avocado trees are sensitive to cold and humidity, so their establishment is recommended in regions free of extreme cold, hot and dry winds. Temperature and precipitation are the two factors with the highest significance in crop development. As for the latter, it is considered that 1,200 mm of rain per year is enough. Avocadoes grow better at altitudes between 800 and 2,500 meters above sea level, in clayey or loamy clay soils, provided that there is good drainage.

Mexico's geographical features make it a perfect home for avocado crops. Moreover, the irrigation technologies and harvesting cycles have been perfected to maximize the output of avocadoes. In Mexico, 46 per cent of the production consists of irrigation mode and the rest is rainfed. Production is highly mechanized, with a focus on plant health; around 80% of the 205,000 hectares planted in 2016 had






technical assistance.

The good implementation of phytosanitary pest control programs has helped boost production. The Mexican Avocado Association has worked with producers to invest in technological improvements that ensure that avocadoes are free of pests, as well as of any chemical residues. Several districts in the states of Michoacan and Estado de Mexico have been acknowledged as free of the plagues known as avocado weevils.

In the light of all these developments, production in Mexico has grown at an average annual rate of almost 6 per cent between 2007 and 2017. During this period, the total area devoted to this crop grew at an average annual rate of 6.5 percent. In 1980 it had a planted area of almost67,000 hectares; in 2000, 95,000 hectares, and in 2017 the planted area reached a historical maximum of 220,000 hectares. SAGARPA, the Mexican Ministry of Agriculture, projected that in 2018, 2024 and 2030, avocado production will rise to 2, 2.6 and 3.2 million tonnes, respectively.

During the recent decade, while the value of Mexico's total agricultural exports grew at an average annual rate of 8 per cent, the value of avocado sales abroad registered the greatest dynamism among agricultural products, as it grew at an average annual rate of 20 percent.

OUT OF MICHOACAN: THE REGIONS OF AVOCADO PRODUCTION IN MEXICO

Today, the state of Michoacan produces 90 per cent of the Mexican avocadoes that are exported from Mexico. Despite having many production zones, the avocado from Michoacan managed to brand itself to the export audiences. Perfect weather and soil conditions in this state allow four harvest seasons (instead of one or two as in the rest of the world), which means that Michoacan can offer the fruit as a year around product. Production in the state is still growing, but the local industry considers that there is

little room for expansion.

Considering that Michoacan has historically targeted the North American market and that production is reaching its full potential, other states are seizing the opportunity to benefit from a growing demand around the world.

In 2017, 95 per cent of the national production of the fruit was concentrated in five states: Michoacán (77 per cent), Jalisco (8 per cent), state of Mexico (5 per cent), Nayarit (2.5 per cent) and Morelos (2 per cent). The greatest dynamism in production between 2007 and 2017 was observed in Jalisco, the state of Mexico and Nayarit. There, the volume harvested grew at average annual rates of 32 per cent, 19 per cent and 8 per cent, respectively.

Jalisco is benefiting the most from lessons learned. Its production is growing significantly, thanks to proven techniques, and now it is focusing on gaining access to new markets, like Europe and Japan.

As it happens with other agricultural products around the world, avocados also face phytosanitary restrictions in some markets. The Government of Mexico offers guidance and technical assistance to producers to make sure that avocadoes meet health plant requirements during production, packing and transport. At the same time, during negotiations to gain access to new markets, the Government abides by scientific and technical evidence to avoid the implementation of non-tariff measures that result in the restriction of Mexican avocado trade in export markets.

Looking towards 2030, the agricultural policy of the government of Mexico has focused on tailoring solutions to different regions. Hence, 23 potential regions have been identified to be further developed, as well as 20 strategic regions, which are consolidated producers and that will follow a strategy for "maximizing". Within this "maximizing" strategy, there are plans to build a national program of comprehensive training, an online system for technical assistance and market information for producers, certifications for avocado plants, as well as the development of a technical manual for plague management, that will differentiate between authorized and unauthorized products. Moreover, production and harvest cycles will be planned according to markets. Considering the ideal natural conditions plus the concerted efforts to improve production and support producers, it is expected that Mexican avocadoes will continue following their rising trajectory.

From its Mesoamerican origin, avocadoes have been the pride of Mexico and continue to be a flagship product for its agricultural economy. The impressive growth in demand and production is a good example of the impact of free trade agreements. ■

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How the International Fund for Agricultural Development (IFAD) uses South-South and Triangular Cooperation in Rural Transformation to Meet the Sustainable Development Goals

THE INCREASING IMPORTANCE OF SOUTH-SOUTH COOPERATION IN AGRICULTURE AND RURAL DEVELOPMENT

South-South Cooperation (SSC) is a development cooperation modality that provides a broad framework for collaboration among the countries of the "Global South"– in the political, economic, social, cultural, environmental and technical domains. Involving two or more countries, such cooperation can take place on a bilateral, regional, sub regional or interregional basis, and covers a wide range of modalities, from strictly market-driven activities to the transfer of financial and other resources for development purposes. SSC is an expression of solidarity among peoples and countries of the South that contributes to their national well-being, their national and collective self-reliance and the attainment of internationally agreed development goals, including the 2030 Agenda for Sustainable Development.

SSC encourages countries to join forces on specific human development areas, resulting in faster progress, higher impact and more innovative tools. It presents a valuable, lower-cost approach for achieving development results, and has proven to be particularly effective in a number of development sectors, such as health, environment, trade, tourism and labour, and most particularly in agriculture and rural development.

In 2014, the global rural population was estimated at 3.4 billion people, nearly 90 per cent of who were concentrated in Africa and Asia. Four years later, the share of the rural

population in these regions remains high: 60 per cent in Africa and 52 per cent in Asia, compared to just 20 per cent in Latin America and the Caribbean. More than 500 million smallholder farms in Asia and sub-Saharan Africa produce about 80 per cent of the food consumed in these regions today. From a development perspective, it is important to note that, despite rapid urbanization, a majority of people in developing countries continues to live in rural areas, and that in virtually all those countries, the degree of poverty is higher in rural than in urban areas.

SSC is frequently used in agriculture due to the similar environments, agricultural yields and general conditions shared by the countries involved. Many of these countries are located in tropical and subtropical regions, or in arid and semi-arid areas that feature similar climatic and environmental challenges, grow the same agricultural crops, raise the same domestic animals, and apply similar rural production patterns and technologies. For example, maize, the staple food of Southern Africa (a region located around the Tropic of Capricorn) originates from Mexico, which is situated on the Tropic of Cancer, with similar climatic conditions. Coffee, originally grown in Ethiopia, is now being produced in almost all tropical and subtropical countries around the world. Cassava, a starchy tuberous root, appears to have originated in Brazil and Paraguay, spreading from there throughout tropical areas to become one of the world's most important food crops. These similarities of environment and of climatic conditions make it easier and appropriate to replicate and adapt agricultural innovations among such countries than those designed in the North and for the North.

The enormous potential for SSC in agriculture, food production and rural development is far from being fully exploited; it needs to be harnessed to a much greater extent than it is today so that the world, in particular developing countries, can adequately meet the challenges of the future, notably those arising from population growth and climate change.The international community – United Nations agencies, as well as international financial institutions – have been investing in SSC for a long time, in particular in activities related to technical assistance and peer-to-peer learning at country or regional levels. Such activities have often been embedded in existing agriculture and rural development projects. Thus, whilst some institutions have recognized SSC as a well-defined and distinct development cooperation modality within their project portfolios, its tracking and classification has not been a priority, an approach that has often ended up in ad-hoc methodologies that lacked accurate monitoring and assessment.

The above notwithstanding, the last two decades have seen increased recognition within the international community of the importance of SSC. This recognition has translated into an increase in resources invested, more dedicated projects, and a broader engagement in SSC-related policy processes at the country and regional levels. On their part, international organizations have begun incorporating SSC as an effective implementation modality in their operations and strategies, adding the aspect of "triangular cooperation". South-South and Triangular Cooperation (SSTC) involves two or more countries of the South, in collaboration with a third party, typically a multilateral institution, a traditional resource partner, or an emerging economy, facilitating SSC through the provision of technical or financial resources. As a consequence, while in the past, SSC consisted primarily of the sharing of knowledge, technical skills, solutions and experts, the new SSTC scenario has broadened into increased volumes of South-South trade, South-South flows of foreign direct investment, technology transfers and dialogue on regional policy coordination.

IFAD'S CORPORATE ENGAGEMENT IN SSTC

IFAD is an international financial institution and specialized United Nations agency that promotes rural transformation in some of the most remote regions in developing countries. Since 1978, the Fund has provided US$18.5 billion in grants and low-interest loans to projects that have reached about 464 million people globally.

IFAD has been engaging in SSTC for two decades; over the last 10 years, IFAD's SSTC work has evolved from a series of ad hoc awareness, technical and advisory activities at country or regional levels, to a broader corporate agenda. IFAD formulated its first corporate SSTC Strategy in 2016. Since then, IFAD Member States have expressed the hope and expectation that the Fund will expand its SSTC activities to support the fight against hunger,poverty and malnutrition. The promotion of SSTC has become one of the priority areas for IFAD, in particular during the consultations for the 11th Replenishment cycle of

the Fund's resources (IFAD11), which set a commitment to embed SSTC in at least two thirds of the country strategies designed by the Fund during the 2019-2021 triennium.

IFAD's approach to SSTC focuses on two mutually reinforcing pillars: technical assistance and investment promotion. Technical assistance includes introducing, testing, documenting and sharing successful rural development solutions that can be adapted and scaled up forwider impact; engaging in policy discussions at the country, regional and global levels to foster pro-poor policy and institutional environments for sustainable and inclusive rural transformation; facilitating people-to-people and institution-to-institution knowledge exchange; and supporting public-private-people partnerships and networks across countries and regions. In terms of investment promotion, among other activities, IFAD facilitates business-to-business links; identifies opportunities for middle-income countries to finance development interventions in developing countries; advocates for greater resource allocation by developing countries to rural poverty reduction; and works towards a greater role for the private sector in supporting sustainable, people-centred agriculture and agri-food sectors.

To support the implementation of this broad corporate agenda, IFAD has undertaken a number of initiatives and embarked on structural changes that have helped promote the Fund's brokering role in fostering SSTC for better rural livelihoods. A few of these are highlighted below.

First, IFAD, with the Government of Brazil, the Food and Agriculture Organization (FAO) of the United Nations, the United Nations Office for South-South Cooperation (UNOSSC) and the International Land Coalition, has organized an international SSTC Conference on "Leveraging Innovations from the Global South to Support Rural Transformation". This conference, which took place in Brasilia in November 2017,had the following objectives:(i) to identify and discuss innovative solutions focusing on agricultural production and productivity, investment promotion, and inclusive information and communications technologies, with a specific focus on rural youth and women; and (ii) to discuss partnership and cooperation opportunities. The event was a milestone in the process leading to the fortieth anniversary of the Buenos Aires Plan of Action for Promoting and Implementing Technical Cooperation among Developing Countries (BAPA+40), which is to be celebrated in 2019.The main outcome of the Conference was the "Brasilia Declaration and Action Agenda", a declaration encouraging Member States, IFAD and the UN Rome-based Agencies (IFAD, FAO and the World Food Programme) to ramp up their efforts in SSTC in the areas of agriculture, rural development, inclusive rural transformation and sustainable development.

Secondly, in February 2018, IFAD launched the China-IFAD SSTC Facility, the first funding facility dedicated to SSTC in IFAD, with the overarching goal of mobilizing knowledge, expertise and resources from countries of the Global South to accelerate rural poverty alleviation, enhance rural productivity, advance

rural transformation and promote investments between developing countries. With funding from the People's Republic of China amounting US$10 million, the Facility is devoted exclusively to smallholder agriculture and rural development, with specific attention to poverty reduction, fighting malnutrition and promoting rural youth employment in developing countries. It is used to finance grants to organizations and institutions in developing countries, based on periodic calls for proposal. The first call for proposals was issued in June 2018, with more scheduled to take place between 2018 and 2019.

Thirdly, in June 2018, IFAD launched the "Rural Solutions Portal", an online platform which makes available rural development solutions for the benefit of rural communities and smallholder farmers. The main objective of the Portal is to make innovative agriculture and rural solutions available to the development community, and in general anyone involved in the rural development sector. The Portal is currently being populated with experiences and knowledge both from IFAD and other organizations. This will provide rural communities with potential solutions to the challenges they face and also serve as a tool for promoting business-to-business linkages among organizations across developing countries including the private sector.

Last, but not least, in the broader context of its operational decentralization and reform process, in 2018, IFAD has established three sub-regional "SSTC and Knowledge Centres" in Addis Ababa (Ethiopia), Beijing (China) and Brasilia (Brazil). The centres will support the operationalization of the main provisions of IFAD's SSTC Strategy, and help strengthen the linkages between IFAD's country, regional and global knowledge activities.

The corporate initiatives implemented at IFAD have allowed the enabling environment for SSTC to be fully embedded in operations, in both country strategies and in loan- and grant-funded projects and programmes.

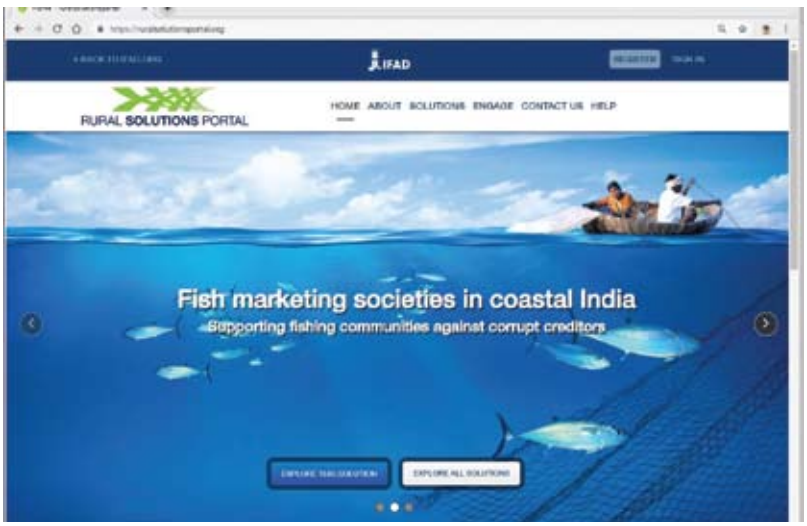
EMBEDDING SSTC IN OPERATIONS

Over the years, the Fund has implemented a very rich and diverse portfolio of agriculture and rural development projects that include SSTC initiatives. These range fromprojects aimed at sharing solutions to strengthenclimate change adaptation, resilience and environmental sustainability; to initiatives designed to promote value chain development, market access for smallholder agribusiness, and cooperative development.

Beyond mere technical cooperation, a number of IFAD-funded SSTC activities have also supported the strengthening of the capacities of governments to shape policies, through the facilitation of high-level policy platforms and events such as policy workshops and seminars, learning tours and bilateral and multilateral exchanges. Other initiatives have invested in the improvement of rural finance and rural institutions, or in sharing biotechnology and agricultural innovations, thus capitalizing on partnerships with research centres.

Three examples can be provided as an illustration of some initiatives that IFAD has implemented over the years; all of which contribute to the achievement of the sustainable development goals and Agenda 2030 through SSTC:

Exchanging knowledge and promoting peer-to-peer learning: IFAD has pioneered and used the Learning Route (LR) methodology; one that has proven to be highly relevant, effective and efficient for SSTC delivery. ALR is a planned journey through which farmers and communities exchange ideas, experiences and innovations, creating a dynamic knowledge exchange and learning network that is used to connect populations in different IFAD projects. For example, a LR implemented in Nigeria, Rwanda



and Uganda had the objective to empower 35,000 vulnerable women and men in rural value chains directly and another 65,000 indirectly through direct and peer capacity-building and action learning, to negotiate a better position in value chains and achieve sustainable and equitable "win-win" collaboration between value chain stakeholders. The LR approach is therefore used to connect smallholders living in different areas, allowing them to share experiences and learn from each other. This methodology has been used within and across several regions, including Latin America and the Caribbean, Africa, Asia and the Near East.

Strengthening of institutional capacities: An historical initiative launched in 2004 was REAF, i.e. the Commission on Family Farming (Reunión Especializada Sobre Agricultura Familiar), a programme for enhancing rural dialogue launched in MERCOSUR countries. With the financial support of IFAD and other partners, the initiative provides a meeting space for family farmers, organizations and rural institutions with the aim of generating a framework for the promotion of regional public policies for family farming. REAF is a unique regional experience that brings together governments, civil society, farmers' organization, and which promotes family farming, addressing priority issues such as access to land, gender, youth, climate change, family production and trade.

Technology transfer: In 2014, IFAD launched, in partnership with the International Centre of Insect Physiology and Ecology (ICIPE), the programme for "Alternative Livelihoods for Food and Income Security in Four Indian Ocean Island Nations". The initiative showed benefits from training on technology transfer in bee-keeping: fifteen people from Mauritius, the Seychelles, Comoros, Madagascar and Zanzibar were jointly trained as lead trainers at ICIPE, consequently facilitating in-depth technology transfer from Kenya to these countries. To date, more than 60 lead bee-keepers have been trained for organic certification by ICIPE and the Kenya Organic Agriculture Network. The development of an International Certification System manual for two farmer organizations has also commenced. Additionally, the ICIPE model successfully linked beekeeping to participatory forest conservation through the value chain approach using technology transfer, training, products and marketplace development.

RESPONDING TO THE CHALLENGES OF TOMORROW

SSTC has evolved into a powerful global instrument to promote rural transformation, reduce poverty, increase income levels and fight against hunger and malnutrition. It plays an important catalysing role in the implementation of the 2030 Agenda for Sustainable Development, and is a key vehicle to achieving sustainable development. The scale and ambition of the sustainable development goals call for new actors to take on a much broader and more integrated role in development, as developing countries can support each other by sharing more adaptive, locally relevant and usually cheaper solutions.

If SSTC aims to be able to respond to the challenges of tomorrow, it will need to demonstrate that it contributes to better operational results on the ground, and that it effectively improves the lives of the populations targeted. Accordingly, more and more countries and organizations are developing, monitoring and evaluating frameworks to assess the contribution SSTC makes to development. As an example, the three United Nations Rome-based Agencies are working on the development of a publication on "M&E Methods and Processes for SSTC in agriculture, rural development and food security", which is expected to be released in 2019, during the BAPA+40 conference, and which will support agencies and governments in conducting a more empirical assessment of the benefits of this development modality.

SSTC is not and should not be a replacement for North-South Cooperation, which it complements through the promotion of innovative development approaches and instruments. In the future, it will evolve further, given the increasing relevance of the countries of the Global South in the world economy, which in some cases will "graduate" into high-income countries. Such transitions will be accompanied by the rise of new emerging economies that will invest in this cooperation modality, based on solidarity, respect for national sovereignty, national ownership and independence, equality, non-conditionality, non-interference in domestic affairs and mutual benefit.

Multilateral institutions and organizations involved in agriculture and rural development, such as IFAD, will need to increasingly adapt to this changing context to ensure they continue supporting effectively the rural populations in developing countries. ■

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Serving Society Through Industry

MERGERS AND ACQUISITIONS IN THE GLOBAL SEED SECTOR AND THEIR IMPACT ON INDIAN SEED INDUSTRY

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Following a large number of mergers in the past few years, the global seed market is now represented by multinationals such as Monsanto, DuPont, Syngenta, and Limagrain, who have expanded their businesses all over the world. Among them, Monsanto and DuPont, took 20% and 15% of the world's total seed market share in 2014, ranking at 1 and 2.

REASONS FOR MERGERS

The main reason for the mergers within the seed industry was the continued depression in prices of global farm products. Figure 1 reveals the downturn in the world cereal price index, since the record high it achieved in September 2012, which was down by 45% in November 2016. With regard to specific crops, Figure 2 shows a 54.56% and 66.06% reduction in corn and wheat prices, respectively, by November 2016, compared to their record high prices in 2012. The soybean price remained on the rise in the first half of this year, but started to dip in the second half, falling by 40.86% this November from its record high in 2012. The considerable drop in cereal prices caused great losses to farmers all over the world, especially commercial growers in North and South America. The price fall eventually affected the income of all seed companies. According to one report, since 2014, the growth in the income of major seed companies has stopped, even declining in 2015 and 2016. When organic growth slows down, it can only be achieved through inorganic growth. Hence, industry mergers occur for the sake of maintaining competitiveness.

Since 2012, a sustained downturn in the world cereal market (Figure 1 and 2) and the slow natural growth made it difficult to maintain growth based on the existing market size. The market slump continued in 2015 and 2016, compelling multinationals to look at opportunities for collaboration.

On December 11, 2015, the first merger was announced between Dow AgroSciences and DuPont. Soon afterward, ChemChina announced its acquisition of Syngenta, and Bayer announced the takeover of Monsanto. The global seed industry was thus redefined.

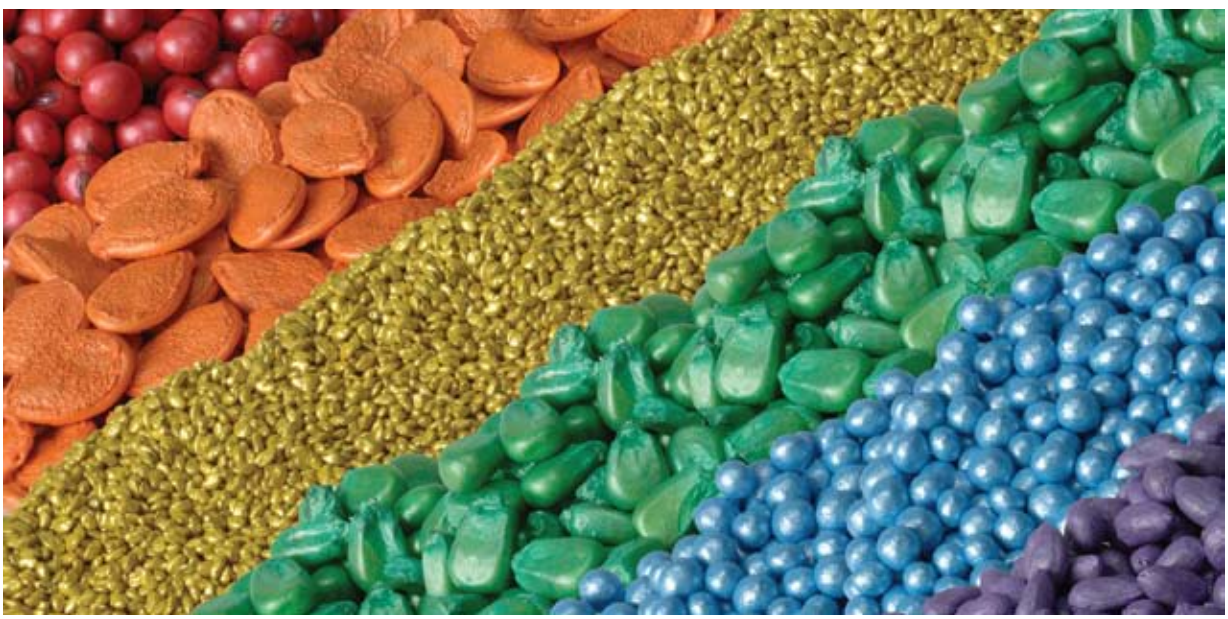


Fig. 1 FAO cereal price Index

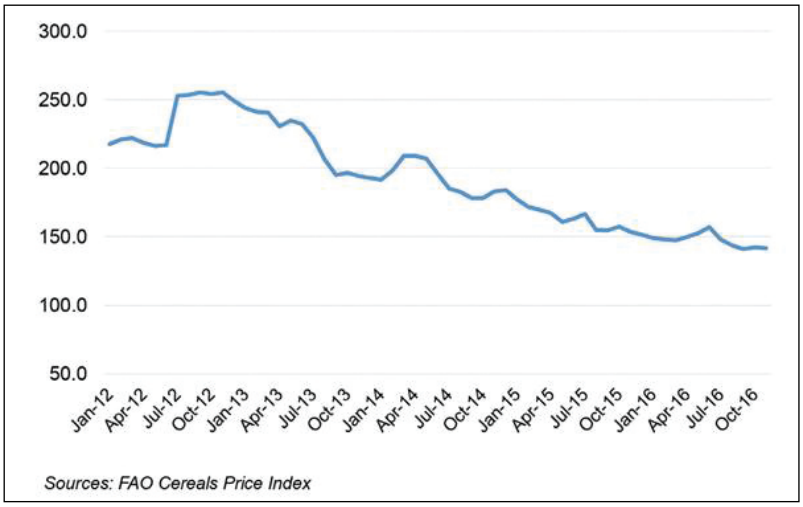
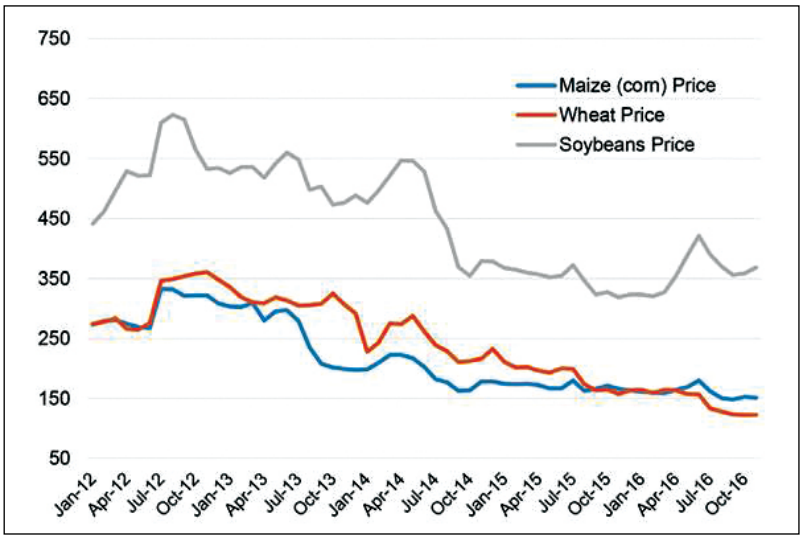


Fig 2. US price for Maize, wheat and Soybeans (US$ per metric Ton)



TOP 10 COMPANIES BEFORE MERGERS

By sorting through the financial statements of most of the seed companies operating in 2015, the top 10 companies in terms of sales (Figure 3) have been identified. They include four US companies (Monsanto, DuPont, Land O'Lake, and Dow AgroSciences), five European companies (Syngenta, Bayer, Limagrain, KWS, and DLF) and one Japanese company (Sakata). Among them, Monsanto's position as the market leader remained unshakable. In 2015, the sales of field crops of the company reached $9,627 billion, backed by the superiority of its genetically modified organisms (GMOs). In the meantime, it also led in the vegetable seed business, reaching sales worth $816 million.

Presuming the three super mergers get approvals from their respective countries, great changes are expected to take place in the global seed industry structure. According to Figure 4, a more apparent monopolistic business model will be formed by the merged Monsanto/Bayer, DuPont/ Dow AgroSciences and Syngenta/ ChemChina, where the business turnover of the three giants will be four times the total sales of the other seven companies in the top 10. Also, GM products will be monopolized by the three giants, because other companies, including the new top 10 players Rijk Zwaan and TAKII, have few GM products in their portfolios.

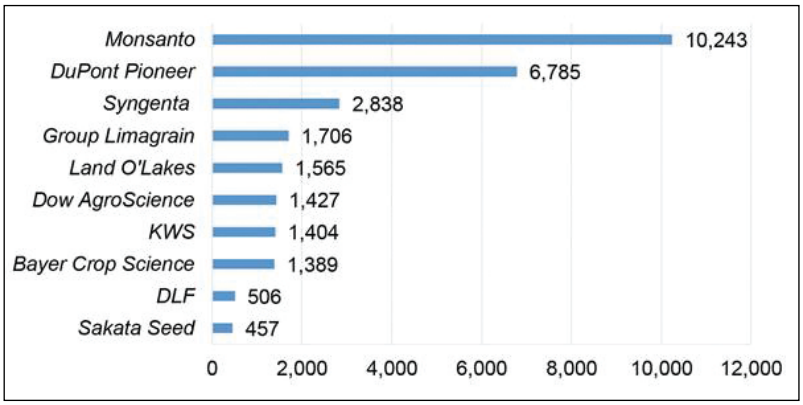
On the other hand, the global business deployment of the top 10 may change significantly in the future. After the mergers are approved, the United States, Europe, and China will each become a seed industry giant, which will eventually result in a global top 10 comprising two US companies, five European companies, one Chinese company, and two Japanese companies.

INDUSTRY CONSOLIDATION INVOLVING LARGE NUMBERS OF SEED ENTERPRISES

In addition to the three super mergers, the adverse market situation has hit a large number of seed enterprises worldwide, including the top 10.

- In February, Limagrain announced the acquisition of Genica Research Corporation (USA), which was expected to enhance its leading position in the US vegetable seed market. AgReliant Genetics, its joint venture with KWS in the United States, announced this September the completion of the acquisition of a soybean seed factory from Sand Seed Service, located in Marcus, Iowa. The completed acquisition is expected to enhance the local soybean

Figure 3. Sales of global top 10 seed companies in 2015 (US$ m) (Ref:Agropages)

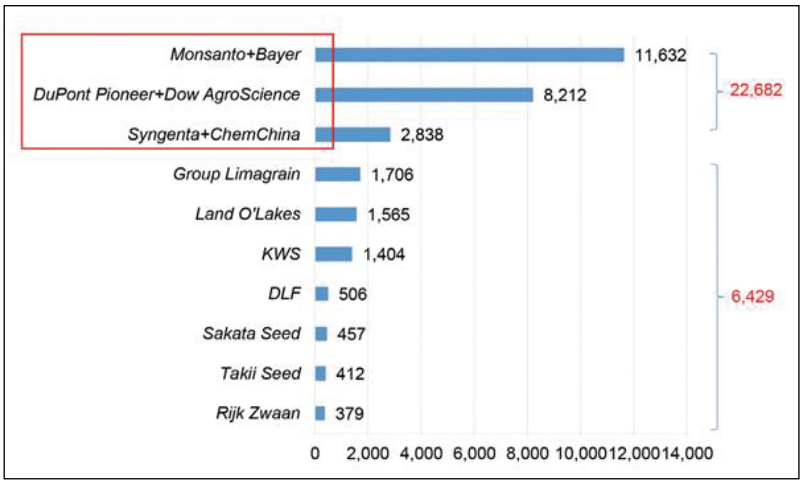


business of the company.

- Land O'Lake focused on feed crops. In May, the company's subordinate Forage Genetics International (FGI) spent $210 million to take over the alfalfa project from Monsanto, as well as the patent and know-how of Monsanto, authorized to FGI at an earlier date, followed by the respective acquisition of Ceres and the alfalfa business of Syngenta in June and July. The acquisitions further enhanced the feed crop business strength of the company.
- In June, DLF acquired the alfalfa seed business of Florimond Desprez, expecting it to strengthen its feed crop business. Later in September, DLF acquired the remaining 50% stake in Jensen Seeds A/S to hold the controlling share of the company. Jensen Seeds is a global hybrid spinach industry leader.
- In August, TAKII acquired the breeding subsidiary of Turkish vegetable seed company Rito Seed to extend its worldwide vegetable breeding capacity.
- In October, the largest family-run seed retailer in the United States, Beck's, announced the acquisition of the seed R&D facility of BASF, located in Kauai, Hawaii, to enhance its corn seed research capacity. Thereafter, Beck's will move its winter research project to Kauai.
- In June, the alfalfa seed industry leader S&W Seed announced the acquisition of the Australian SV Genetics, having extended its product range to sorghum and sunflower seeds. The company believes the combination of two kinds of seeds and the existing alfalfa seed business will create a synergy.

It is expected that mergers between seed companies in 2016 will affect their business performance after 2016.

Figure 4. Top 10 after three big M&A (US$ m) (Ref: AgroPages)



IMPACTS OF MERGERS ON INDIA

The seed price is expected to increase. But, Indian seed companies are competitors to the MNC. Monsanto, India has sold its cotton business to Tierra seed.

But globally, fewer players will mean less farmer choice when it comes to products. Globally, the merger is projected to raise aggregate seed prices by 5.5% but could raise cottonseed prices by more than 20%.

On average, farmers using Monsanto brand cottonseed will see their seed prices increase by 19.23%, while farmers using Bayer brand cottonseed will see their seed prices increase by 17.41%. On the other hand, competition still exists in this arena.

There are more players across agriculture than ever. Hundreds of start-ups have annually entered the agricultural space. Investment in agricultural technology over the last three years is estimated at $10 billion. Even among big players, plenty of collaboration between parties will occur and will not change the need for innovation investments. ■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H.E. Mr. Giedrius Surplys
Minister of Agriculture,
Republic of Lithuania

AGRICULTURE AND ANIMAL HUSBANDRY - A SOURCE OF INSPIRATION FOR ARTISANS

Lithuania is a Baltic country with a history reaching back to ancient times. We greet our guests not only with spectacular landscapes, but also with amazing and unique works of our artisans, the traditions of festivals, our culinary heritage, and the hospitality of people. In Lithuania, agriculture and animal husbandry have been not only a means of living, but also a source of inspiration for artisans. Thus, in the world full of changes the nurturing of traditional crafts allowed our country to retain its uniqueness and foster national consciousness. Since ancient times, Lithuanians ate rye bread, fresh, salt-cured and smoked meat, fresh and sour milk products, drank barley beer, and used linseed oil. Inhabitants of the seaside and lakeside areas consumed more fish. The interest in traditional and healthy food that has increased in the recent years encouraged restaurants and food producers to revive the food preparing traditions.

Lithuanian agriculture and food industry is one of the key economic sectors in the country that has long traditions. Traditionally, Lithuania holds a strong position in the production of milk and meat products, with a focus on organic production and farming, national heritage. Milk production is one of our country's largest agricultural sectors and it accounts for about a fifth of all agricultural production. In Lithuania, milk production has been a traditional agricultural business since



very old times. Favourable climate and natural conditions (Lithuania lies in the geographical centre of Europe) – grass meadows and sufficient rainfall allow developing sustainable milk production system what lets us to produce the highest quality and healthy milk. The self-sufficiency of milk and dairy products is about 154 per cent in our country. Over a half of total milk products is exported. Lithuania currently exports dairy products to more than 80 countries. Lithuania exporters can offer a much wider range of products such as fresh and matured cheese, milk powder, lactose, milk desserts from curd, protein concentrates, ice-cream and other products. The one of the most important Lithuanian dairy products is cheese. Lithuanian dairy plants produce the highest quality matured cheese which have received a number of awards in many international exhibitions. Special one - curd cheese. It's white, neither sweet nor sour, is strongly reminiscent of childhood holidays in your grandmother's village. Ask any Lithuanian what this reminds them of and they'll undoubtedly all say – curd cheese.

More and more Lithuanian regional traditional food products get included into European Union Protected Geographical Indication registries. As of now, the European Commission has recognised seven Lithuanian products as certifiably traditional and exceptional products: Daujenai Home-baked Bread, SamogitianKastinys, Stakliskes Mead, Lithuanian Curd Cheese, Seinai and Lazdijai Region Honey, and Lithuanian Skilandis and cheese Liliputas. These products are endowed with unique characteristics and quality and are made according to authentic recipes. Lithuanian food products marked with a special EU certification sign are becoming increasingly popular in the European Union market.

Lithuanian food products have already attracted international attention. Our companies such as *Green Week, Anuga, Biofach, Gulfood, Foodex Japan, SIAL China, PLMA International, Fruit Logistica* and others successfully participating at International Food Fairs worldwide.

Today Lithuanian agriculture sector faces many challenges, but at the same time living tremendous growth time. Today, we are exporting our production to more than 143 countries. The latest scientific achievements and advanced technologies are combined with traditional skills to produce high-quality food products, which are available both to lithuanians and to the foreigners. ■

HE Adam Burakowski
Ambassador of Poland to India

POLAND'S AGRICULTURAL STRENGTH

While the differences between the agricultural sectors in India and Poland may seem apparent, particularly in terms of climatic conditions, the types of crops and agricultural commodities cultivated, the agricultural practices extant in both countries, etc., this sector in both these countries stands as the backbone of their respective economies. Additionally, agriculture and the related food industry, form the basis of the traditions and cultures in both India and Poland.

At present, there is an estimated 1.5 million farms, or agricultural landholdings in Poland. Indeed, the importance of agriculture in Poland can be encapsulated by the fact that approximately 60% of all land in Poland today is devoted to this sector.Furthermore, according to the Central Statistical Office of Poland, around 12% of Poland's workforce is involved in the agricultural sector - a figure which is slightly higher than the average in the European Union. Another key indicator in the Polish agricultural sector is the fact that approximately 14.7% of farmers in Poland are below the age of 35, far higher than the E.U. average of 7.5%.This last metric is an important indicator of the dynamism of agriculture in Poland today, since it indicates the existence of a workforce which is more ready to adapt to new and innovative agriculture practices and technologies, as well as a greater willingness to shift to more economically advantageous practices, such as organic farming.

In 2017, in value terms, approximately

60.9% of production in the Polish agricultural sector was comprised of livestock production, with the remaining 39.1% comprised by the crop production segment.More specifically, livestock for slaughter accounted for 34.5% (in value terms) of the Polish agricultural sector, with a subsequent 19.4% and 5.6% comprised of milk and egg production respectively.Cereals, vegetables and fruits accounted for an additional 11.3%, 8.4% and 4.8% of Polish agricultural sector, in value terms, respectively.

The statistics mentioned above, offer an insight into how well diversified agriculture in Poland is today.In fact, Poland is one of the largest producers across various categories of agricultural commodities, livestock products and processed foods. Indeed, Poland is one of the largest exporters of apples in the world. According to E.U. estimates, one of every four apples produced in the European Union is produced in Poland. In 2017, Polish apples accounted for 28.7% of all apples produced in the European Union. In 2017/18, the production of apples in Poland was pegged at 2.8 million MT, with almost half that figure being supplied to the food processing industry for the production of apple juices, concentrates, etc.According to the latest estimates released by the Central Statistics Office of Poland, the production of apples in Poland during the current year 2018-19, is expected to witness a historic growth to approximately 3.6 million MT.Poland is also amongst the top-three largest producers of various other categories of fruits, including strawberries, cherries and blueberries. In all, Poland is the sixth-largest producer of fruits and vegetables in the European Union.

Poland is also a well-known producer of milk and dairy products - it is the fourth-largest producer of milk products in the E.U. According to publicly available data, approximately 13.8 million MT of fluid milk was produced in Poland in 2017. This figure is expected to rise to 14 million MT during the current year. The large majority of the milk produced in Poland is utilised for the production of cheese. In 2017, cheese production in Poland stood at 0.925 million MT. This figure is expected to rise to approximately to 0.93 million MT during the current year. The importance of the dairy sector in the agri-food industry in Poland can be seen by the fact that there are over 175 large-scale dairy co-operative processing plants scattered across Poland today. These facilities employ an estimated 32,000 people.

With regard to livestock products, Poland is a leader in the European Union in the production of pork and poultry products. In 2017, according to official estimates, Poland produced approximately 1.86 million MT of pork products and 2.8 million MT of poultry products. The vast majority of Polish agri-food commodities are exported to the European Union and to wider markets in North America, Asia and Africa.

In 2017, the value of all Polish agri-food exports were valued at EUR 27.8 billion, representing a 14.3% increase from the level of EUR 24.3 billion, recorded in the previous financial year.Similarly, the value of all Polish agri-food imports in 2017 was pegged at EUR 19.3 billion - indicating a growth of 11.5% from the value recorded in 2016.

Indeed, agri-food exports play a vital part in Poland's total export revenues. Bearing in mind that Poland's total export revenues in 2017 were recorded as being EUR 206.6 billion, agri-food exports accounted for 13.5% of Poland's total export earnings.Among the most significant Polish agri-food commodities exported in 2017 (in value terms) were: meat products, valued at EUR 4.764 billion; tobacco, valued at EUR 2.99 billion; dairy products, valued at EUR 2.479 billion; and processed foods made from cereals and dairy products, valued at EUR 2.318 billion.The vast majority of Polish agri-food exports are destined towards fellow E.U.

member states. Indeed, Polish agri-food exports to E.U. member states in 2017 were pegged at EUR 22.757 billion, accounting for around 81.8% of all Polish agri-food exports. The major recipients of these Polish products are Germany, the United Kingdom, Holland and the Czech Republic.

Similarly, the total value of Polish agri-food imports in 2017 was estimated at EUR 13.639 billion, which contributed 9.4% to Poland's total import bill during this period. Major exporters of agri-food products to Poland in 2017 were Germany, Spain and Holland.

By comparison, the value of Indo-Polish agri-food trade is comparatively low. According to the Directorate General of Foreign Trade (DGFT) of India, India imported approximately USD 11.56 million worth of agri-food products in FY 2017-18. Despite this low figure, it is important to bear in mind that the figure for the preceding financial year FY 2016-17 stood at USD 7.95 million. The main commodities imported into India from Poland during FY 2017-18 were fresh apples (H.S. code 08081000), which were valued at USD 3.17 million. This was followed by imports of fresh fowls, fruit juices and whey protein powders valued at USD 1.65 million, USD 1.22 million and USD 0.78 million, respectively.

On the other hand, Poland imported agri-food products valued at USD 111.99 million from India in FY 2017-18, representing a significant growth from the USD 95.35 million recorded in the preceding financial year.The main agri-food commodities exported from India to Poland during this period included: miscellaneous processed food preparations, valued at USD 28.02 million; coffee, tea, mate and spices, valued at USD 24.22 million; tobacco products, valued at USD 17.71 million; and seafood products, valued at USD 9.5 million. The above figures indicate that Indo-Polish trade in agri-food products during FY 2017-18 stood at only 5.35% of the total trade between both countries.

I believe strongly that the mutual and complementary strengths of the agricultural sectors of both countries can be harnessed to significantly increase bilateral trade in agri-food commodities over the course of the

coming years.Just as in the case of the agricultural sector, the related food processing industry has also witnessed dynamic growth over the course of recent years.

According to industry estimates, there are around 33,000 people directly and indirectly engaged in the Polish food processing sector, collectively generating approximately USD 64 billion in 2017. This sector also contributes 24% to the total industrial production in Poland, and approximately 6% to the country's annual GDP.

The food processing sector in Poland today is the largest in the Central & Eastern European Union (CEE) and the sixth-largest in the E.U.Furthermore, according to the National Bank of Poland's statistics, the Polish food processing industry attracted USD 1.06 billion in net foreign direct inflows in 2016. This represented nearly 25% of the FDI inflows received by the entire manufacturing sector in Poland during that year.In recent years, this sector - and the wider Polish economy - have been attracting ever increasing amounts of FDI inflows. Indeed, according to the E&Y's European Attractiveness Survey for 2016, Poland was ranked as the most attractive FDI inflow destination in the Central & Eastern European (CEE) region, and the fifth most attractive destination in the E.U.Poland received 256 FDI projects in 2016, resulting in the creation of approximately 22,000 new direct and indirect jobs, amounting to USD 13.926 billion in FDI inflows.

These indicators are a strong sign of the strength of the Polish food processing sector. Indeed, the presence of a highly-motivated and educated workforce, lower labour costs in comparison with other E.U. member states, lower costs of production in Poland, as well as the efficient and far-reaching incentives offered by the Polish government have made Poland one of the most attractive FDI destinations in Europe for the food processing sector. Indeed, several large-scale food and beverages manufacturers have already relocated their production facilities from other E.U. member states to Poland.

I look forward to witnessing the continued strengthening of Indo-Polish collaboration in the agricultural and food processing sectors. ■

Agriculture Sector and Indian Economy

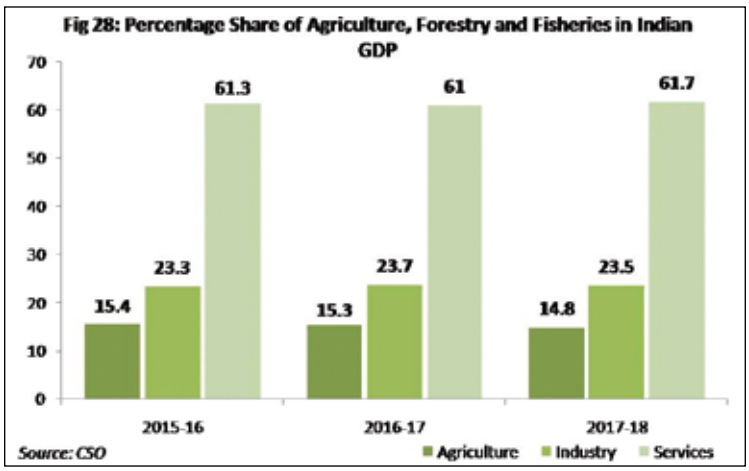
Agriculture and allied activities have provided a solid foundation to the Indian economy, especially in a year marked by shocks imparted by demonetisation and the implementation of GST in the recent time.

In the recent times, as the Indian economy continues its steadfast progress being the fastest growing economy of the world, agriculture sector of the country is presenting some noteworthy fundamental changes vis-a-vis the Indian economy. Contribution to the nation's economy by the primary sector is shown in Fig 28. The noteworthy fundamental changes about the agriculture sector can be viewed as follows:

- The share of livestock in GVA in agriculture has been rising gradually, the share of the crop sector in GVA has been on the decline.
- Agriculture sector in India is undergoing re-orientation in policies towards this sector in terms of strengthening the agricultural value chain.
- Focus on allied activities like dairying and livestock development along with gender-specific interventions is increasingly gaining centre stage.
- Share of livestock in total farm incomes which was just 4 per cent during the early 2000 has increased to 13 per cent currently.

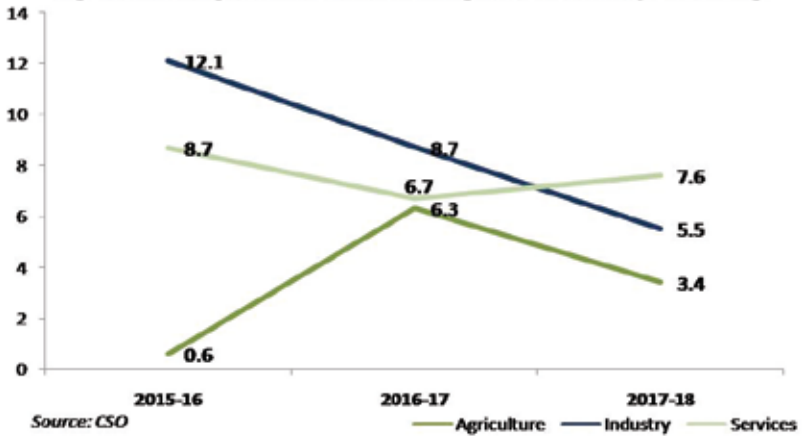
Percentage growth of GVA from the Agriculture, forestry and fishing sector have been witnessing a fluctuating trend in the recent years. The growth was 0.6% in 2015-16 and increased to 6.3% in the following year before declining again to 3.4% in 2017-18 (Fig 29). As a part of the recent emphasis of the policy makers, the contribution of women to agriculture and food production is gaining more importance from the point of view of a sustainable devel-

Fig 28: Percentage Share of Agriculture, Forestry and Fisheries in Indian GDP



Source: CSO

Fig 29: Percentage Growth GVA from of Agriculture, forestry and Fishing



Source: CSO

opment of the agriculture and rural economy. Women play a significant and crucial role in agricultural development and allied fields including in the main crop production, livestock production, horticulture, post-harvest operations, agro/social forestry, fisheries, etc. However, only 12.8 per cent of the operational holdings were owned by women, which reflect the gender disparity in ownership of landholdings in agriculture. As a result, the Ministry of Agriculture, Farmers Cooperation and Welfare has come out with a comprehensive set of initiatives designed at increasing the rights of the women farmers. Following are some of the important measures taken up recently:

- Earmarking at least 30 per cent of the budget allocation for women beneficiaries in all ongoing schemes/ programmes and development activities.
- Initiating women centric activities to ensure benefits of various beneficiary-oriented programs/ schemes reach them.
- Focusing on women self-help group (SHG) to connect them to micro-credit through capacity building activities and to provide information and ensuring their representation in different decision-making bodies.
- Recognising the critical role of women in agriculture, the Ministry of Agriculture and Farmers Welfare hasdeclared 15th October of every year as Women Farmer's Day.

UNION BUDGET 2018-19 AND AGRICULTURE SECTOR

The budgetary allocation of Agriculture and Farmers Welfare Ministry was Rs. 51,576 crore for the year 2017-18 which has been increased to Rs. 58,080 crorein this year's budget of 2018-19. A number of measures to enhance rural income and develop the agriculture sector further were proposed in the Union Budget 2018-19. Some of the noteworthy measures and initiatives are:

- Setting up an Agri-Market Infrastructure Fund with a corpus of Rs.20 billion
- This corpus fund shall be used in developing and upgrading agricultural marketing infrastructure in the 22,000 Grameen Agricultural Markets (GrAMs) and 585 Agricultural Produce Market Committees (APMCs).
- Creation of a Fisheries and Aquaculture Infrastructure Development Fund (FAIDF) and the Animal Husbandry Infrastructure Development Fund (AHIDF).
- Relaunching the National Bamboo Mission in a refurbished and restructured form with an outlay of Rs.12.9 billion.
- Launching "Operation Greens" along the lines of "Operation Flood" to promote Farmer Producers Organisations (FPOs), agri-logistics, processing facilities and professional management.
- Further expansion of the ground water irrigation scheme under the Pradhan Mantri Krishi SinchayeeYojana with the slogan of "HarKhetkoPani".
- Bringing 100 million poor and vulnerable rural families under a health protection cover with an

outlay of Rs. 0.5 million.

CURRENT STATUS OF MINIMUM SUPPORT PRICES FOR IMPORTANT AGRI CROPS IN INDIA- A QUICK LOOK

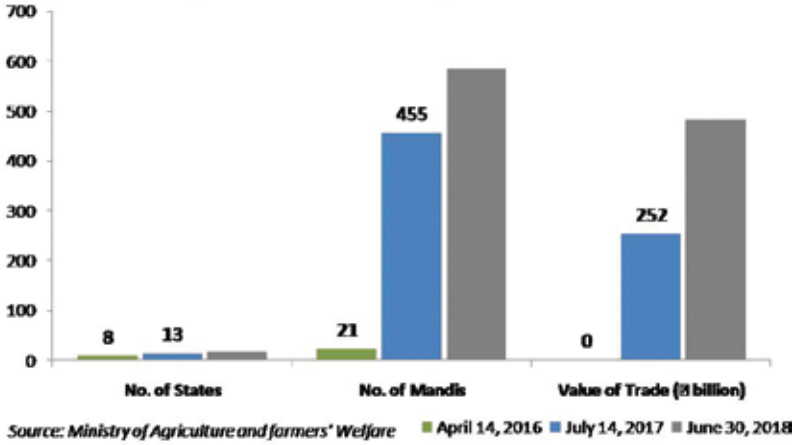
Based on recommendations of the Commission for Agricultural Costs and Prices (CACP), Government every year announces minimum support prices (MSPs) for 23 crops every year. This year, Government in its Union Budget 2018-19 announced provision of MSPs for crops at 1.5 times the cost of production, which is 50% higher than the production costs incurred by the farmers. In 2017-18, the National Agricultural Cooperative Marketing Federation of India said it bought 31.9 lakh tonnes of pulses and oilseeds at the MSP, benefiting 20 lakh farmers. This accounted for about 6% of the total production of pulses and oilseeds during the year across the country. India produced about 240 lakh tonnes of pulses and 300 lakh tonnes of oilseedsduring 2017-18.

PRADHAN MANTRI ANNADATA AAY SANRAKSHAN ABHIYAN (PM-AASHA)

On 12th September, 2018, Cabinet Committee on Economic Affairs gave green signal to PM-AASHA scheme. This scheme clubs together an existing procurement scheme with two newly introduced options meant for oilseeds only. These two new options are additional procurement by private traders or a cash payment scheme. This scheme is aimed to enable farmers to take advantage of the increased MSP because in case the farmers are not able to sell their produce, MSPs are of no use. To enable this initiative, Cabinet approved an additional government credit guarantee of Rs.16,550crore for agencies to undertake procurement, in addition to the already announced Rs.15,053 crore to be spent over a two-year period. The other salient features of PM-AASHA are:

- **Price Deficiency Payment Scheme:** For pulses and copra, Central agencies like the NAFED and the Food Corporation of India will procure the produce whenever the market rates fall below MSP, up to a maximum limit of 25% of the total harvest. Under the price deficiency payment scheme, farmers will sell their produce in the market, and the government will directly pay them the difference between the MSP and the average market rate. The cash payment will be deposited in their bank accounts
- **Pilot Scheme for Procurement by selected private procurement agencies:** Under this pilot scheme, selected private procurement agencies will procure the commodity at the MSP, instead of the government. Maximum service charges up to 15% of the notified MSP will be payable to the private agency.

Fig 30: Latest Staus of Coverage of eNAM in India



Source: Ministry of Agriculture and farmers' Welfare

E-NAM AND ITS GROWING ACCEPTANCE

In order to create a unified national market for agricultural commodities, e-NAM, the e-trading platform for the National Agriculture Market was launched in April 2016. Today, its reach has expanded considerably and the platform now covers 585 markets across 16 states and two Union Territories. Leveraging the ICT platform, the scheme has immense potential to transform the agricultural marketing structure and ushers in a new era of smoother inter-state movements, more efficient price discovery and removal of intermediaries. However, one can argue that the adoption process is still relatively slow and gradual with a majority of traders and farmers still continuing with the manual auctioning process. To give a fillip to the speed of adoption of eNAM across the country, recently the following measures have been undertaken:• simplifying registration of farmers on the portal

- expanding payment options and addition of Unified Payment Interface through BHIM
- extending e-NAM trading in six different language (Hindi, English, Bengali, Gujarati, Marathi and Telugu) and making the website readable in eight different languages (Hindi, English, Gujarati, Marathi, Tamil, Telugu, Bengali and Odisha). ■

STATUS OF FOOD SECURITY IN INDIA AND IN THE WORLD

India will witness a total utilization of cereals to the tune of 238 million tonnes in 2018 with a stock status of 40 million tonnes. The average utilization of cereals in India from 2015 to 2017 was 233 million tonnes and the stock balance was 40 million tonnes. The forecast stock in 2019 is 241 million tonnes. Per capita cereal consumption in India is about 147 kg per year.

In terms of monetary value, experts feel that India currently has a stock of cereals worth Rs 50,000 crore, over and above the stipulated buffer limits. Out of the total cereals, the stock of wheat currently in India is

Fig 82: Utilization vs Total Stocks of Cereals in India (million tonnes)

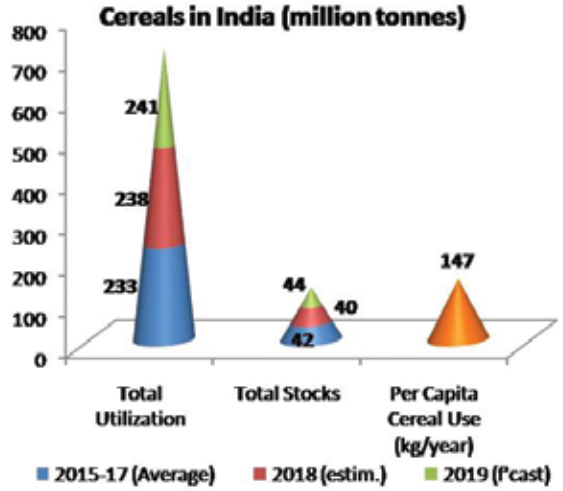


Fig 83: Utilization vs Total Stocks of Coarse Grains in India (million tonnes)

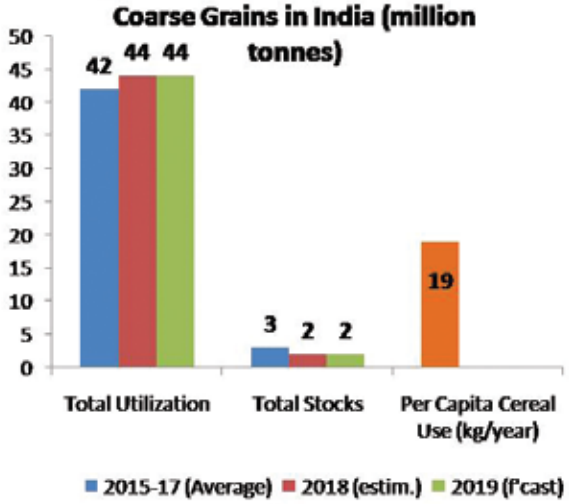


Fig 84: Utilization vs Total Stocks of Wheat in India (million tonnes)

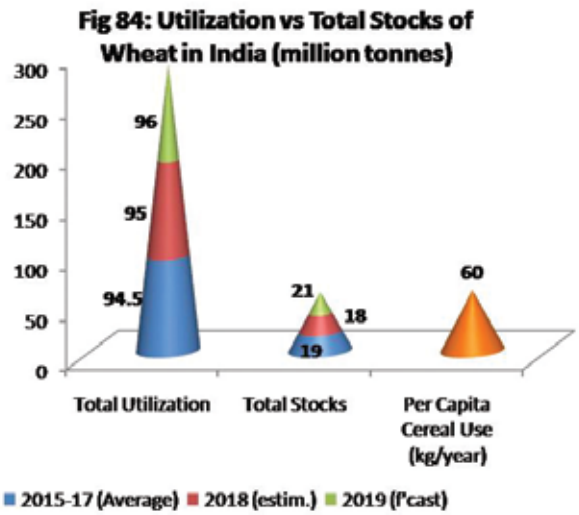
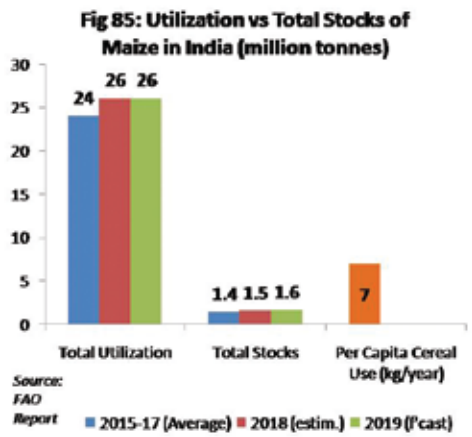
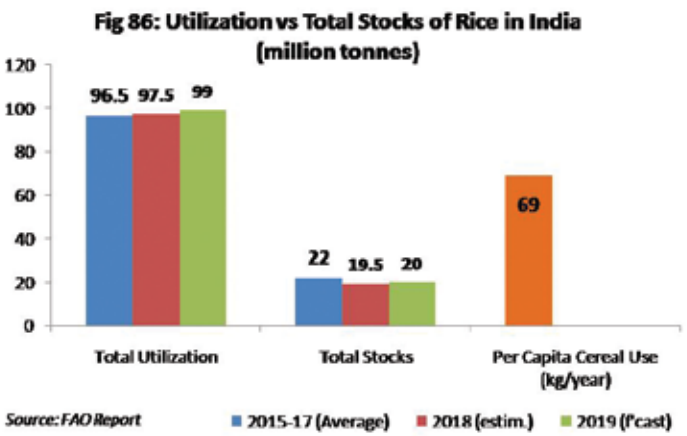


TABLE 4: GLOBAL UTILIZATION VS STOCK STATUS OF FOOD GRAINS

Year	Total Utilization						Total Stocks					
	Asia	Africa	Central America	South America	North America	Europe	Asia	Africa	Central America	South America	North America	Europe & Oceania
2015-17 (Average)	1245.8	252.5	69.5	146.3	384.2	410.5	472.5	54	10.1	40	91.2	69.5
2018 (estim.)	1292.1	264.8	74.7	152.2	395.8	420	497.4	56	13.4	54.3	97.1	81.4
2019 (f'cast)	1310	265.4	78.3	156.4	396	419.5	484.5	53	11	47.7	79.7	65





about 18 million tonnes. The country consumed a total of 94.5 million tonnes of wheat as the average of 2015 to 2017. Similarly in the coarse grains segment, India currently has an estimated stock of 2 million tonnes which is a marginal decline from 3 million tonnes in the previous years' average. The total average utilization of coarse grains in India from 2015 to 2017 was 42 million tonnes which increased to 44 million tonnes in the current year. The per capita consumption of coarse grains in India is about 19 kg per year.

India currently has stock of 18 million tonnes of wheat in the country and the total consumption in 2017-18 is estimated to be about 95 million tonnes. The consumption in 2018-19 is forecast to increase to 96 million tonnes and the corresponding stock status will be 21 million tonnes. The per capita wheat consumption in the country is 60 kg per year.

Similarly for maize, the total consumption was 26 million tonnes in 2017-18 which is forecast to remain the same in the current production year too. The stock status of maize in India currently is about 1.5 million tonnes. Per capita consumption of maize in the country is about 7 kg/year.

The estimated utilization of rice in the country during 2017-18 is 97.5 million tonnes. Utilization has increased from the previous average utilization figure of 96.5 million tonnes from 2014-15 to 2016-17. The projected utilization will further increase to 99 million tonnes this year. The current stock status of rice in the country is about 20 million tonnes and the per capita rice utilization is about 69 kg per year. ■

AGRI CREDIT SCENARIO IN INDIA

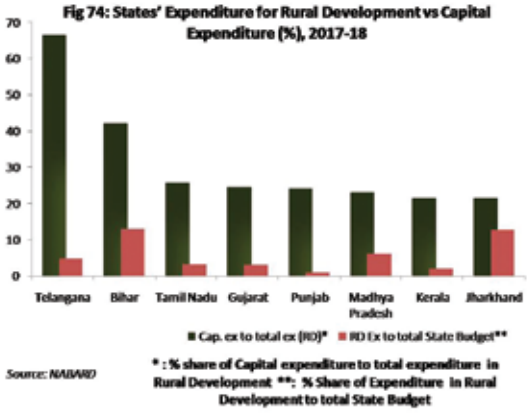
Recent years have seen increased budgetary expenditure on rural development by various States. This is a ripple effect of the increasing thrust of the Government of India on rural development and developing rural livelihood. Fig 74 provides an important overview of the status of the budgetary estimates for capital expenditure by some major States on rural development. It shows that Telengana and Bihar as the two States which have substantial percentage share of capital expenditure to total expenditure in rural development (66.5% and 42% respectively). Other six States (Tamil Nadu, Gujarat, Punjab, Madhya Pradesh, Kerala and Jharkhand) have over 20% share for the same. In terms of the percentage share of expenditure in rural development to total State Budget, Bihar and Jharkhand shows substantially high share when compared to the other States in discussion. In 2017-18, Bihar and Jharkhand as States had 12.9% and 12.7% respectively as the percentage share of the expenditure in rural development activities to the total budget of the respective States. While Punjab had 24.1% of its share as capital expenditure to total expenditure in rural development, it had a meagre 0.9% Share of expenditure in Rural Development to total State Budget. While Telengana had the highest percentage share of capital expenditure to total expenditure in Rural Development at 66.5%, it had just 4.8% of its total State budget being spent in rural development related expenditure in 2017-18.

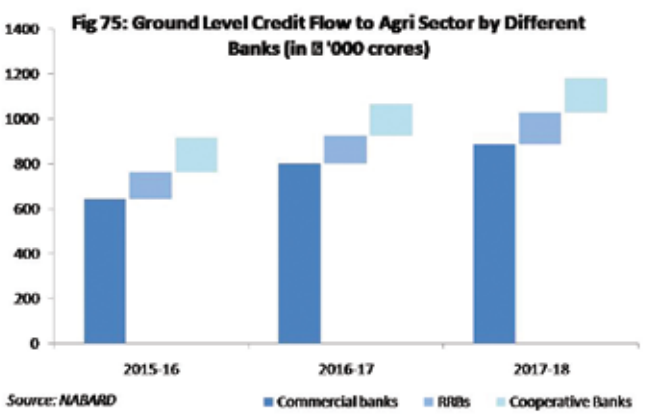
Ground level credit flow to the agriculture sector in India is generally done by the commercial banks, the regional rural banks (RRBs) and the cooperative banks. It is interesting to note that despite the shocks of demonetisation in November 2016, credit flow to the agriculture sector sustained an increased quantum even in 2017-18.

As can be seen in Fig 75, agricultural credit disbursement in the country continues to be dominated by the commercial banks. In 2017-18, almost Rs. 886 thousand crores of agricultural credit was disbursed by the commercial banks. This accounts for 75% of the total credit flow to the sector. In terms of Cumulative Annual Growth Rate (CAGR), between 2015-16 and 2017-18, the credit flow to the agriculture sector from the commercial banks grew by a CAGR of 11.3%.

RRBs had a share of 12% of the credit flow in 2017-18 at Rs.142 thousand crores and between 2015-16 and 2017-18, the credit flow to the agriculture sector from the RRBs grew by a CAGR of 6%. Credit flow to the agriculture sector from the cooperative banks accounted for 13 percent of the total credit flow of □ 1179 thousand crores in 2017-18. The cooperative banks disbursed a total of □ 150 thousand crores during the year. However, among all the categories of banks, the cooperative banks registered a minute negative CAGR of 0.6% between 2015-16 and 2017-18. However, effect of demonetisation does not seem to be the reason as the dip in credit flow from the cooperative banks occurred in 2016-17 when it decreased from □ 153 thousand crores in 2016-17 to □ 143 thousand crores in the next financial year of 2016-17 (Fig 39).

Fig 76 provides an overview of the share of institutional credit flow to different regions of the country. Southern region had the highest share of the total credit flow to agri sector with 35% in 2016-17. Total credit flow to the southern region in this year was Rs.444 thousand crores. This region also recorded the highest CAGR of almost 12% between 2014-15 and 2016-17. During the same period, Eastern re-





RURAL INDEBTEDNESS AND INSTITUTIONAL MEASURES

- About 52 percent of the agricultural households in the country were estimated to be indebted
- Though flow of institutional credit to the agriculture sector has increased as already discussed, still at all India level, only about 60 percent of the outstanding loans were taken from institutional sources
- This indicates the fact that farmers are still considerably dependent on private money lenders for meeting their credit needs
- Reserve Bank of India (RBI) has taken several measures to increase institutional credit flow and bringing more and more farmers including small and marginal farmers within the fold of institutional credit. Some of these measures are:

o Domestic Scheduled Commercial Banks are required to lend 18% of the Adjusted Net Bank Credit (ANBC) or Credit Equivalent to Off-Balance Sheet Exposure (CEOBE), whichever is higher, towards agriculture

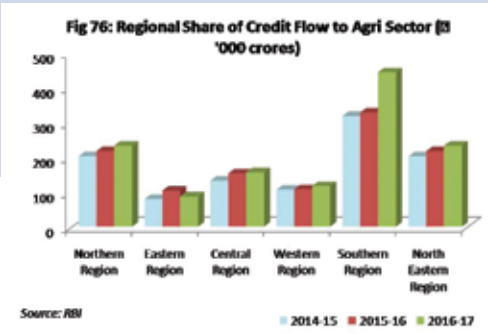
o A sub-target of 8% is also prescribed for lending to small and marginal farmers including landless agricultural labourers, tenant farmers, oral lessees and share croppers

o Similarly, in the case of Regional Rural Banks 18% of their total outstanding advances is required to be towards agriculture and a sub-target of 8% has been set for lending to small and marginal farmers

o Interest subvention scheme is available for short term crop loans up to ₹ 3.00 lakhs

o RBI has directed to Banks to waive off margin or security requirements of agricultural loans upto₹ 1,00,000 (Rupees one lakh)

o The requirement of 'no due' certificate has also been waived off for small loans up to ₹ 50,000 to small and marginal farmers, share-croppers and the like and, instead, only a self-declaration from the borrower is required



gion witnessed a fluctuating flow of credit to the agri sector from institutional sources, increasing to Rs104 thousand crores in 2015-16 fromRs80 thousand crores in the previous year before decreasing toRs87 thousand crores in the following year of 2016-17. Overall, this region recorded a positive CAGR of about 3% from 2014-15 to 2016-17.

Low share of credit flow to the agri sector in the eastern region needs a careful intervention from the policy makers because of the growing importance of the region in terms of ushering in the second green revolution. Low rate of credit flow to agri sector is definitely not desirable and not in sync with the vision formulated related to development of agriculture in the region.

It is encouraging to see that the flow of institutional credit to the agri sector in the North Eastern region is consistently increasing during the past years. From Rs 202 thousand crores in 2014-15, the credit flow in the region increased to Rs 233 thousand crores in 2016-17, registering a CAGR of about 5% which is a healthy sign. ■

KISAN CREDIT CARDS (KCC)

- The Government introduced the KCC Scheme, for issue of KCC to farmers for uniform adoption by the banks
- This was done with the aim to enable farmers to readily purchase agriculture inputs such as seeds, fertilizers, pesticides etc. and draw cash for their production needs
- Under the KCC Scheme, a flexible limit of Rs. 10,000 to Rs. 50,000 has been provided to marginal farmers (known as Flexi KCC)
- Flexi KCC is based on the land holding and crops grown including post harvest warehouse storage related credit needs and other farm expenses, consumption needs, etc., plus small term loan investments without relating it to the value of land
- Following is the status with KCC in terms of numbers and financial amount (Table 1):

TABLE1: KISAN CREDIT CARD (KCC) SCHEME

Year	Number of Operative KCCs(in millions)	Outstanding Crop Loan (in ₹ billion)	Outstanding Term Loan (in ₹ billion)
2016-17	23.37	3,851.89	498.13
2017-18	23.53	3,911.34	419.8

Source: RBI

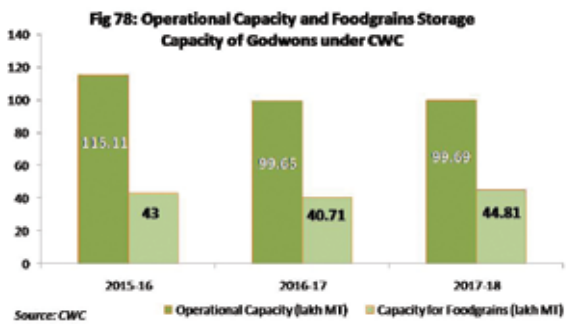
WAREHOUSING SCENARIO IN INDIA

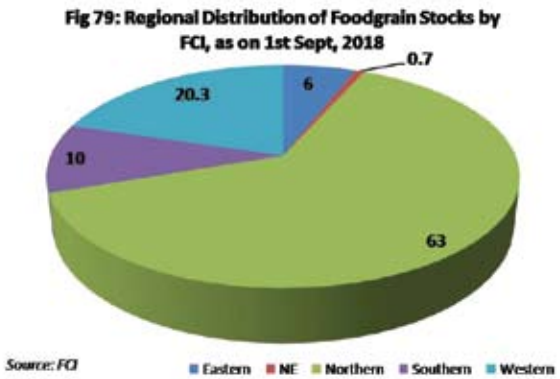
CENTRAL WAREHOUSING CORPORATION

Storage of food grains in India is an important aspect which is mainly taken care of by Government institutions like the Central Warehousing Corporation (CWC), Food Corporation of India (FCI) apart from some private warehouse operators as a part of private sector warehousing that is being encouraged in recent times. Apart from well built warehouses for food grains storage, modern silos for storage of food grains like wheat and rice are also being encouraged in the recent times. As a matter of fact, India expects to double the capacity of silos under public-private partnership (PPP) by 2019 to 15 lakh tonnes, 30 lakh tonne capacity by 2020 and 50 lakh tonne by 2021.

The leading organization in India for food grain storage is the CWC. As on 31st March, 2018, CWC has 435 warehouses across the nation. Apart from normal warehouses, CWC also has 44 custom bonded warehouses, 30 Container Freight Stations (CFSs) or Inland Clearance Depots (ICDs) and 3 Air Cargo Complexes (ACCs). During 2017-18, CWC added almost 29 thousand tonnes of additional storage capacities.

As depicted in Fig 78, CWC has 99.69 lakh MT of operational storage capacity in 2017-18. This is a marginal decrease from what it had in 2015-16 (115.11 lakh MT) and in 2016-17 (99.65 lakh MT). Out ofthe total storage capacity of CWC in 2017-18, about 45 lakh MT of storage capacity was present exclusively for food grains while 2.42 lakh MT for fertilizer. Efficiency of food grain storage is indicated by the storage loss and in 2017-18, CWC sustained a storage negligible loss of 0.06%. However, a major problem faced as a whole in the Indian warehousing sector is that many of the existing warehouses are quite old and need to be oriented and renovated in line with modern storage technology. In terms of States, most of the storage capacity under CWC is located in States like Punjab (50 lakh MT), Madhya Pradesh (55.44 lakh MT), Uttar Pradesh (38 lakh MT) apart from States like Andhra Pradesh (12 lakh MT), Chhatisgarh (18.6 lakh MT), Maharashtra (19.3 lakh MT.





FOOD CORPORATION OF INDIA (FCI)

FCI is the nodal agency of the Government of India for procurement and distribution of foodgrains across the country. Its primary duty is to undertake purchase, storage, movement, transport, distribution and sale of foodgrains. It purchases foodgrains at government announced rate and rate as per the Minimum Support Price (MSP) and supplies to states for the public distribution system at subsidised rates.

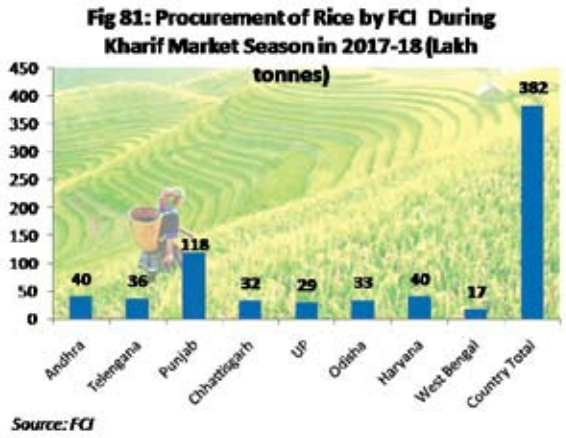
FCI plays a crucial part in helping Government honour the food law of the country. In line with the food law, the government sells 5 kg of highly subsidised foodgrains per person, per month at a central issue price (CIP) of Rs 1-3 per kg via the public distribution system (PDS), known as ration shops. FCI is the nodal agency for supplying food grains to these ration shops. The required foodgrains for the subsidised sale via PDS are purchased by state-run Food Corporation of India (FCI) at an economic or subsidised cost, which includes MSP and other charges.

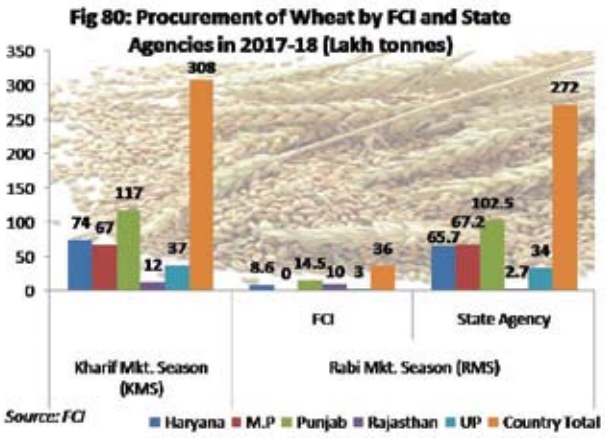
Table 3 below provides the latest stock scenario of food grains under FCI storage. Till September 2018, about 591 lakh MT of food grains were in stock with FCI, out of which

TABLE 3: LATEST FOOD GRAINS STOCK SCENARIO WITH FCI (JAN-SEPT, 2018), IN LAKH MT

Commodity	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.
Rice	162.06	198.93	232.79	248.73	253.62	242.70	232.52	218.55	205.77
Wheat	195.62	175.47	151.55	132.31	353.45	437.55	418.01	408.58	385.09
Total	357.68	374.40	384.34	381.04	607.07	680.25	650.53	627.13	590.86
Unmilled Paddy	254.42	210.00	142.47	77.16	65.43	78.75	64.25	46.10	30.47

Source: FCI





rice was about 205 lakh MT and wheat was 386 lakh MT. 30.47 lakh MT of unmilled rice was also in the stock of FCI till the end of September 2018.

For the stocks under FCI as on 1st September, 2018, Northern region accounted for 63% of the total stocks, while the Western region has 20.3% of the stocks. The North East has a meagre share of 0.7%.

Apart from storage and procurement of food grains, another important activity of the organization is related to the movement of food grains across the country. FCI undertakes movement of foodgrains in order to:

- Evacuate stocks from surplus regions
- Meet the requirements of deficit regions for NFSA/ TPDS and Other Schemes
- Create buffer stocks in deficit regions

On an average 40 to 42 million tonnes of foodgrains are transported by FCI across the country in a year by rail, road and waterways.Around 85%

of stocks are moved by rail to different parts of the country.

The total procurement of wheat by FCI during the kharif market season (KMS) in 2017-18 was 308 lakh tonnes. Highest procurement of 117 lakh tonnes was done in Punjab, followed by Haryana and M.P. as the second and third states in terms of total procurement of wheat during the KMS in 2017-18. The procurement in these two states was 74 lakh tonnes and 67 lakh tonnes respectively. For the rabi market season (RMS) in 2017-18, the total procurement of wheat by FCI was 36 lakh tonnes while state agencies together made a procurement of 272 lakh tonnes of wheat. Highest procurement of wheat during the RMS in 2017-18 by the state agencies was in Punjab with a total procurement of 102.5 lakh tonnes.

Total procurement of rice by FCI during the Kharif market season in 2017-18 was 382 lakh tonnes. Highest procurement was done in Punjab with a total of 118 lakh tonnes. Andhra Pradesh and Haryana witnessed a total procurement of 40 lakh tonnes each while Telengana contributed with a procurement of 36 lakh tonnes. Procurement is undertaken by state-run Food Corporation of India (FCI) and state agencies for the central pool to meet the requirement of food security law. Rice is purchased at the minimum support price (MSP).For the 2017-18 crop season, the Government had fixed paddy MSP of 'common' grade variety at Rs 1,550 per quintal, while that of 'A' grade variety at Rs 1,590 per quintal. ■

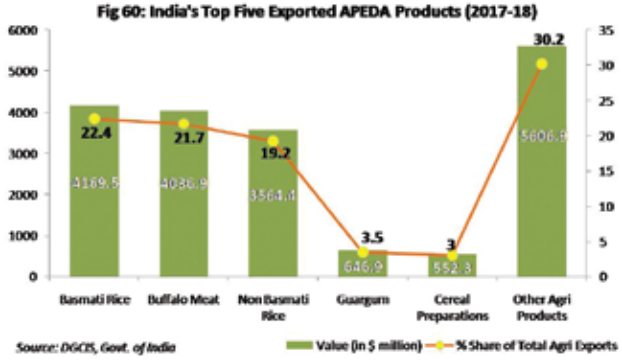
INDIAN AGRIBUSINESS EXPORT -IMPORT SCENARIO

Share of agricultural exports in total exports of the country was about 12.3 percent in 2016-17. This is a marginal decrease from the share in 2015-16 which was about 12.6%. In terms of figures, India's agricultural exports were US$ 33.87 billion in 2016-17 while it was US$43.23 billion during the previous year. The highest exported agriculture commodity from India is Basmati rice. In 2017-18, India exported about US$ 4.2 billion worth of Basmati rice (Fig 60). Closely followingin 2016-17 was buffalo meat which was exported to the tune of US$ 4 billion. About US$ 3.6 billion worth of non basmati rice was exported in the same year. Thus if one sees, rice category constitutes a whopping US$ 7.8 billion, which is about 23.5% of the total value of agri export from the country.

India's exported 48039.4 MT of dairy products worth US$ 185.49 million during the year 2017-18.The highest quantity of dairy products was to UAE in terms of values. In 2017-18, India exported dairy products worth Rs. 2 billion. The total quantity of the dairy products exported to UAE was 5.7 thousand tonnes. As seen in Fig 35, UAE, Egypt, Bhutan, Afghanistan, Nepal, Singapore, Bangladesh, USA, Oman and Qatar are the top ten destinations for India to export its dairy products. One can note that even though the quantity of export to countries like Bhutan, Afghanistan and Nepal is almost equivalent to the quantity of products sent to countries like UAE, Egypt etc., in terms of value, the trade receipt is lower in case of countries like Bhutan, Afghanistan, Nepal etc. This is because of the trade benefits that these countries enjoy apart from the possibility of importing low value dairy products.

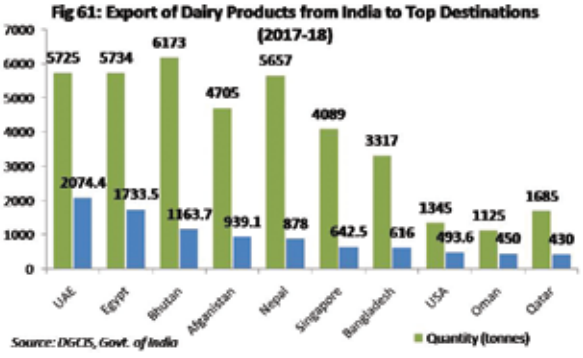
The export scenario of the food processing sector as a whole is unfortunately not that encouraging and a lot remains to be done to boost the sector. After witnessing a

Fig 60: India's Top Five Exported APEDA Products (2017-18)



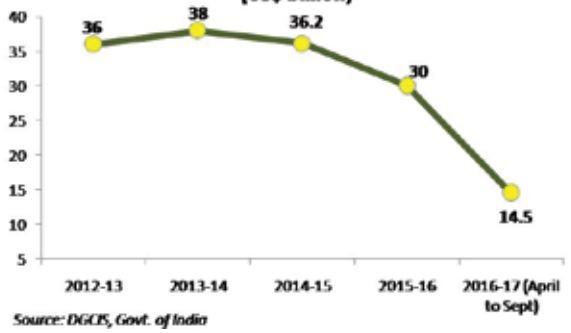
Source: DGCIS, Govt. of India

Fig 61: Export of Dairy Products from India to Top Destinations (2017-18)



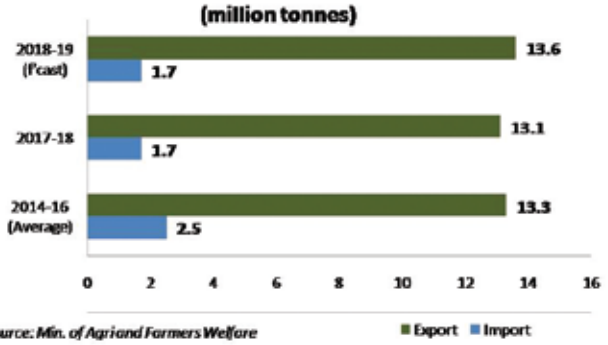
Source: DGCIS, Govt. of India

Fig 62: Export Volumes of Food Processing Sector in India (US$ billion)



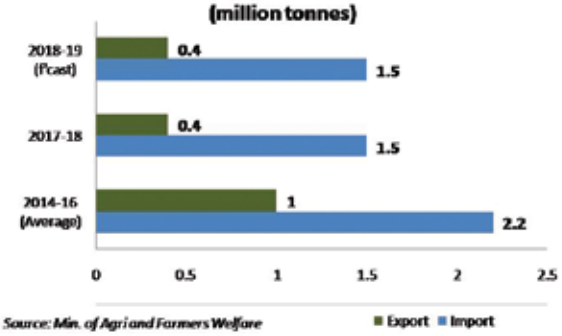
Source: DGCIS, Govt. of India

Fig 63: Export-Import Scenario of Cereals in India (million tonnes)



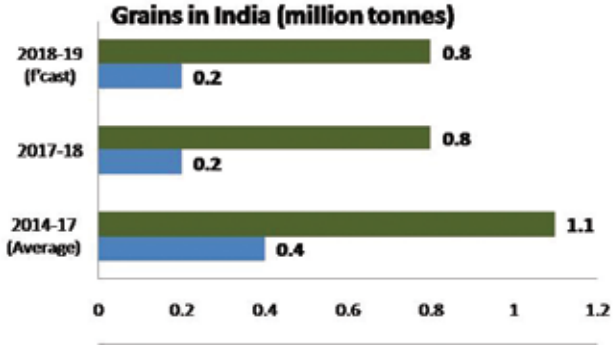
Source: Min. of Agri and Farmers Welfare

Fig 64: Export-Import Scenario of Wheat in India (million tonnes)



Source: Min. of Agri and Farmers Welfare

Fig 65: Export-Import Scenario of Coarse Grains in India (million tonnes)



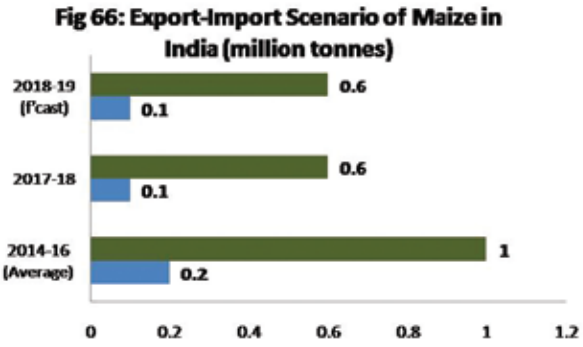
marginal increase from US4 36 billion in 2012-13 to US$ 38 million in 2013-14, export of processed food from India has been on a continuous dip (Fig 62). One of the most important barriers to increased export of processed food products from India as opined by experts is the issue with quality and food safety. Recent data reveals that Indian food products often fail to pass the desired quality parameters set by various countries. Food testing is gaining importance in the recent years and regulatory bodies like FSSAI are doing their bit but still a lot more focus is needed to increase the quality of food items.

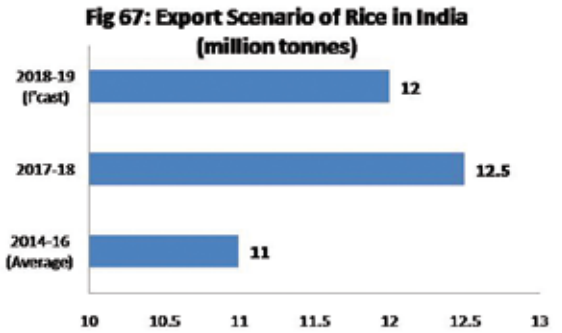
India is a leading producer of cereals in the whole Asian region and in the world market as a whole. The country as such is a net exporter of cereals. The total export of cereals from India over the last 5 years has been hovering around a little over 13 million tonnes. The concomitant import of some of the cereals by India is currently around 1.7 million tonnes. The total global production of cereals this year in 2018 is expected to be on the down side and as a result of this, ultimately at the end of the year, the net export of cereals from India could actually go higher than the forecast amount of 13.6 million tonnes.

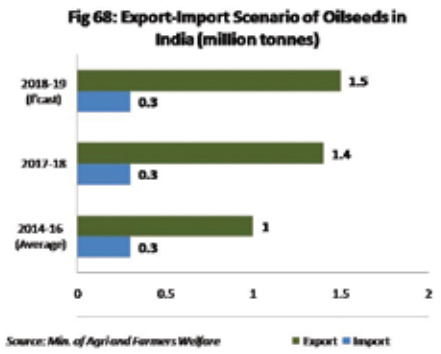
Though the export forecast for wheat by India is at 0.4 million tonnes in 2018-19, the country has always been a net importer of wheat. The quantity of wheat import has however come down to some extent in the recent years. During 2015 to 2016, while India used to import on an average of about 2.2 million tonnes of the commodity, currently it imports 1.5 million tonnes. This is as a result of growing production in the country. The major countries from where wheat is imported to India are Australia, France and Ukraine. The government usually maintains the import duty at zero to keep a control over the price of wheat in the domestic market. Once the production season of wheat begins in the country and wheat starts arriving in the local domestic markets, the import duty sometimes is spiked up to 10%.

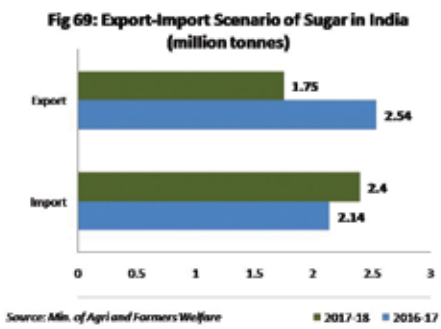
In general, India is a net exporter of coarse grains with the current export hovering around 0.8 million tonnes. The net import of coarse grains is around 0.2 million tonnes. Mostly the neighbouring countries like Nepal, Bangladesh, Sri Lanka, Myanmar, Pakistan etc. import coarse grains from India. This year, India's export of total coarse grains might in fact be a little higher than the forecast quantity as so far there is a strong demand of the grains from across various countries.

Among the various coarse grains, maize is increasingly finding its place in the Indian cultivation and export scenario. India is relatively a weak





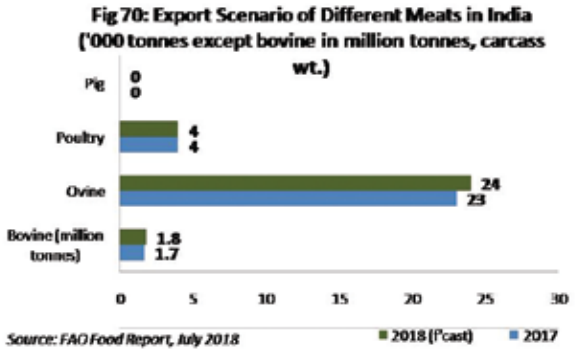


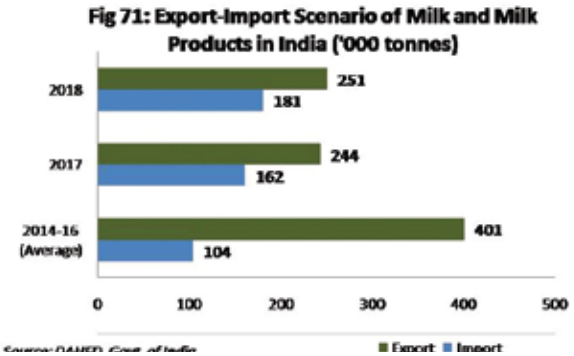


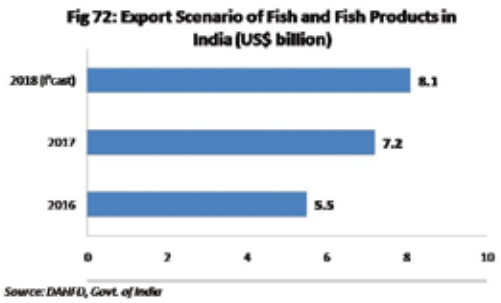
producer of maize in the world, lagging far behind the other major growing countries in the world. However, the crop has a huge untapped potential in the agriculture production canvass of the country. In terms of export and import scenario, India is a net exporter of maize with about 0.6 million tonnes of export in the current years. Internal demand of maize in the country is increasing considerably and to meet the growing demand, per hectare yield of maize is estimated to rise to 2.36 million tonnes by the end of 2020, as against 1.7 million tonnes currently. Maize possesses tremendous potential in terms of feed for the dairy, poultry and piggery industries. In the coming years, increase in maize production in the country is desirable not only to meet its internal consumption demand but also to meet the growing demand of the international market. Within Asia, maize imports in 2018-19 are predicted to reach a new high of 71.2 million tonnes, up 1.8 percent from 2017-18. Countries like Bangladesh, the Republic of Korea, Saudi Arabia and Vietnam are largely expected to import substantial quantity of maize. The growing demand of maize is driven by its increasing use in animal feed. Another important use of maize is in the production of bio-fuel in the form of ethanol.

India is globally an important player in rice export. It was just a decade back that India actually had a ban on export of rice along with some other food grains just in order to meet its domestic demand. Today the scenario has changed and India is not only able to meet its domestic demand, but also exports a huge quantity of rice to various countries. Basmati rice from India has a niche in the global market. Currently, India is exporting about 12 million tonnes of rice, which consists of basmati as well as non basmati varieties. Major destinations for basmati rice export from India are Iran, Saudi Arabia, United Arab Emirates, Iraq, Kuwait, Yemen, the UK and USA. Other rice varieties in the non basmati rice category are exported to almost all across the world. However, countries like Bangladesh (about 19 lakh kg), Benin and Senegal (both about 8 lakh kg), Nepal (6 lakh kg), Sri Lanka (5 lakh kg) etc. are the important export destinations for Indian rice.

There has been a steady improvement in oilseeds production in India but still the country needs to import a considerable quantity of edible oil from other countries. But in terms of export and import of raw oilseeds, India is a net exporter. Currently, the country is exporting about 1.5 million tonnes of oilseeds. However considering the existing huge demand of edible oils extracted from oilseeds in addition to palm oil, the scope of oilseed production in the country is much higher. Other than factors like significantly higher domestic demand of edible oil exceeding the production of oilseeds in the country, there is also a growing demand of the crop from neighbouring countries which is currently being met by other distant countries. In 2016-17 India's total edible oil demand was at 24 million tonnes out of which 9 million tonnes were met from domestic production and 15 million tonnes met from imports. The latter valued at around Rs.65,000crore, constituted around 2.5% of India's total import bill.







Sugar is an important agri based commodity in the country and India exports almost as much quantity of sugar as it imports. India is under WTO obligation of MFN treatment (equal and non discriminatory treatment to all countries) for all WTO member countries and particularly for a commodity like sugar, it imports even from countries like Pakistan. Value-wise, in the year 2016-17, total import of sugar was US$ 1,019 million and it declined to US$ 934 million in 2017-18. This year during April-May, the total import of sugar has been US$ 37.75 million. In terms of quantity, in the year 2016-17, total import of sugar was 2.14 million tonnes and it marginally increased to 2.40 million tonnes in 2017-18. During April-May 2018, the total import of sugar has been 116,512 tonnes. International sugar prices, as measured by the ISA (International Sugar Agreement) daily prices for raw sugar, have been declining since the beginning of 2018 as result of increased production and increased inventory of sugar across the world. Owing to this, the net export and even the import quantity of Sugar in India this year is expected to witness a considerable decline.

The meat sector in India is actually a very important source of foreign exchange earning. Meat from India is exported to over 60 countries across the world. The export of meat includes buffalo meat (bovine), sheep/ goat meat (ovine) and poultry products and the important destinations are Vietnam, Malaysia, Egypt, UAE, Iraq Saudi Arabia etc. In 2017, India exported a total quantity of 1.7 million tonnes of bovine meat. It also exported 23000 tonnes of ovine and 4000 tonnes of poultry meat. In terms of value, India's exports of animal products in 2017-18 was US$ 4,623.05 million, out of which bovine meat was US$ 4036.89 million, ovine meat US$ 129.68 million andpoultry meat US$ 85.71 million. The demand for Indian buffalo meat in international market has sparked a sudden increase in the meat exports in the recent years. However, this year China is anticipated to witness a recovery after three years of retrenchment because of which India might face a tough competition in the global meat market in terms of export.

India is a major player of milk and milk products in the world and is in fact is the top producer, consumer and exporter of milk and milk products. The dairy sector in the India has shown remarkable development in the past decade and India has now become one of the largest producers of milk and value-added milk products in the world. Other than fresh milk, the important milk products are butter, cheese, skimmed milk powder and whole milk powder. However, the net export of dairy products has declined considerably in the recent years. The average quantitythat was exported from 2014 to 2016 was 401000 tonnes which witnessed a massive slump in 2017. This export figure is expected to remain in the lower side even in 2018. The decline in export is a result of huge global supplies and concomitant low prices. In addition, there is a very steep import duty levied by some of the European countries on dairy products in the recent years.

As far as the export scenario of fish and fish products from India is concerned, India is increasingly becoming a strong player in the global fish and fish products market. The total value of export in the fisheries sector in 2016 was US$ 5.5 billion which increased significantly by almost 31% to US$ 7.2 billion in 2017. The export forecast this year in 2018 for the fisheries sector marks a further annual increase of 12.5% to US$ 8.2 billion. The CAGR between 2016 and 2018 is about 14% in the export value of fish and fish products from India. ■

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.

INTERNATIONAL AGRICULTURE CONSULTING GROUP
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CROPS IN FOCUS

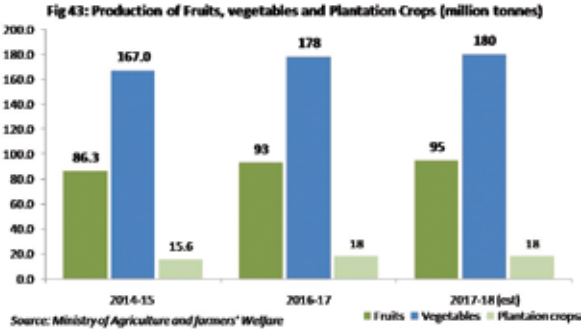
Horticulture Sector Production in India

India has witnessed record production of horticulture crops during 2017-18. Production of horticulture crops like vegetables and fruits touched 275 million tonnes in 2017-18, about 1.5 % higher than the previous year and about 7 % higher than average of the previous five years. As seen in Fig 19, production of fruits increased by 10% from 86.3 million tonnes in 2015-16 to 95 million tonnes in 2017-18. Plantation crops recorded an increase of 15% from 15.6 million tonnes in 2014-15 to 18 million tonnes in 2017-18.

This is the sixth consecutiveyear when India's horticulture sector production has exceeded food grains production. This clearly showcases a structural change in Indian agriculture, where farmers are increasingly growing perishable commercial crops due to a growing market and a quicker cash flow. Horticulture crops require less time from sowing to marketing when compared to other field crops or agricultural crops.

However, what remains as a major point of concern for the horticulture sector is the price volatility. Several times

Fig 43: Production of Fruits, vegetables and Plantation Crops (million tonnes)



Source: Ministry of Agriculture and farmers' Welfare

Fig 44: Production of Major Fruits in India (in '000 tonnes)

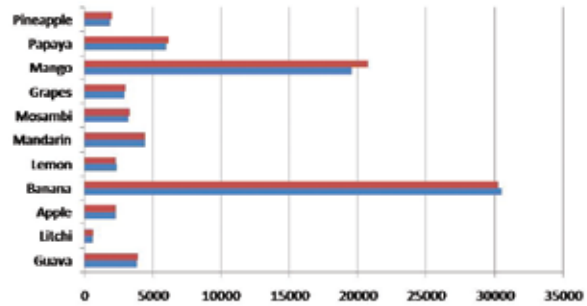
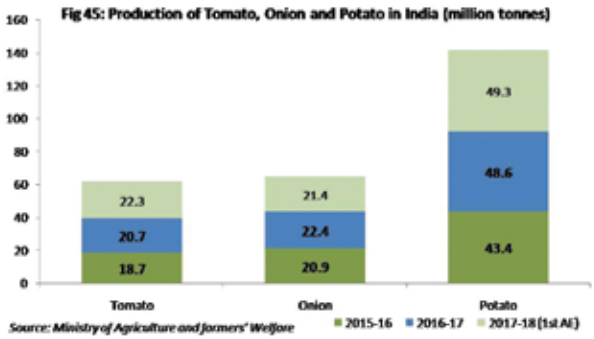


Fig 45: Production of Tomato, Onion and Potato in India (million tonnes)



Source: Ministry of Agriculture and farmers' Welfare

INCREASE IN HORTI PRODUCTIVITY- A POSITIVE SIGN!

In the recent years, there has been not much increase in net sown area under horticulture crops in the country but the production has increased. Higher production is mainly attributed to increase in productivity which is a very positivetrend.

PRIME MINISTER SHRI NARENDRA MODI'S TOP PRIORITY!

"Those growing vegetables and fruits are among our top priority. When I say TOP, I mean whichever part of the country you go, three vegetables are very much visible - Tomato, Onion and Potato".

- Narendra Modi, Prime Minister

during the last year, prices of onions, tomatoes and potatoes fell below production costs. While farmers in Madhya Pradesh were forced to sell onions as low as Rs.2 per kg in June last year, in northern India, farmers from Punjab, Haryana and Uttar Pradesh were forced to dump their potato crop for want of buyers around the same time.

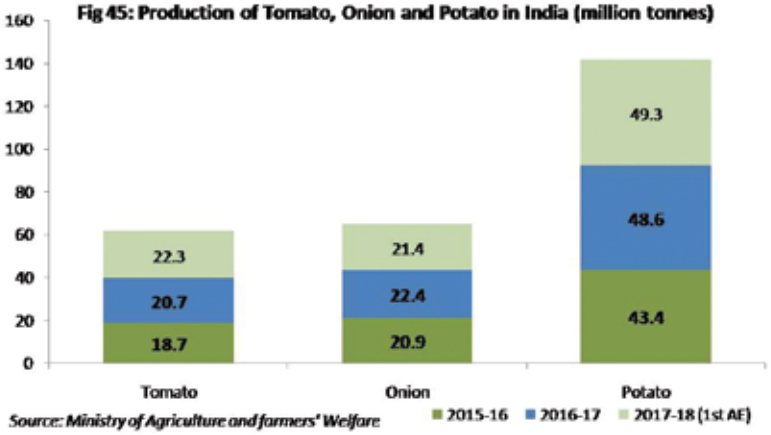
India is a leading producer of Banana in the world producing annually about 30 million tonnes of the fruit. Apple production in the country is about 2.2 million tonnes. In terms of apple production, the country is facing systemic problems with over 60% of apple orchards in India producing inferior quality fruits and hence weak market competiveness when compared to the leading producers in the world. The country is a leading producer of citrus fruits in the world and in 2017-18, total production of all the citrus

fruits combined together was about 12 million tonnes.

For a country like India, vegetables like tomato, onion and potato are very important from the point of view of dietary habits of a large percentage of the population. Onion is so important that every Government takes particular care to maintain a good production level and contain price spikes. As seen in Fig 45, tomato registered a CAGR of 6% from 18.7 million tonnes in 2015-16 to 22.3 million tonnes in 2017-18. Similarly, production of potato in the country registered a CAGR of 4.3% with the production increasing from 43.4 million tonnes in 2015-16 to 49.3 million tonnes in 2017-18. rom the Government.

However, onion witnessed a fluctuating trend of production during the last three years. Price has also been fluctuating. During April-July 2017, the average price of onions was around Rs 15 per kilo in retail and many farmers in Maharashtra and Madhya Pradesh had to sell their produce at well below their production cost. ■

Fig 45: Production of Tomato, Onion and Potato in India (million tonnes)



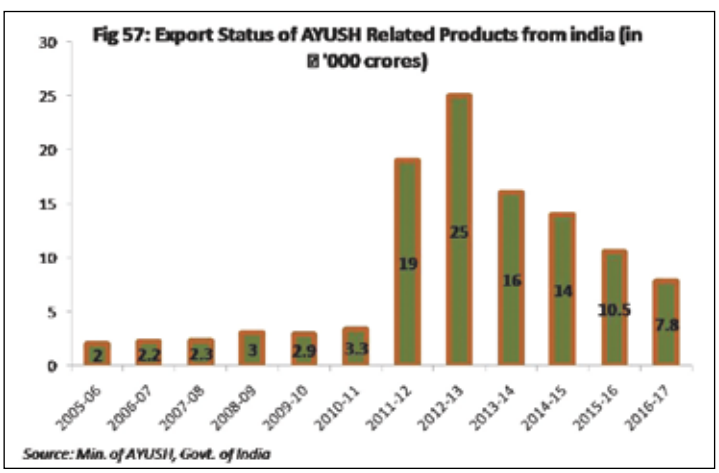
Source: Ministry of Agriculture and farmers' Welfare

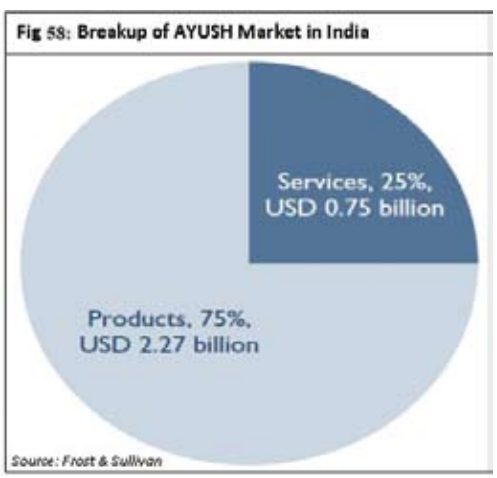
Medicinal and Aromatic Plants (MAPs) and the AYUSH Sector in India

India is a rich cradle of 15 agroclimatic zones harbouring 17000-18000 species of flowering plants of which 6000-7000 are estimated to have medicinal usage. These plants have found use for their medicinal properties in folk and indigenous population of the country along with documented systems of medicine, like Ayurveda, Siddha, Unani and Homoeopathy.

The use of medicinal plants in herbal medicinal products and supplements has increased tremendously over the past three decades with not less than 80% of people worldwide relying on them for some part of primary healthcare. India has also seen increased use and awareness about medicinal plants. India has witnessed the emergence of large sized companies in the trade of herbal medicines and Patanjali is a striking example of the success story of herbal based companies. The use of herbal remedies has also been widely embraced in many developed countries. Termed in these countries as Complementary and Alternative Medicines (CAMs), herbal remedies are now becoming mainstream in the UK and the rest of Europe, as well as in North America and Australia. Some of the important growth drivers for medicinal plants sector in the recent times are:

- Scientific research based claims on the efficacy or effectiveness of plant medicines
- Preference of consumers for natural therapies and a greater interest in alternative medicines
- General belief that herbal products are superior to man-





ufactured products and having no adverse side effects

- Dissatisfaction with the results from orthodox pharmaceuticals products and increasing resistance to various modern medicines
- Belief that herbal medicines might be effective in the treatment of certain diseases where conventional therapies and medicines have proven to be ineffective or inadequate
- High cost of most modern drugs
- Significant improvements in the quality, efficacy, and safety of herbal medicines with the development of science and technology

Recognizing the growing importance of medicinal plants in India, policy makers decided to form a dedicated Ministry for Indian system of medicines and named it as Ministry of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) in 9th November, 2014. Earlier this was functioning as the Department of Indian System of Medicine and Homeopathy (ISM&H) since 1995 and was renamed as Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) in November 2003. The specific activities related to the development of medicinal and aromatic plants in terms of research, identification, sustainable cultivation and market development is looked after by the National Medicinal Plant Board, under the Ministry of AYUSH.

Let us now take a look at the export scenario of AYUSH related products (as shown in Fig 30) during a 12 year period from 2005-06 to 2016-17:

- Export of AYUSH products registered a steady growth about Rs. 2000 crores in 2005-06 to about Rs. 19000 crores in 2011-12
- The export then decreased from Rs. 25000 crores in 2012-13 to about Rs. 15000 crores in 2013-14 with showing a decline annual growth rate of 36%
- It further decreased to aboutRs. 14000 crores in 2014-15 with declined annual growth rate is 13%.
- The export of AYUSH products has kept its decreasing trend sustained from Rs. 14000 crores in 2014-15 to Rs.10500 crores in 2015-16 with showing a decline annual growth rate of 23%
- It has further decreased to Rs. 78000 crores in 2016-17 with negative annual growth rate of 26%.
- This steady decline over the past few years can be attributed to the decrease in export of certain AYUSH products like vegetable saps and extracts, pectic substances, agar products, other mucilaginous products and thickeners

Fig 59: Important Stakeholders of Ayurveda Sector in India

Source : Frost & Sullivan

As per government data, during 2014-15, percentage share of AYUSH products in the total trade of India was 0.32% compared to 0.36% in 2013-14. During 2016-17, percentage share of AYUSH products in the total trade of India was 0.20% compared to 0.28% in 2015-16. Similarly, AYUSH products shared 0.42% of Export volume of India in 2016-17.

According to an estimate by the market research organization Frost & Sullivan, the anecdotal evidence indicates that the total Ayurveda market in India is about US$ 3 billion in 2016 and growing at a CAGR of 15-16%.

The current Ayurveda industry in India can be broadly categorised into services and products where products constitute the bulk of the market at 75% market share (Fig 58). ■

PALM OIL FOR FOOD APPLICATIONS

Dr. Nagendran Bala Sundram
Malaysian Palm Oil Board (MPOB)
Mumbai

Dr Ainie Hj Kuntom
Malaysian Palm Oil Board (MPOB)
Malaysia

The oil palm *(Elaeis guineensis)* is a perennial oil crop with a productive lifespan of about 25 years that produces two important vegetable oils, i.e. palm oil from the mesocarp (outer pulp) and palm kernel oil from the endosperm (kernel). In the year 2017, palm oil accounted for 34% of the total global oils and fats production of about 220 million tonnes. Palm oil is again a major player in terms of global oils and fats trade, and accounted for 61% of the 87 million tonnes of the total exports of oils and fats. Malaysia,with about 5.8 million hectares of land cultivated with oil palm is one of the leaders in the world palm oil sector, and produced19.92 million tonnes of crude palm oil (CPO) in the year 2017.

The oil palm was introduced to Malaya (as Malaysia was then known) by the British as an ornamental plant in the 1870s. However, commercial planting of oil palm effectively began in 1917, when a French entrepreneur Fenri Fauconnier planted oil palm seeds at the Tennamaram Estate in the state of Selangor. It was just last year - in 2017 that the Malaysian oil palm industry celebrated its 100th year anniversary.

The oil palm is the most productive oil crop, as one hectare (ha) of oil palm yields about 4.0 tonnes of palm and palm kernel oils/year, compared to about 0.76 tonnes of rapeseed oil/ha/year, 0.65 tonnes of sunflower oil/ha/year and 0.43 tonnes of soybean oil/ha/year. Thus, the oil palm is the most productive oil crop with a productivity which is 6-10 times higher than other oil crops. In fact, Malaysia's 5.81 hectares of oil palm crop represents a miniscule 0.11% of global agricultural land.

Malaysian palm oil is exported to 214 countries and in 2017, Maalysia's palm oil exports totaled 16.56 million tonnes.

VERSATILITY OF PALM PRODUCTS

All fats and oils are composed of fatty acids that are esterieifed to a glycerol backbone.Palm oil has a balanced fatty acid composition as it contains almost equal amounts of saturated and unsaturated fatty acids. The triglycerides (TAGs) in palm oil are either monosaturated

EXPORT OF MALAYSIAN PALM OIL BY DESTINATION COUNTRY

No.	Country	Million Tonnes
1.	India	2.028
2.	The EU-28	1.992
3.	China PR	1.917
4.	Pakistan	1.017
5.	The Philippines	0.752
6.	Turkey	0.679
7.	Vietnam	0.633
8.	U.S.A.	0.555
9.	Iran	0.524
10.	Japan	0.503

Source : MPOB

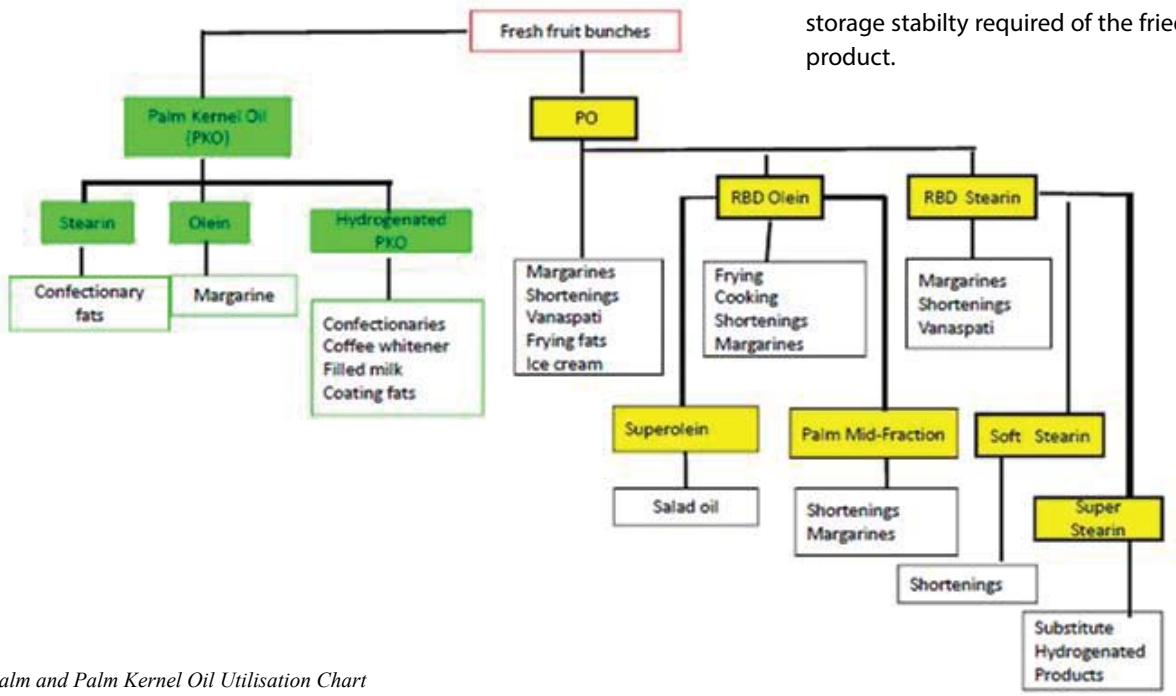
(POO, OPO and PLO)* or disaturated (POP and PPO)* (Note* P= Palmitic, O= Oleic, L = Linoleic). The triglyceride composition of palm oil allows it to be fractionated into two main fractions. The liquid fraction of palm oil is called olein, and the solid fraction is referred to as stearin. Fractionation of palm oil can result in a wide range of different fractions. The fractionation can be tailor made to produce various fractions with properties that are ideally suited for different applications in the food industry. Similarly, palm kernel oil too can be fractionated into palm kernel olein and the high value fraction palm kernel stearin.

PALM OIL PRODUCTS IN FRYING

The balanced fatty acid composition makes it highy resistant to oxidation, prevents polymerization and provides excellent mouthfeel to the fried product. Palm oil is most suited oil for industrial frying, especially for frying of products that absorb large quantity of fats or oils and are eaten cold (e.g. potato crisps). In terms of handling in larger scale operations, palm oil, unlike solid frying fats, allows for immediate circulation of oil at start-up.Other advantages of palm oil as frying oil include:-

- Presence of natural antioxidants (tocopherols and tocotrienols)
- Does not produce room stench
- Competetive pricing

Palm olein, which provides ease of handling due to its relatively lower melting point (~22°C) is also an excellent frying oil with performance comparable to palm oil. It is alo an excellent choice in the production of extruded snacks, as well as a frying medium for nuts (used as snacks) as it provides glossines to the fried nut as it is virtually 100% at room temperature (20°C). Both palm oil and palm olein are also the preferred oils for the production of instant noodles as these oils confer storage stabilty required of the fried product.



Palm and Palm Kernel Oil Utilisation Chart

PALM PRODUCTS IN SOLID FATS

Bakery fats provide texture and tenderness to bakery products and have to be tailor-made for the specific applications i.e., the characteristic required of the baked product – pastry, biscuit or bread. For pastries, the fat used should confer a crumbly and tender texture, which have good plasticity. A 100% palm-based shortening would provide this property. In puff pastries, the product is characterised by the layers of pastry films, which can be obtained by the use of a hard fat that can withstand the repeated rollings. Blends of palm oil, palm olein and palm stearin with natural semi-solid consistency are ideal for this purpose. Bakery shortenings can be tailor made for various palm fractions, including interesterified palm olein with addition of a small quantity of palm stearin to achieve the desired consistency. Trans-free vanaspati may be produced by blending or interesterifying palm stearin with soft oils such as soy, sunflower or rapeseed oils, or a blend of palm oil and palm stearin.

MAJOR PALM FRACTIONS

Fraction	Description
Palm olein	• Liquid fraction of palm oil commonly used as household cooking oil
	• Highly suitable for shallow and deep frying
	• Blending of palm olein with other liquid oils can improve the oxidative stability of the latter
Palm stearin	• Solid fraction of palm oil that may be used as hardstock for solid fats when blended with other oils
	• Especially suitable for formulations of trans-free margarines, shortenings and vanaspati
Palm superolein	• Usually obtained as liquid fraction of refractionation of palm olein
	• Suitable for cooking and frying
	• Better cold stability than olein
Palm mid fraction (PMF)	• May be obtained by refractionation of palm olein or palm stearin
	• Has a sharp melting profile making it very suitable for confectionery fats
Palm kernel olein	• Liquid fraction of palm kernel oil
	• When hydrogenated, can be used as coating fats
	• Interesterification with palm stearin can yield solid fats for margarine
Palm kernel stearin	• Solid fraction of palm kernel oil
	• May be used directly or with hydrogenation, for confectionery fats
	• Miscible with cocoa butter in small quantities

PALM PRODUCTS IN CONFECTIONERY FATS

Cocoa Butter Equivalents (CBE) are non-lauric fats which comprise of symmetrical triglycerides (POS, SOS, POP) that are similar to cocoa butter and are compatible with cocoa butter. As PMF comprises of POP triglycerides, it is an excellent CBE.

Cocoa Butter Substitutes (CBS) have similar physical properties to cocoa butter, but with different triglyceride composition, and may be classified as lauric acid CBS or non-lauric CBS. The former rely on high lauric acid content, while the

latter rely on high levels of transisomers. Ideal lauric type of CBS are fractionated palm kernel oil (PKO) such as hydrogenated PKO or hydrogenated palm kernel stearin.

SUSTAINABILITY IN MALAYSIAN OIL PALM SECTOR

The oil palm industry in Malaysia has a long and proven track record in sustainabilty based on the 3 Pillars of Sustainability - People, Planet and Profitability (3Ps). The Malaysian Sustainable Palm Oil (MSPO) is a national standard on sustainability that is applicable to Malaysian oil palm industry which covers the small, medium and large plantations in Malaysia. MSPO complies with Malaysian laws as well as international convention that Malaysia has ratified. Through MSPO, the Malaysian oil palm industry is able to inform the global edible oil market that it is committed to sustainability, protection of environments and social responsibility. This is important because the industry has been unfairly blamed for causing environmental damage and violation of social requirements.

The MSPO standard and certification was developed at the initiative of the oil palm industry together with MPOB and other relevant agencies. With the establishment of MSPO as national standard, the oil palm industry continues to implement sustainable practices. To ensure acceptance of MSPO globally, we ensure that the development of the standard is along the line of United Nation Global Compact for Sustainable Food and Agriculture Business Principles.

The MSPO standard comprises of four parts covering general principles, independent smallholders, plantations & organised smallholders, and mills; and is registered as Malaysian Standard MS 2530:2013. Besides the four parts of MSPO standards, another eight documents were developed for the MSPO scheme. The eight documents are certification scheme, requirements for certification bodies, risk management, procedures for handling appeals and complaints, palm oil supply chain traceability requirements, usage of the logo, guidelines for auditing and requirements for palm-based products to fulfill the European Renewable Energy Directive (EU-RED). MSPO has also been accepted by the Tokyo 2020 Olympic & Paralympic Games Board of Trustee as a tool for sustainable sourcing of palm oil. This a recognition of MSPO at the international level.

MSPO principles have also been adopted into the Indian Palm Oil Sustainability (IPOS) Framework. This Framework aims to improve sustainable practices in the supply chain and assist in achieving compliance with the relevant national and international regulations and voluntary codes. An expert committee constituted by Government of India had identified a total area of 1.9 million hectares (ha) as being suitable for oil palm cultivation, of which a total of 315,000 ha have been planted under oil palm in India.

Palm oil provides a functional ingredient that can be used in a wide range of food industries. Palm oil can be used in industrial frying, bakery industry and various solid fats used in the different food industries in India. The oil palm industry itself is a highly regulated industry and is undergoing rapid transformation into ecological agriculture. MSPO is a reflective of UN Global Sustainable Food and Agriculture Business Principle, which incorporates the UN Goal on poverty eradication. Hence it is a standard certification scheme the Malaysian oil palm industry is proud to implement it. ■

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Coimbatore, Tamil Nadu

FUTURE OF SUGARCANE IN INDIA

Sugarcane, the prime source of sugar in India is cultivated in an area of 4.78 million hectares with a production of 355 million tonnes. Sugar industry, the second largest agro based industry in India sustains the livelihood of 12.34 million farmers and farm workers. In India, sugarcane is cultivated all over the country from latitude 8^0N to 33^0N, except cold hilly areas like Kashmir Valley, Himanchal Pradesh and Arunachal Pradesh. India by contributing 19.08% area and 18.10% production ranks second among sugarcane growing countries of the world in both area and production of sugarcane. Sugar industry is also emerging as a substantial source for meeting a part of the ever increasing energy needs of the country through the co-generation of electricity and Ethanol, which are renewable sources of energy. So, there is the opportunity in terms of growing demand for sugar and other by-products of sugarcane. The average productivity of sugarcane in India is about 68 t ha^{-1}, against the theoretical maximum cane yield of 375 t ha^{-1} and there exists a wide gap between the potential yield and the present yield of sugarcane. The reasons being continuation of old and degenerated varieties, use of inferior quality seeds over years, improper crop and ratoon management, dwindling water resources, poor soil health, high labour cost and non-availability of timely labour for doing various cultural operations. Conventional method of sugarcane planting requires 8 to 10 tonnes of seed cane per hectare and this is the main reason for slow rate of seed replacement. Sugarcane being a long duration crop and heavy biomass producer requires about 1500 to 2500 mm water. The availability of water is declining at a faster rate. The problem is further aggravated by the variability of rainfall influenced by climate change. So, unless sugarcane farmers are provided with options of high yields with much less water, India will find it difficult to meet its growing demand for sugar. Hence, there is a need to adopt water

saving technologies for sustainable sugarcane production. The ICAR-Sugarcane Breeding Institute has developed a model comprising of integrated approach, keeping in mind the situations in future, for sugarcane agriculture. Components of the model are

- High yielding and better quality varieties
- Settling Transplanting raised from single budded setts/ bud chips
- Subsurface drip irrigation and fertigation
- Wider row planting
- Intercropping
- Trash mulching
- Multiple ratooning

HIGH YIELDING AND BETTER QUALITY VARIETIES

Choice of correct set of varieties suited to particular geographical location is vital in attaining best possible sugarcane productivity. A number of elite varieties combining high cane yield, sucrose content and resistance to red rot have been developed from ICAR-Sugarcane Breeding Institute. Varieties suitable for tropical India include Co 86032, Co 09004, Co 06030, Co 0403, Co 0212, and Co 06022. In sub-tropical India, Co 0238 is spreading in large area by virtue of its high cane yield and sugar recovery. Co 98014, Co 0118, Co 05011, Co 06034 and Co 09022 are the other promising varieties released from the ICAR-SBI, Regional Centre, Karnal.

SETTLING TRANSPLANTING

In the traditional method, the issues like requirement of high seed cane rate, poor germination rate, difficulty in seed transportation, seed quality, etc. affects the cost of cultivation as well as the productivity. Doubling the farmers' income can be achieved by increasing the productivity and/ or reducing the cost of cultivation. Transplanting sugarcane single bud/ bud chip settlings can save seed cane requirement up to 80 per cent, besides providing healthy plants and good field establishment. It is less expensive and labour saving when compared to sett planting. This method also reduces the initial water requirement of the crop and reduces crop duration in main field. Transplanting sugarcane settlings in wider row spacing provides more space and sunlight for a longer duration which increases cane productivity, and also facilitates intercropping and mechanization of sugarcane agriculture from transplanting to harvesting. The ICAR-SBI, in collaboration with ICAR-CIAE, has developed a tractor drawn two-row sugarcane settling transplanter to further reduce the labour requirement and cost of cultivation.

SINGLE BUD SETTLING PREPARATION

Major steps involved in single bud settling preparation are

- Preparation of single bud setts from 6-8 month old plant crop
- Sett treatment with nutrients and pesticides (0.1% each of urea, $FeSO_4$ and $ZnSO_4$; and 0.04% propiconazole fungicide)
- Fill the portrays/cavity trays with the potting mixture of sand: soil: decomposed FYM/Coirpith in 1:1:1 ratio) with setts with buds facing upwards
- Cover the trays with polythene sheet and leave for 5-6 days
- Spread portrays and water regularly and settlings will be ready for transplanting in main field by 30-35 days.

SUB SURFACE DRIP IRRIGATION AND FERTIGATION

Though India has the largest irrigated area in the world, the coverage of irrigation is only about 40 per cent of the gross cropped area as of now. One of the main reasons for the low coverage of irrigation is the wide use of flood (conventional) method of irrigation, where water use efficiency is very low due to various reasons. Available estimates indicate that water use efficiency under flood method of irrigation is only about 35 to 40 per cent because of huge conveyance and distribution losses. Drip irrigation is one such technology which saves irrigation water requirement (upto 50 per cent) through reduction in conveyance loss and labour, reduced evaporation from soil, continuous maintenance of soil available moisture and thereby high water use efficiency (90%). Apart from saving water, drip fertigation saves fertilizer also by enhancing fertilizer use efficiency and reduces environmental pollution. The drip irrigation method results in less weed infestation and provide option of automation in irrigation and chemigation thereby reducing the labour requirement. This is one of the ways to achieve 'more crop per drop' mission.

FERTIGATION SCHEDULING

Adoption of soil test based fertilizer recommendations for sugarcane is essential to ensure balanced fertilization. The recommended dose of organic manure and the entire dose of phosphorus, sulphur, $FeSO_4$ and $ZnSO_4$ should be applied as basal for plant and ratoon crop. In plant crop, the fertilizers may be applied in the furrows before planting. For ratoon crop, within 10 days of harvest, the above basal manures after off barring has to be carried out and irrigated.

N and K fertigation schedule:For plant crop, fertigation may be started from 5th week of planting and continued at weekly intervals till 25th week after planting. 30% of the recommended N and K_2O is split equally and fertigated from 5th to 12th week and 70% of the recommended N and K_2O is split equally and fertigated from 13th to 25th week. For ratoon crop, application of 25% extra N is needed. Hence, 55% of the recommended N is split equally and fertigated from ratoon initiation to 12th week. 30% of recommended K_2O is split equally and fertigated from 5th to 12th week. The remaining 70% of the recommended N and K_2O is split equally and fertigated from 13 to 25th week as in the case of plant crop.

ADVANTAGES

- Saving in power consumption and irrigation labour cost is 58% and 90%, respectively in the drip irrigation method over furrow irrigation.
- About 50 per cent saving in water by adopting drip system with an increase in cane yield of 10 to 20 per cent can be achieved when compared to furrow irrigation method.
- Drip fertigation results in saving of 25% N and K when compared to the conventional method of application of the recommended dose of fertilizers.
- Drip irrigation fertigation results in saving of about Rs 31,596 per hectare (due to increased cane yield, labour saving reduction in fertilizer cost).

WIDE ROW SPACING

Transplanting settlings in wide row spacing provides more space and sunlight for long duration which increases cane productivity and decreases pest and disease incidence. Wide row spacing (≥4.5') facilitates intercropping and use of machineries for intercultural operations and harvesting. In case of paired rows, distances of 1.5 to 2.0 feet between rows and 5 ft between two such paired rows are maintained. The yield and additional returns from intercrops grown under wide row planting will also be more compared to intercrops grown in close spaced sugarcane.

INTERCROPPING

Adoption of wide rows would facilitate intercropping during the initial stages of sugarcane growth, which will generate intermittent income to the sugarcane farmers. Under wide rows, as the availability

of growth resources like solar radiation and space is more, medium canopied high yielding varieties of crops can be grown as intercrops. Growing of legumes as intercrops can also result in improvement of sugarcane fertility. Legumes could fix atmospheric nitrogen under favourable conditions and it may become available to associated sugarcane crop. A large number of crops have been tested for their compatibility with sugarcane. Generally short duration crops which can be harvested before the final earthing up are recommended. They should be of determinate growth habit and dwarf in nature. Green gram, black gram, soybean, coriander, potato, onion, garlic, chilly, mustard, marigold, papaya etc. could be raised as intercrops in sugarcane.

TRASH MULCHING

Sugarcane on an average produces 30-35 leaves under good growing conditions. As the cane grows, the lower leaves gradually dry up. The de-trashing,of loosely adhering dried leaves,is done on 5th and 7th month during its growth period. Sugarcane produces about 10 to 12 tonnes of dry leaves per hectare per crop. This trash contains 28.6%-organic carbon, 0.35 to 0.42 per cent nitrogen, 0.04 to 0.15 per cent phosphorus, 0.50 to 0.42 per cent potassium. The sugarcane trash incorporation in the soil influences physical, chemical and biological properties of the soil, reduction in soil EC, improvement in the water holding capacity, better soil aggregation and thereby improves porosity in the soil. Sugarcane trash incorporation reduces the bulk density of the soil and there is an increase in infiltration rate and decrease in penetration resistance. Besides conserving soil moisture by reducing evaporation from soil surface, mulching also moderates soil temperature helps in improving germination, better tiller survival and checks weed growth. Trash mulching immediately after ratooning results in conservation of soil moisture resulting in better development of root system and increased cane yields in ratoon crop.

MULTIPLE RATOONING

Ratooning is a practice of growing full crop of sugarcane from sprouts of underground stubble left in the field after harvest of plant crop. In settling transplanting technique, multiple ratooning is an important aspect owing to its low cost of production when compared with (plant) main crop as it saves the cost of seedbed preparation, seed material and planting operations. It is an essential requirement in case of sub-surface drip irrigation. Ratoon also helps in extending the crushing schedule of sugar factories as they mature earlier than plant crop. The increased yield of ratoon crop and improved soil quality can be obtained with proper and timely ratoon management practices like stubble shaving, off baring, gap filling, early manuring, control of chlorosis and management of pests and diseases combined with selection of varieties having multi-ratooning potential. Co 86032 and Co 0238, popular varieties of tropical and subtropical regions are excellent ratooners.

Settling transplanting technique comprising high yielding and better quality varieties, transplanting sugarcane single bud/ bud chip settling, subsurface drip irrigation and fertigation, wide row planting, intercropping, trash mulching and multiple ratooning involves reduced use of agricultural inputs like seeds, water, nutrients etc. By adopting this technique farmers can increase their sugarcane productivity with reduced cost and also by maintaining ecological sustainability. ■

GLOBAL STATUS OF CASHEW PRODUCTION AND TRADE:
CHALLENGES AND STRATEGIES FOR INDIA TO REGAIN WORLD LEADERSHIP

M. G. Nayak and Siddanna Savadi
ICAR- Directorate of Cashew Research, Puttur, Karnataka

The cashew tree *(Anacardium occidentale L.)* is an important export-oriented plantation crop supporting the livelihood of farmers and providing employment to rural poor in India. Cashew is believed to be a native of Brazil, from where it has dispersed to different parts of the world primarily for soil conservation, afforestation, and wasteland development. Cashew was introduced to India by the Portuguese between 1563 and 1570 AD primarily for soil conservation along the West coast, where fertile soil were lost due to erosion by heavy rainfall.

Currently, cashew cultivation has assumed a great importance and commercially it ranks second to almond among the important tree nuts in the world trade. The main economic product is the kernel, which is a rich source of nutrients. The whole kernels are consumed directly or after roasting and salting, whereas the kernel pieces are used in confectionary. In recent times, oil extracted from kernels is also gaining importance. Cashew apple is also edible and it is processed into products like jam and jellies. The cashew juice after fermentation is used in the beverages production. Cashew nut shell liquid (CNSL) is the byproduct of cashew nut processing industry and it is used in insulating varnishes, brake linings, waterproofing of boats etc.

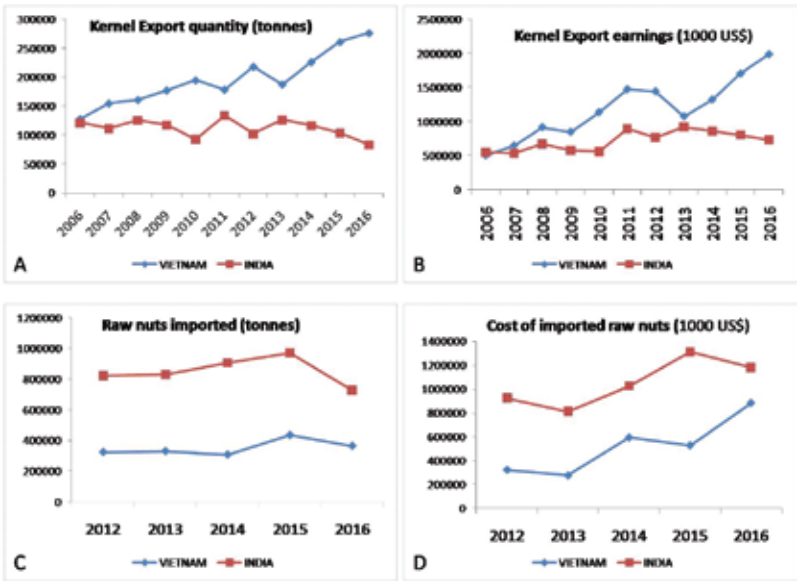
In the early 1920s, world cashew trade started with the visit of representatives of the General Food Corporation to India. Gradually, Indian cashew export expanded to several European countries, particularly to the United Kingdom and Netherlands. By 1941, the cashew kernels export by India had reached about 20,000 tonnes. Since then, the number of cashew producing countries across the world has increased and new producers continue to emerge resulting in expansion of world cashew

area and trade. Recent trends in world cashew production suggest that the traditional major producers of cashew like India, Côte d'Ivoire, and Brazil are gradually being replaced by newly emerging countries like Vietnam and Philippines. In the last decade, cashew production in Vietnam has shown a sharp rise, whereas in countries like India the growth is almost steady and a declining trend is observed in Brazil.

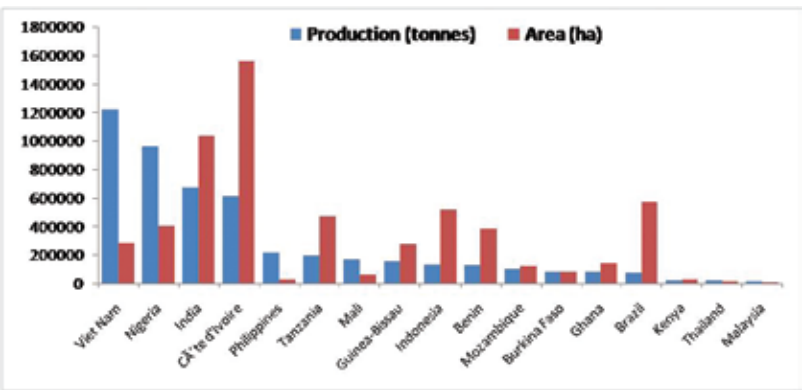
WORLD PRODUCTION, AREA, AND PRODUCTIVITY

Currently, a total of 33 countries in Asia, Africa, and Americas are commercially cultivating cashew over an area of 6.08 m ha. Among these, Vietnam, Nigeria, India, Côte d'Ivoire, Philippines, Tanzania, Mali, Guinea-Bissau, Indonesia, Benin, and Mozambique are the major producers of cashew. World production of cashew nuts is increasing annually and it has reached 4.89 million tonnes in 2016. Vietnam is the world leader in cashew production and has produced 1.22 m tonnes (25% of world production) followed by Nigeria with 0.96 m tonnes (20% of world production) and India with 0.67 m tonnes (14% of world production). Côte d'Ivoire with 1.56 m ha (26% of total) and India with 1.04 m ha are leading countries in the area under cashew cultivation. However, due to poor productivity, the production levels are low compared to the emerging countries like the Philippines and Vietnam. India stands in 20th position with respect to the cashew productivity with 648 kg/ha. The highest productivity is achieved in S.E. Asian countries like Philippines and Vietnam.

A COMPARISON OF QUANTITY AND EARNINGS OF CASHEW KERNELS THROUGH EXPORTS (A & B) AND QUANTITY AND COST OF IMPORTING RAW NUTS (C & D) BY VIETNAM AND INDIA



AREA AND PRODUCTION UNDER CASHEW CULTIVATION IN THE MAJOR CASHEW GROWING COUNTRIES OF THE WORLD



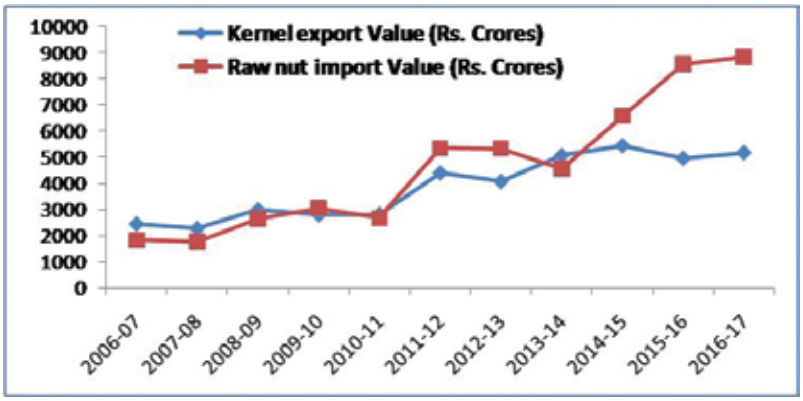
CASHEW TRADE AND INCREASING DEMAND FOR CASHEW

Traditionally, India dominated the international cashew trade and in fact, it was the first country to set up processing industries dependent on skilled labor. Till 2006, India was the world's primary importer of raw nuts, as well as the primary exporter of processed nuts mainly to the USA and European countries. Vietnam overtook India in cashew kernel exports in 2006. Since then, there has been a constant increase in the export quantity and earnings in Vietnam, whereas in India it shows a declining trend with a drastic reduction in export quantity. Currently, the exporting earnings in Vietnam from kernels is

about US $ 2 billion which is almost three times that of India *i.e.,* US $ 0.7 billion. The reason for an increase in Vietnam's kernel exports is the lower kernel prices compared to India as the processing is cheaper and the domestic consumption of cashew is low in Vietnam.

Further, import of cashew nuts primarily from the African countries has increased in both Vietnam and India over the years. In future, the supply of raw cashew nuts by import into India may be drastically reduced as Vietnam competes with India for the raw nuts and also as the African countries have intended to promote processing in their own countries. Currently, Vietnam has been importing raw cashew nuts from West Africa at a higher price. Furthermore, foreign exchange spent on import of nuts by India has significantly exceeded the earnings from the export of kernels. Further, global per capita cashew kernel consumption has increased from 0.072 kg/year in 2007 to 0.106 kg/year in 2016 suggesting about 47% increase. In India, the per capita cashew consumption has increased by about 5.5 times i.e., from 0.041 kg/year in 2007 to 0.228 kg/year in 2016. In the year 2016, the demand for cashew kernels has increased by 7% suggesting increased demand for cashew. These facts reveal the need for enhancing domestic cashew nut production to meet the demands of the local processing industries for meeting the local demand for cashew products and expanding exports.

AREA AND PRODUCTION UNDER CASHEW CULTIVATION IN THE MAJOR CASHEW GROWING COUNTRIES OF THE WORLD



CHALLENGES AND STRATEGIES FOR ENHANCING CASHEW PRODUCTION IN INDIA

In India, the productivity and area under cashew cultivation have remained the same over the few years. Although India is the largest processor of raw cashew nut, it produces only 50% raw cashew nuts for processing and hence, depend on imports from African and

A view of ultra high density planting in cashew

other countries to meet processing capacity. In near future, as the African countries envisage starting their own processing industries, import of raw cashew nuts to India may gradually decline. Currently, domestic consumption of cashew is increasing by 15-20% every year and the raw cashew nut requirement of the country is estimated at 40-50 lakh tonnes or even more by 2050 AD. Therefore, there is a pressing need for enhancing the domestic cashew production to bridge the huge demand and production gap.

The major constraints for cashew production are the low yielding varieties, insect pest damages and the poor management of crop. To address the issue, appropriate strategies include expanding area under high yielding varieties to potential non traditional cashew growing regions, wastelands etc., replacing the old senile and seedling raised low yielding plantations with high yielding cultivars graft, and also increasing productivity by adopting advanced cashew production technologies such as use of quality planting materials, high and ultra-high density planting, integrated management of tea mosquito bug and cashew stem and root borers, integrated nutrient management, drip irrigation, canopy management, appropriate soil conservation measures.

The government of India has planned to expand the area under cashew cultivation by 1.20 lakh hectares in the next three years in 13 states. Of this, the expansion of cashew crop on 60,000 ha in the current year is in the North-East States such as Tripura and Meghalaya, and in Jharkhand, Chhattisgarh, Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh and Odisha states.

Supply of quality planting material, demonstration, and dissemination of cashew production technologies and financial support for initial establishment and maintenance and also information on marketing opportunities will encourage farmers to take up cashew cultivation. Currently, there is a shortage of quality planting materials for cashew area expansion as the production of planting material is season dependent. Another major hurdle in plantation crops like cashew is the low replacement rate of low yielding old cultivars with new high yielding cultivars due to low multiplication rates and an unwillingness of farmers to remove old plantation as new establishment needs initial investment and the regular income from plantation will be stopped for 4-5 years. The supply of good quality planting material can be met by developing efficient tissue culture based propagation methods which will not only allow rapid multiplication of lakhs of plants from a small amount of plant material but allows a year-round supply of disease-free planting material. Further, farmers could be encouraged with monetary benefits and providing advanced cashew production technologies.

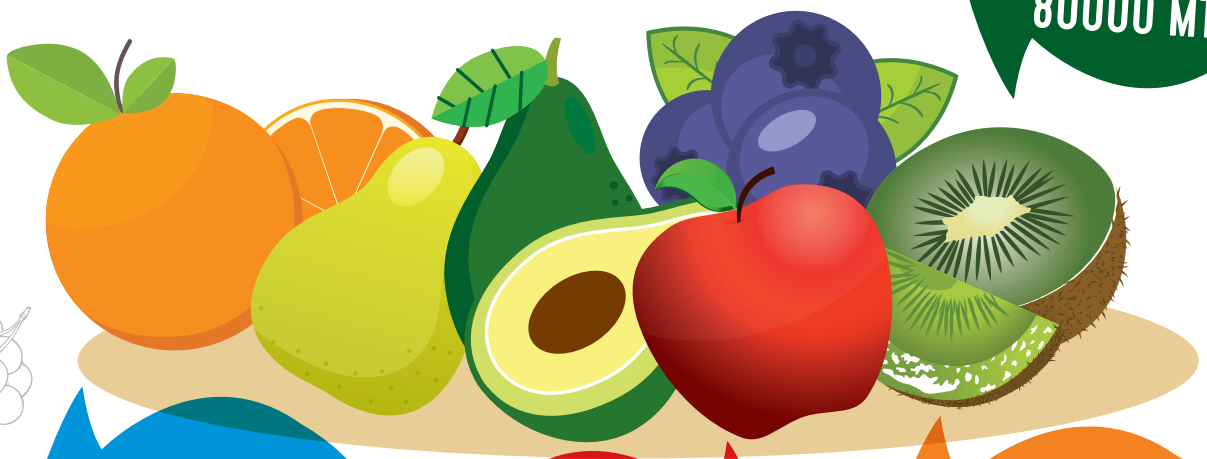
Vietnam exports cashew at a much competitive price compared to India as processing costs are lesser in Vietnam. Therefore, to compete in the international cashew market and regain its dominance in cashew trade, productivity needs to be enhanced and processing costs need to be reduced in India. To address the trade issues, improved mechanization of processing, product value addition and diversification, by-product utilization and post-harvest management of cashew nuts and apple is required.

Cashew has attained great economic importance and is currently the second most important tree nut. Over the years the global production and international trade have changed with new potential players entering the cashew market. Cashew brings foreign currency and is considered a key crop that could potentially support the livelihood of local communities and empower the most vulnerable groups in rural areas. ■

AN INDIAN GROUP WITH GLOBAL OUTLOOK

IG International Pvt. Ltd.
An Indian Group With Global Outlook

ANNUAL VOLUME OF OVER 80000 MT



28 WHOLESALE OUTLETS ACROSS INDIA

LEADING MARKETER AND DISTRIBUTOR OF HIGH QUALITY FRESH FRUITS ACROSS INDIA

TEMPERATURE CONTROLLED WAREHOUSING WITH A CAPACITY OF 40,000 PALLETS ACROSS 16 LOCATIONS

TECHNOLOGY IN AGRICULTURE

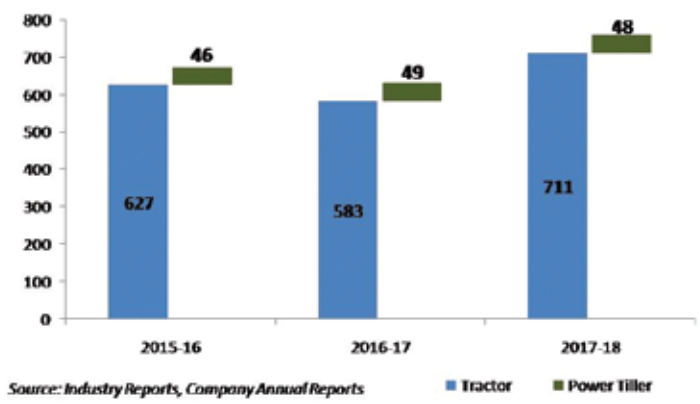
RECENT STATUS OF FARM MECHANISATION IN INDIA

India has come a long way in terms of adoption of farm mechanization since the early years of independence. At the time of the green revolution in the late sixties, 92% of the farm power was coming from animate sources. Thereafter, farm mechanisation had received attention of policy makers and during the current times, the situation has reversed with 90% of the farm power coming from mechanical and electrical sources.

However, when looked at the degree of farm mechanisation, expressed as a ratio of mechanical power to cultivable unit area, a very slow progress has been noticed during the last several decades. From 0.48 kW/ha in 1975-76, it has increased to 1.84 kW/ha in 2013-14 and further to 2.02 kW/ha in 2016-17.

In between 2015-16 and 2017-18, sale of tractors in India decreased from 627000 to 583000 in 2016-17 before witnessing an increased sale of 711000 in 2017-18 (Fig 73). Tractor sales recovered its momentum due to consecutive years of healthy monsoons, still penetration of tractors in India is low (20 tractors per 1,000 hectares) whereas growing use of tractors for non-agriculture use which is currently at estimated at 20% of the total sales has been observed. Because of non agricultural use of tractors, the sales cannot be completely linked to the aspect of farm mechanisation in India. Power tillers on the other hand maintained a relatively consistent market trend, hovering between 46000 and 49000. The sales of power tillers in 2017-18 as shown in the figures is an estimated figure from various industry reports. ■

Fig 73: Sales of Tractors and Power Tillers in India (in '000)



Source: Industry Reports, Company Annual Reports

K R Venkatadri
Chief Operating Officer
Rallis India Limited – A Tata Enterprise

IMPACT OF DIGITAL TECHNOLOGY ON AGRICULTURE

Agriculture plays a very strategic role in the economic development of any country. In the case of developing economies, Agriculture plays an even more critical role and is the main source of food, employment, source of income mainly to the rural population, generates a substantial percentage of the GDP for the country and in many cases the earner of foreign exchange. It is true in all senses that if the process of economic development is to be self-sustaining, it should begin with agricultural sector.

Though all the above facts are true, there are many challenges faced by the Agricultural sector especially in developing countries like India. Nearly three- quarters of India's families depend on rural incomes, majorly farming. Furthermore, the majority of Indian population nearly 70% is found in rural areas and are directly and indirectly connected to agriculture for their living.

Some of the challenges that we face in India are small and fragmented land holdings, imbalanced use of fertilizers and pesticides, lack of information, shortage and good quality of agri inputs, knowledge on produce price movements, storage facilities for produce and much more.

The answer to many of the challenges in Agriculture space today is Technology – whether seed technology, micro irrigation technology or digital and so on. We are aware that digital technology has disrupted many industries like media & entertainment, hotel industry, car hiring industry etc. Now we can see Digital impacting and transforming agriculture in a fundamental manner.

WHAT IS CHANGING NOW?

Agriculture is in the early stages of a digital revolution. With satellites costs coming down continually and data storage and analytical capability becoming cheaper, churning the

billions of bytes to provide weather, soil conditions etc. are becoming affordable. Now information being made available digitally about weather, soil conditions and crop health is already helping farmers maximize their harvest yields. The digital revolution is changing the way agriculture is to be done, with technological advancement, digital way of doing farming has become the most important for farmers worldwide. Highly automated tractors and other equipment are already traversing our fields, collecting data about plant health, yields, soil composition and field topography. Drones and satellites are likewise helping farmers work more efficiently by generating millions of relevant data points. Nowadays satellite imaging allows us to analyze a single patch of land at a resolution of just 30 centimeters. The ability to analyze highly accurate data from the previous growing season and comparing it with current years, brings a whole new dimension to modern agriculture. "Farmers are able to better predict influences affecting yields and respond more quickly to changes. This means they can take prompt action to prevent harvest losses. Many global AgChem companies are investing huge sums of money to develop digital tools which can benefit farming. Digital is not only helping farmers, it is also throwing up new business opportunities for companies.

WHAT ARE THE PROBLEMS FOR INDIAN FARMERS?

The different issues that impact productivity for farmers in India are

- With a limited area covered under irrigation, farm sector is very heavily dependent on monsoon. With climate change issues, the monsoon over the last few years have become more unreliable with issues on timing of monsoon, which refuses to stick to schedules & is scanty in many areas while excess in others.
- Climate change, deforestation, excessive use of fertilizers, erratic use of pesticides – these have made the productive capability of soil go down
- Small land holding impacting the cost effectiveness to use high technology
- Labour availability impacting de-weeding and spraying activities
- Insect and disease attacks are becoming adhoc and difficult to predict with legacy systems.
- Farmers unable to predict the supply-demand for their produce at the end of the season – leading to produce being destroyed by farmers at their fields when unremunerative

Above agro climatic challenges become a deterrent to guaranteed crop yield and future of agriculture is becoming extremely vulnerable. These make it difficult to plan for both agro-companies and farmers without appropriate decision and forecasting tools.

HOW HAVE WE APPROACHED THIS?

In order to deal with these uncertainties that plague the Agriculture ecosystem, Rallis has come up with a State of the art remote sensing based Crop monitoring system "DRISHTI" which provides actionable insights with respect to farming operations, thereby helping them to take informed decisions & improve their farm net incomes. Through DRISHTI we monitor 160 million hectares of Indian agricultural land on regular basis.

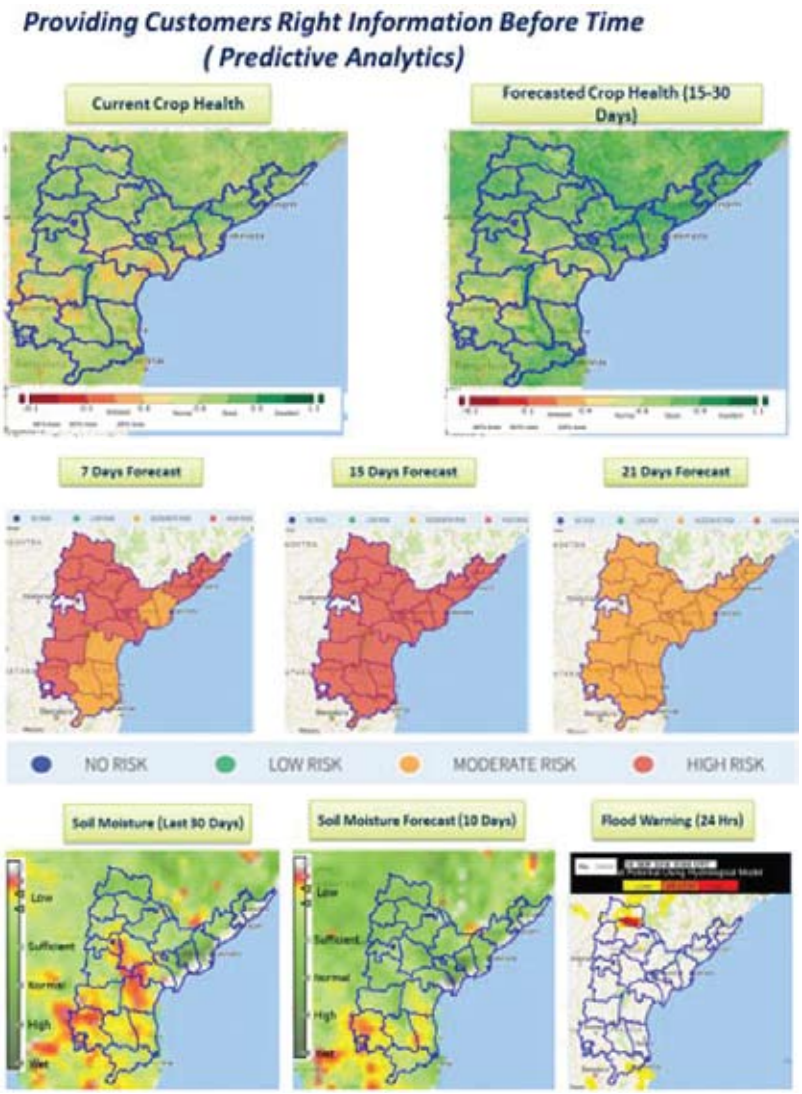
Various technologies are available to generate remote sensing based information related to weather& crop like Aircraft, Drone, and Satellite. Among these Best available tools are Satellite based agri – monitoring and forecasting system. Satellite technology allows coverage of thousands of kilometers in few minutes and it is also less costly than other options. With the number of satellites being launched, the cost of this service is also coming down.

For this project we are using pictures of more than 9 satellites both from ESA & NASA to acquire adequate spatial & temporal resolutions. Multi spectral satellite images are analyzed and outcomes are plugged into the AI to derive information regarding following important agricultural parameters.

This way we digitally provide many insights which can impact farmers yield at greater extent, some of which are:

- **Identification of Crop and estimation of net sown area and comparison with previous years.** This not only helps us in monitoring the country's sowing progress on a real time basis but also gives us insights on crop shift patterns & trends over the years
- **Detection of current vegetative health of the crop** and providing forecasting up to next 15 days as well as comparing this with same time last year. This helps Rallis get insights on season progress on a real time basis
- **Weather and weather anomaly forecasting up** from 7 & 15 days up to next six months
- **Detection of Soil moisture.** This parameter combined with the weather forecasts helps us educate farmers on right irrigation practices
- **Yield forecasting** and identification of crop loss.
- **Insect and disease forecasting** for next 7, 15 & 21 days. This is a powerful insight as we are able to tell the farmers in advance on the pest / disease attacks there by helping them to decide if they need to go for a preventive or curative method to tackle the problem
- **Risk index calculation** for a geography. This helps the management & senior sales team members to decide on strategy for the season & where to invest their resources.

This information is available at country level and can be drilled down to a farm level, which helps us to offer personalized advisory to the farmers as well as help our sales and marketing team to deploy products and resources effectively.



DRISHTI provides the farmer actionable insights on Soil Moisture content, Weather forecast, likelihood & intensity of pest / disease & overall health of the crop.

These are powerful information that a farmer can use to move from curative to preventive approach & save his crop from losses, optimize his cost of cultivation thereby improving next incomes

This proves that Digital technology will be key to increasing productivity and income alike.

Advances in Technology have revolutionized every other industry, and farming is no exception. Machinery, Technology, Information are becoming more and more efficient and easily accessible.

Indian agriculture has been traditionally rain dependent and climate changes have made farmers extremely vulnerable to crop loss. Insights from AI and other Digital platforms/tools through the agriculture life cycle will help reduce uncertainty and risk in agriculture operations. Thus Embracing Digital in agriculture can potentially transform the lives of millions of farmers in India and world over. ■

Zinc in Fertilizers

Immediate Results...Long-term Benefits.

Zinc deficiency takes an enormous toll on both humans and crop productivity. Adding zinc fertilizer to soils and crops can significantly increase crop yield, boost nutrition in humans and improve farmers incomes.

Zinc fertilizer increases crop yield and reduces the impact of drought, resulting in healthier, stronger crops.

Zinc fertilizer increases the nutritional value of crops, resulting in increased zinc nutrition in the diet.

Zinc fertilizer increases the yield and quality of crops, resulting in increased income for farmers.

Zinc has emerged as the most widespread micronutrient deficiency in soils and crops worldwide, resulting in severe yield losses and deterioration in nutritional quality. About 40% of Indian soils are deficient in zinc, leading to decreased crop productivity and nutritional value.

Zinc Nutrient Initiative

GET INVOLVED

International Zinc Association,
ZNI - India
P: +91-11-2996 0040
E: sdas@zinc.org
W: zinc.org/zni

Zinc
...essential for life

CROP MANAGEMENT

STATUS OF AGRI INPUTS SECTOR IN INDIA

FERTILIZER SECTOR:

India is second biggest consumer of chemical fertilizers in the world, only next to China. Following are some of the important statistical aspects of the fertilizer sector of the country:

- Production of total nutrients (N+P2O5) registered a marginal increase of 0.1% during 2016-17 over 2015-16
- Production of nitrogenous fertilizers declined by 0.7% whereas phosphatic fertilizers (P2O5) increased by 2.8% during the period

- Production of Urea and SSP declined by 1.1% each and NP/ NPKs by 5.4% during 2016-17 over 2015-16
- Production of DAP recorded a robust increase of 13.4% during the same period
- Import of Urea, DAP and MOP was of the order of 5.48 million metric tonnes (MMT), 4.39 MMT, and 3.74 MMT, respectively, during 2016-17
- Import of NP/NPK complex fertilisers was about 521000 tonnes during 2016- 17
- Total fertiliser nutrient consumption declined by 3% in2016-17 over 2015-16
- The consumption of N, and P2O5 declined by 3.3% and 1.6%, respectively, during 2016-17 as compared to 2015-16 but consumption of K2O increased by 4.4% during the same period
- 10 states in India, namely Uttar Pradesh, Maharashtra, Madhya Pradesh, Punjab, Andhra Pradesh, Karnataka, Gujarat, Bihar, West Bengal and Telengana together consume 78% of the total fertilizer consumption in the country (Data Source: Fertilizer Association of India)

CROP PROTECTION CHEMICALS:

- India is the fourth largest producer of agrochemicals worldwide, after United States, Japan and China and is the 13th largest exporter of pesticides globally

- The Indian Agrochemical industry is valued at USD 2.2 billion in FY16, having grown at a CAGR of around 3.5% from FY13 to FY16
- It is further estimated to grow at a CAGR of 6.4% to reach USD 3.2 billion by FY22
- Export market is expected to grow at 8.6% (Data source: FICCI Report on Indian Agrochemicals Industry, 2018)

INDIAN SEED INDUSTRY:

- Domestic vegetable seeds industry is expected to double from the current size to around Rs. 8,000 crore in the next five years
- Indian seed industry is one of the most vibrant sectors with a growth rate of 12%compared to global growth of 6-7%
- In terms of self sufficiency for seeds within the country, India has achieved 100% self sufficiency for crops like rice, wheat, maize, pulses and oilseeds
- Following is the quantitative demand of seed for different crops in India:
  - Rice: 106.5 million tonnes
  - Wheat: 96 million tonnes
  - Maize: 96 million tonnes
  - Pulses: 19 million tonnes
  - Oilseeds: 33 million tonnes

THE FALL ARMYWORM PEST INCIDENCE IN INDIA

NEED TO FAIL THE PEST IN THE BEGINNING

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The occurrence of Fall Armyworm (commonly referred to as "FAW", and scientifically known as *Spodoptera frugiperda*) has recently been reported for the first time in Karnataka and a few other states in southern India, including Andhra Pradesh, Telangana and Tamil Nadu. There are several other insects belonging to this group - adult moth laying eggs; caterpillars damaging parts of specific crop plants, and then completing the life cycle. However, presence of FAW in maize fields (as of now, the incidence is highest in maize, which is the most preferred among various crops that FAW can potentially feed on) has generated lot of significant concern among the stakeholders and heightened the attention of Government machinery for some important considerations.

FAW is not new to the scientific community. This highly destructive and invasive insect-pest has been prevalent in the Americas since several decades, but was reported for the first time in West Africa in the beginning of 2016. Since then, FAW incidence was noticed so far in 44 countries across Africa (except countries in North Africa). As per the assessment made by CGIAR Research Program on Maize, led by the International Maize and Wheat Improvement Center (CIMMYT), the FAW in the last two years caused damage to more than 1.5 million hectares of maize crop in Africa, affecting the food security and livelihoods of smallholder farmers, and triggering widespread concern.FAO experts recently have warned that fall armyworm is likely to spread from India to other parts of Asia, with south-east Asia and south China mostly at risk. The invasion by fall armyworms could potentially become global, if collaborative efforts are not made by actors at each level, be it local; regional; national or international.

The pest migrates very fast (almost 100km per night, and nearly 500 km before laying eggs), and thus, can invade new areas quickly. It can complete its life cycle within 1-2 months (depending on weather conditions), with each female moth capable of laying on average

1500 eggs). It is one of the most destructive crop pests, with a wide spectrum of host range (including maize, rice, sorghum, sugarcane, soybean, vegetables etc.). Yet, we must recognize the fact that FAW can be effectively managed by adopting an integrated pest management (IPM) strategy, suitable for the agro-ecology and cropping system landscape. It is in this context, the article intends to sensitize the stakeholders, including farmers, extension workers, scientists and policy makers in India on the approaches to sustainably managing the insect-pest and fail it in the beginning.

LIFE CYCLE OF THE FALL ARMYWORM

The FAW completes its life cycle in about 30 days (in warm summer months). However in cooler temperatures, it may extend up to 60-90 days. The female moth lays on an average about 1500 eggs attaching them to the foliage; the egg stage lasts for only 2 to 3 days in warmer weather. The FAW, in general, has six larval instars (stages) before it goes for pupation. The entire larval stage lasts for 14 to 30 days depending on the weather conditions (especially temperature and humidity).

Destruction of leaves, stems or reproductive parts of the crop plants is done mostly by the last three instars of FAW; therefore, control is best achieved early in the life cycle of the pest, not in the later stages. The damage often results in extensive defoliation (see Pic). The insect normally pupates in the soil lasting for 8 to 9 days in summer, which may extend up to 20-30 days in cool weather. The nocturnal adults live for 10 days on an average and are most active during warm and humid evenings.

MONITORING AND SURVEILLANCE ARE KEY

Scientists of University of Agricultural Sciences, Bengaluru and University of Agricultural and Horticultural Sciences, Shivamogga in Karnataka state have scientifically validated the incidence of FAW in the maize fields in various districts. There have been isolated reports of incidence of this invasive pest on maize crops in other states like Andhra Pradesh, Telangana, Gujarat and Maharashtra. Fortunately, the pest has been localized and not created massive destruction as yet.

As reported in the literature, the FAW moth population can travel several hundred kilometers during its life span, and the egg laying by the females is also profuse. Being polyphagous, the pest can damage a number of crops; therefore, the common perception that the fall armyworm is ONLY a maize pest is incorrect.

In such a scenario, it is of paramount importance on the part of the States of India (especially those where the pest has been already noticed) to nip the problem in the bud. A mass awareness campaign needs to be made to build necessary awareness (avoiding panic) amongst the farmers and extension workers as to how they could effectively recognize various stages of the pest (eggs; moths; early stages/instars of the larvae) and manage/control the situation with right interventions, by following integrated pest management practices. In no uncertain terms, we need to advise farmers or extension personnel (and even scientists) NOT to panic or create panic when they notice FAW in any crop field. As the pest has appeared in specific areas of the country, creation of awareness through traditional means like pamphlets/posters showing characteristics of the insect pest; pictures of egg mass (for hand collection and destruction by farmers themselves at the initial stage); radio/TV broadcasts, as well as through use of Information and Communication Tools (SMS/Social media) can spread the message.

Surveillance systems by public and private extension machineries by way of setting traps (usually pheromone-based) would be an effective mechanism to monitor the movement of the FAW populations within the targeted geographic locations. Trained technical personnels based on their knowledge of the pest and the concerned agro-ecosystem can also suggest to the affected farmers on specific interventions based on

IPM. Rapid capacity building of such staff by scientific institutions (with required domain knowledge) is extremely important. The National Agriculture Research and Extension System (NARES), consisting of the vast network of Indian Council of Agricultural Research (ICAR) and the State Agricultural Universities (SAUs), along with the CGIAR institutes that are actively engaged internationally in tackling the FAW challenge, like CIMMYT, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and others, need to come together to effectively address the issue.

NEED FOR INTEGRATED PEST MANAGEMENT (IPM)

Many organizations, including both public and private sector, have been intensively working on identifying/validating/developing technologies and management practices that can help manage the FAW in Africa, as well as for creating awareness among the stakeholders on IPM-based FAW control. The experiences and lessons learnt so far could be very valuable to India in effectively tackling the pest incidence. From the experience so far, it is clear that there is no single solution for sustainable management of FAW in Africa or Asia; we need to have a science-based, inclusive and well-balanced IPM strategy.

An effective IPM strategy for control of FAW will employ host plant resistance, biological control, cultural control, and environmentally safer synthetic and bio-pesticides to protect the crops from economic injury while minimizing negative impacts on people, animals, and the environment. USAID Feed-the-Future and CIMMYT have jointly released "Fall Armyworm in Africa: A Guide for Integrated Pest Management" in January 2018. This publication could serve as an initial basis for decision making and strategic planning in India.

National research systems of many countries in the North and South America as well as international organizations like CIMMYT, have already designed the right mix of approaches to contain the pest below economic- threshold- level (ETL). With increasing awareness on correct pesticide usage (use chemicals ONLY when the pest load has crossed the ETL), effective pesticide management is all the more important. Scientists of NARES may come out with the protocol and list of environmentally safer and effective pesticides which are compatible with the IPM strategy.

Evidence-based mechanical and cultural control practices against FAW should be promoted in the affected states in India, as the FAW problem is fortunately still localized and not gone beyond proportions. As mentioned earlier, the female moth of FAW lays up to 1500 eggs a month. These eggs are discernible to naked eyes and therefore, with proper training, farmers can recognize and destroy these egg masses so as to prevent the caterpillars from destroying the crops. Landscape

management approaches and cultural practices which have already been tried for FAW and other pests could be validated and up-scaled. Scientists should also come out with specific recommendations based on principles of agro-ecological control.

Biological control is an important component of an IPM strategy against many major crop pests in India and elsewhere. Quick identification and validation of biological agents, such as parasitoids, predators and entomopathogens, against FAW, and wherever possible, release of well-validated bio-pesticides should be taken up as a priority item by NARES in India. Bio-rational pesticides (like neem-based preparations) could also be potentially incorporated into the strategies. The supply-chain of the biological control agents of the FAW and continuous training of the farmers and extension personnels would be key to the success of biocontrol-based IPM strategies.

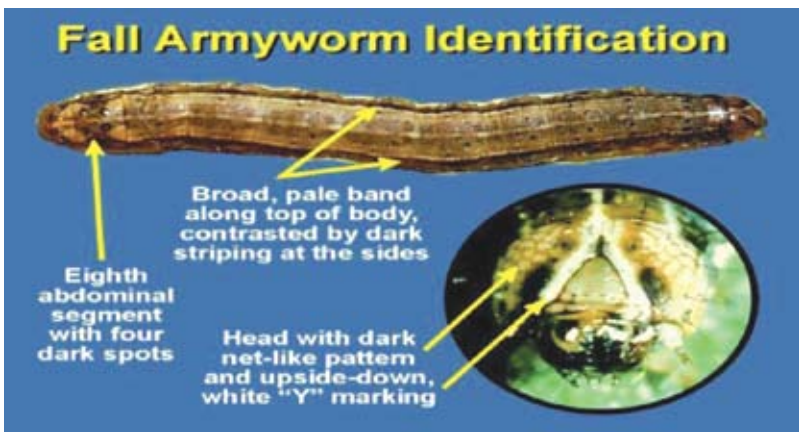
We must recognize that FAW being a polyphagous pest, can attack a host of crop plants (as high as 80). Therefore, ICAR and CGIAR institutes like CIMMYT and ICRISAT which have a vast array of germplasm in their Gene Banks and also, varieties that could be tested for native genetic resistance to the FAW need to work together intensively. Molecular biological tools now offer great scope to accelerate development of new and promising varieties that could offer tolerance/resistance to FAW and a host of other biotic stresses. This is a medium- to long-term strategy and requires effective coordination and resources from the Indian Government (as well as host country Governments in the FAW-affected nations in Africa), donors, and the private sector. A well thought-out research and development coupled with global partnership is the need of the hour for jointly benefiting from such efforts and to safeguard the interests of the smallholder farmers from serious threats such as FAW.

Unlike the farms in several countries in Africa, the FAW is yet to siege the croplands where they have been noticed in India. But we must not lower the guard against the pest.

FALL ARMYWORM R4D INTERNATIONAL CONSORTIUM

CIMMYT and IITA (International Institute on Tropical Agriculture) have recently initiated the "Fall Armyworm R4D International Consortium". The Consortium brings together more than 35 different institutions worldwide (including North America, South America, Europe, Africa, and Asia, and from the public and private sectors) to explore ways to synergistically work on short-, medium-, and long-term solutions to tackle the challenge of FAW in Africa, and in other parts of the world where the pest is prevalent. ICRISAT, the only CGIAR center headquartered in India has already offered its willingness for this global network for identification/validation and development of suitable technologies/management practices against the FAW. ICAR, having one of the largest pools of scientific talents in the world, should also join hands in this important initiative to prevent FAW from becoming a potential threat for major crops to the smallholders in India, as well as other countries in Asia.

In a changing climate and global connectedness through trade and tourism, invasive pest attacks could become more frequent than ever before. Wherever possible, we need to step up our phytosanitation and quarantine efforts to prevent the onset of transboundary pathogens/pests. Effective monitoring, surveillance and early warning systems, coupled with capacity to quickly respond to any new insect-pest threat through IPM, are vital for safeguarding the crops and to protect the income and livelihoods of the smallholders that dominate the Asian agrarian landscape. India must fail the spread of the pests like Fall Armyworm in the beginning itself through concerted and synergistic inter-institutional and multi-disciplinary efforts. ■



FOOD PROCESSING

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Processing And Value Addition Of Horticultural Crops For Income Generation

India has attained global supremacy in the production of fruits and vegetables, occupying the first and second positions, respectively. Despite such a huge production, there is 25-33% post harvest loss of horticultural produce owing to highly perishable nature of fruits and vegetables. The major cause of post harvest loss is lack of infrastructure for post harvest management (PHM) and processing of commodities. These losses can only be minimized by proper handling, marketing and processing of the agricultural commodities. According to national level study conducted under AICRP on PHT, the post-harvest losses during different farm handling operations like harvesting, sorting, grading and packing accounts for about 13% ,during farm storage stands about 6% and during storage at godown, wholesale and retail level about 12%. Thus on an average, about one third of horticulture produce never reaches the ultimate consumer. Insufficient knowledge of pre and post-harvest operations and lack of proper facilities for handling like pre-cooling, grading, packaging, transport, storage, processing and marketing altogether compound the post-harvest losses for more than Rs 65,000 crores. The food processing industry ranks fifth in size in the country and employs 16 lakh workers which is 19% of the country's industrial labour. It accounts for 14% of the total industrial output with 18% of industrial GDP and 6.3% of countries GDP. Despite such good rank, there is only <2.4% processing in India as compared to advanced countries (60-70%). So, food processing can play a vital role in India's prosperity. The food processing industry sector in India is one of the largest sectors in terms of production, consumption, export and growth prospects. According to ASSOCHAM-Grant Thorton Research paper, food processing sector possess potential to generate employment of 9 million persons by 2024 in India and expected to generate about 8,000 direct and 80,000 indirect jobs. India exported 12.70 Lakh tonnes of processed foods comprising of mango pulp, juices, concentrates, dried and processed vegetables, pickle and

chutney, alcoholic and non-alcoholic beverages worth Rs 10583.41crores (APEDA, 2017).The food processing export share is around 12% to the total export in India. The foreign direct investment (FDI) in the food processing sector is expected to rise by 38%. For accelerating the growth of the food processing industries, GOI has implemented a number of schemes and has doubled the allocated amount of Rs 715 crore during 2017-18 to Rs 1400 crore in 2018-19.

TECHNOLOGIES DEVELOPED BY NAVSARI AGRICULTURAL UNIVERSITY

The development of processing industries to preserve perishable agricultural produce will not only improve economic and nutritional status of our population but it may also help in employment generation in rural as well as urban areas of the country. This can be achieved by linking production, and post harvest technology in synergistic way. For this purpose, the department is equipped with excellent Fruit and Vegetable Processing Units for pilot scale testing of technologies, providing in-plant training and imparting community canning service to the students, farmers and enterpreneurers. Further, in view of 'Wealth from the Waste', NAU has done remarkable research on waste utilization, particularly the banana pseudostem processing, water melon rind processing etc. Banana plant residue after harvesting is a major problems for the farmers and they are spending about Rs.15,000 – 20,000 per hectare to remove that from field to take ratoon crop or new crop. Instead of it, now farmers can get additional income of around Rs.1.25 lakh per hectare from the waste by preparing different value added products. The research achievements of the PHT Unit of NAU, Navsari which can enhance the income of the farming communities are enlisted here under.

NAU has developed process for freeze drying of sapota slices for high

Sapota Chips

quality dehydrated sapota chips and powder. High quality dehydrated sapota chips can be prepared by pre-freezing 5 mm thick sapota slices in freezers for 10 hours followed by freeze drying under vacuum of 760mm Hg at a temperature of 70°C for 12 hours.

The university has also developed technology for utilization

Banana Peel Sev

of banana peel for preparation of sev. Banana peel after pre-treatment and blanching are ground to make paste and mixed (30% ripe banana peel paste) with gram flour (70%) for preparation of fibre rich sev.

Besides this, NAU has standardized method for extraction

Noni Juice

of 'Noni' *(Morinda citrifolia)* fruit juice. Noni juice can be extracted by treating crushed fruits with 0.10 % pectinase for 3 hours to get higher juice recovery. The juice after extraction must be filtered, pasteurized (96°C), packed in glass bottles followed by processing (96+1°C) for 30 min.

The formulations for preparation of noni mango nectar from Noni juice

Noni Mango nectar

has also been standardized. Noni juice can be utilized for preparation of blended noni mango nectar to increase the acceptability of noni juice. For preparation of blended noni mango nectar, blend 5% noni juice with 15% mango pulp by maintaining 160 Brix TSS and 0.3% acidity. The nectar after blending, is filtered, pasteurized (96°C), packed in glass bottles followed by processing (96+1°C) for 30 min.

NAU has developed technology for dehydration of onions rings, okra slices and cauliflower segments by giving pre-treatment to onion rings with combination of 2000 ppm potassium meta-bisulphite (KMS)

Dried Cualiflower

and 500 ppm citric acid, okra slices with 1500 ppm KMS and citric acid @ 500 ppm and cauliflower segments with 1500 ppm KMS and citric acid @ 500 ppm for 15 minutes followed by dehydration.

Technology for preparation of Ready to Serve (RTS) beverage from

Banana Pseudostem RTS

banana pseudostem sap is also available with NAU. RTS beverage can be prepared from blend of banana psuedostem sap and aonla fruit juice having 3.5% and 8% TSS respectively with the ratio of 90:10 and can be stored up to six months in glass bottle.

NAU standardized technology for processing of Banana Central Core Jam. The processors and house wives are recommended to prepare banana pseudo stem central core jam by replacing up to 50% fruits (mango, guava, papaya, pineapple) with central core. Mix fruit jam with central core is most acceptable combination as it not only reduces the production cost but also increases the fibre content of the jam without affecting jam quality.

Banana Central Core Jam

Banana Central Core Candy

NAU has also achieved processing of Banana Central Core into candy. Candy from banana pseudo-stem central core can be prepared by giving blanching pre-treatment for 3 min followed by osmotic dip to cubes of central core in 70° Brix sugar syrup.

Besides this NAU standardized technology for preparation of water

Watermelon rind candy

melon rind candy by mixing 100 g sugar per 100 g water melon rind along with 0.20 per cent acid. The prepared candy was rated best on the basis of higher sensory score as well as nutritional composition.

Technology utilizing Mango peel and kernel powder for preparation

Mango Peel and kernel based biscuits

of biscuits using formulation of 5% mango peel powder, 7.5% kernel powder and 87.5% maida (F7) was developed by the University. The biscuits remained shelf stable during storage for three months in polypropylene bags.

The recipe for the preparation of jam from the fruits of Palmyra palm has been Standardized. Jam from tender fruits of palmyra palm can be prepared by using pulp:sugar ratio (1:1.2) and addition of pectin @16g/kg of pulp and it also can be stored for six months at ambient temperature in glass bottle. Similarly, the recipe for the preparation of candy from the fruits of Palmyra palm has also been devloped. Candy from the fruits of Palmyra palm can

be prepared by steeping the slices (5cm x 5mm) in sugar syrup having 65% TSS for 8 hours followed by drying of slices for 7 hours at 65°C and packed in PE pouches which can be stored successfully up to six months at ambient storage.

Hot water dip treatment for eradication of fruit fly and extension of shelf life of mango fruits cultivars - Kesar and Alphonso, is also another work that was carried out successfully in NAU. Exporters are recommended to give hot water treatment at 50°C for 20 min to eradicate fruit fly infestation in Kesar and Alphonso mango for getting export quality fruits. NAU also developed protocol for shelf life extension of the mangoes.

The technique for colour extraction from *Butea monosperma* flowers for preparing herbal gulal was another technology developed by NAU.

NAU optimized the level of temperature and KMS for processing of ripe banana puree at pilot scale.

NAU has also developed technologies for extraction of banana fibre and to convert it into various types of paper, fabrics, microcrystalline cellulose, handicrafts and many more. Farmers can process waste of banana pseudostem in to enriched high quality vermi-compost and bio-compost. Banana central core can be processed into various nutritive edible products. Fresh banana pseudostem sap is a rich source of potassium and iron and can be applied in any agricultural crop as organic liquid manure, which can increase the yield by

10% with significant reduction in cost of production. Technology for enrichment of this fresh sap in to NOVEL organic liquid nutrients, which is internationally patented technology was also developed by NAU. NOVEL is rich source of N, P, K and all the micronutrients along with the natural plant growth promoters like gibberellic acid, cytokinin and NAA. NAU releases recommendation for the farmers for all the crops, which can increase the crop yield by 15 – 20 % with 15 – 20 % reduction in cost of production. In the new era of organic farming, NOVEL can become a big game changer. NAU has signed 13 MOUs across India for commercial scale production of NOVEL using IPR, so that this unique technology can reach each and every farmer's field which can help to increase farmer's income under mission of doubling farmer's income. NAU is seeking for more and more entrepreneurs to promote this project in all corners of India. ■

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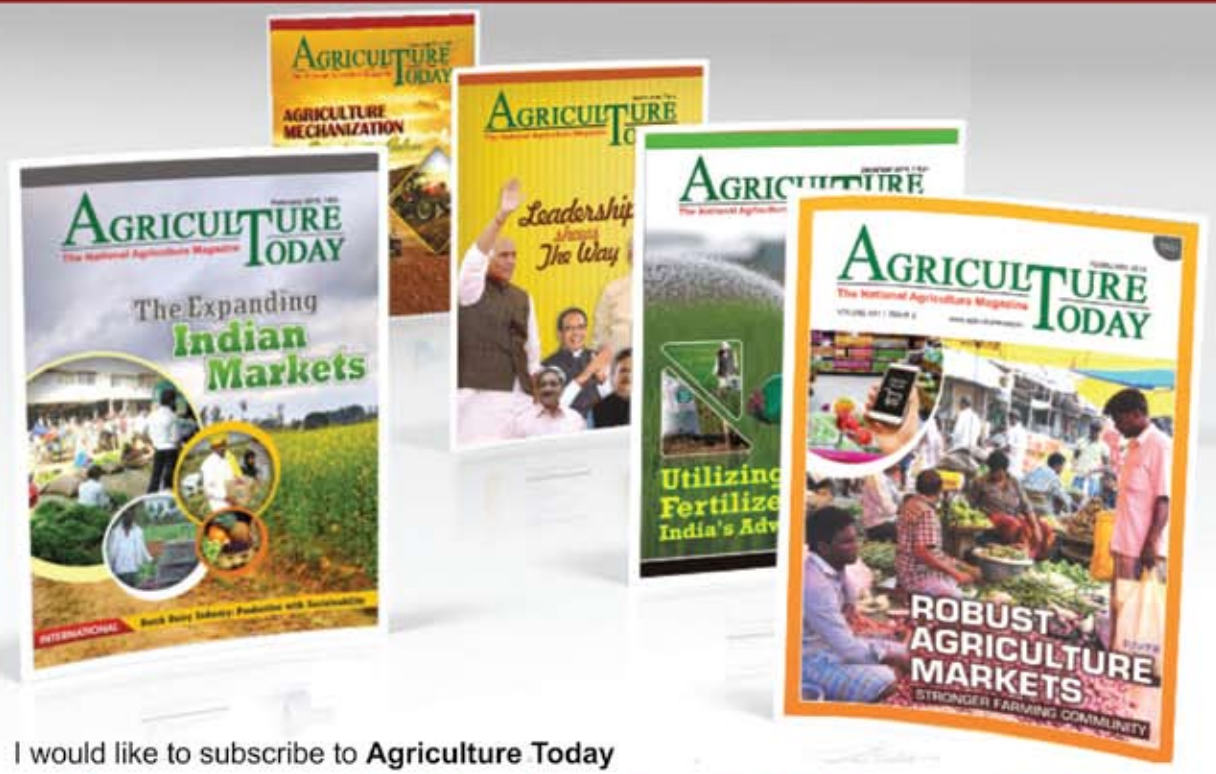

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AGRICULTURE TODAY

SUSTAINABLE AGRICULTURE AND BIODIVERSITY

Prof.M S Swaminathan
India's Architect of Green Revolution

AGRICULTURE : THE NEXT PHASE

Our agriculture is making good progress but there are many problems which need attention as it is clear from the many farmers' agitations in different parts of the country. Farmers face the problems of climate change and market volatility and steps will have to be taken to ensure income stability to farmers. I would like to deal in this article with a few contemporary issues starting with the problem caused by the flood fury in Kerala.

BEYOND THE FLOOD FURY IN KERALA

There are signs of abatement of the rain fury in many parts of Kerala, the time has come both to look back and to look forward. The immediate concern should be relief and rehabilitation of the affected population. At the same time, an inter-disciplinary committee could be set up to mitigate hardship during similar future rain induced problems. I have dealt with these in several reports, lectures and in the Kuttanad package. Immediately, there have to be programmes aiming at the rehabilitation of agriculture and the plantation industry. At the same time, drinking water supply should receive overriding priority. It is essential to avoid water borne diseases. For the future, we should set up in every Panchayat a Rainfall Management Centre which will prepare both drought and flood codes for anticipatory action. For example, immediately in the case of agriculture, farmers need seeds or planting materials. The appropriate varieties will have to be provided. This will need building of Seed Banks for use on occasions like this. I hope the calamity caused by the floods will become an opportunity for a flood tolerant agriculture. At the same time, the human dimension of flood management needs adequate attention.

IMPACT OF FLOODS ON RADIOACTIVE SAND IN KERALA

The unprecedented floods and rains in Kerala

emphasise the need for proactive preparation to meet such calamities. I had recommended in Sardar Patel Lectures of All India Radio in 1973 that we should have both a drought code and the flood code ready so that we can minimize the adverse impact of deficit or excess of rainfall. The Kuttanad package also provides some guidelines for flood avoidance or management. In this connection, there is also need to study the impact of floods in the coastal regions of Kerala (old Travancore area) which contain radioactive minerals like Thorium. Such monazite sands need to be conserved since they provide raw material for nuclear power plants. I hope this urgent task will be undertaken by the Kerala Science and Technology Commission. Thorium came to our help when we were denied uranium.

BUILDING A NEW KERALA

Floods are receding, there is increasing interest in building a new Kerala characterised by climate resilience. The new Kerala should provide for climate risk management centres and for shelters to those affected by natural calamities. Climate risks include damage caused by sea level rise. There are large numbers of people in Kerala living near the coast and it is important that they are insulated from the adverse effect of climate change. Particular provision should be made for housing climate refugees who are rendered homeless. I hope there will be a serious discussion on the development of a new Kerala based on sound principles of ecology, economics, employment and gender and social equity. The new Kerala could then become the flagship of the sustainable development.

SUSTAINING AND EXPANDING THE HORTICULTURE REVOLUTION FOR NUTRITION SECURITY

Horticulture production has reached 307 mt during this year thereby making us one of the largest producers of fruits, vegetables, and flowers. A major problem in horticulture has been the deterioration in quality caused by inadequate cold storage and processing facilities. Prime Minister's goal of doubling farm income can easily be achieved if horticulture crops are integrated in the farming system. Also we can aim to produce 500 mt of fruits, vegetables and flowers in another ten years if we can promote peri-urban horticulture.

In 1982, I had recommended the establishment of a National Horticulture Board on the model of the National Dairy Development Board. The National Horticulture Board is functioning although not on the same lines as the National Dairy Development Board (NDDB). Enough investment in post-harvest management and technology are lacking.

What is important is integrated attention to production, storage, processing and marketing on the one hand and improved consumption on the other. Our country is known for its problems of malnutrition and hidden hunger caused by a lack of micronutrients in the diet. The horticulture revolution can help us to overcome this problem and help to convert the goal of moving away from food security to nutrition security. Conservation, cultivation using organic farming methods; Consumption and commerce are all integral parts of the movement "horticulture for nutrition security".

TECHNOLOGY AND PUBLIC POLICY IN RELATION TO HUNGER

12 September 2018 is the 9th death anniversary of Norman Borlaug, the greatest hunger fighter of the 20th century. Also, there is a report from several UN organisations that the number of hungry increased to 821 million from 16.6 million since 2009, the highest in eight years. I have formally drawn attention many times to the anomaly of the coexistence of Grain Mountains and hungry millions. Obviously, food production alone is not enough. We have to take steps to ensure that every child, woman and man has the ability to

access and absorb the needed food. This will call for a cadre of Hunger Fighters in every village. MSSRF has developed a training programme for hunger fighters. A Panchayat level committee can undertake the task of training adequate number of hunger fighters who will help to ensure that in the concerned village, all the three forms of hunger, viz., undernutrition, protein hunger and hidden hunger caused by micronutrient deficiencies are eliminated. Nobel Laureates like Dr Borlaug have shown the way to achieving freedom from hunger. It is now up to the political leaders and policy makers to help in developing appropriate public policies for achieving the zero hunger goals. It is only interaction between technology and public policy that can end the paradox of hungry people living along with Grain Mountains.

WATER SECURITY FOR AGRICULTURE

The occurrence of floods in Kerala and several other parts of our country would lead to our forgetting that soon we will be confronted with widespread drought. This has been our past experience. Therefore we should take proactive steps for ensuring water security for farmers. We should make rain water harvesting mandatory both in rural and urban areas. This will help dry farming areas with the possibility of a crop life saving irrigation. Other desirable practices like raising community nurseries will also become easy. Rain water harvesting will help to enrich the aquifer and thereby limit the dependence on surface water resources.

Inter-basin transfer of water through river linking should be encouraged and made possible. Linking the rivers of peninsular India, which are under our political control, would help to create an Indian Rhine in South India. All this will need the fusion of technical skill, political will and people's cooperation.

WORLD WATER DAY

The importance of water to all forms of human security needs hardly any emphasis. Therefore every nation should have a National Water Security Policy based on community participation and scientific data. In India we should develop immediately a water security policy consisting of the following five components:

- Groundwater which is really controlled by rainfall and by the water holding capacity of the aquifer
- Surface water which again is regulated by a rainfall and by the melting of snow in the hills. All the major rivers fall under this category
- Sea water which constitutes 97% of the world's water resource. Sea water farming should become a method of agriculture in coastal areas
- Rainwater which is a source of most of the water systems
- Recycled water based upon recycling waste water

While the above will help to augment supplies we need concurrently a strategy for demand management. For example, considerable amount of water used in agriculture can be saved through methods like drip and sprinkler irrigation. Conjunctive use of water will also help to use economically different sources of water particularly ground and surface water. Demand management can also be achieved through the selection of appropriate crops based on moisture availability. Three dimensional farming can be adopted to benefit from both water and sun.

ALLEVIATING FARMER'S DISTRESS

It is now recognised that unfavourable economics is creating numerous difficulties for farmers. I am glad the government of India has taken two major steps to correct the imbalance. First more favourable minimum support prices (MSP) has been announced. Secondly, government of India has also decided to purchase surplus grain on the basis of the improved MSP. Procurement is vital to ensure that MSP is meaningful. We need to attend to all the three major aspects governing the economics of farming, viz., providing a favourable MSP; public procurement to ensure that the MSP reaches the farmers and finally public distribution which will end the dichotomy of grain mountains coexisting with hungry millions. Strengthening the procurement system will also need greater investment in post-harvest infrastructure. If these problems are attended to, a major cause of farmer's distress would have been attended to.

Agriculture is a main source of job-led economic growth. If agriculture goes wrong, nothing else will have a chance to go right. Therefore we should go back to the advice of Jawaharlal Nehru viz., "Everything else can wait but not agriculture".

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- **Introduction:** Junagadh Agricultural University is extensively engaged in research, education and extension education since its inception from 1st May, 2004. University's jurisdiction is spread over **ten districts** of the Saurashtra region, comprising of 32.74% (6.43 mha) area of the Gujarat state (19.60 mha).
- **Mission:** Play pivotal role in teaching, research and extension education related to agriculture and allied sciences.
- **Vision:** Junagadh Agricultural University intends to be one of the nation's leading universities in terms of its academic quality, advancement in technological research and farmers' knowledge for sustainable agriculture as well as ensuring food and nutritional security to the people.

- **Education:** Junagadh Agricultural University offers education (UG & PG) in the faculties of Agriculture, Horticulture, Agricultural Engineering, Fisheries Science, Veterinary Science & A.H. and MBA in Agri-Business Management. University also offer Diploma Courses in the field of Agriculture, Horticulture, Agril. Engg., Agro Processing and Animal Husbandry. The University **accredited for five years** from 28th March, 2016 by ICAR, New Delhi.

- **Research:** The University has **31 research stations,** functioning in the North Saurashtra & South Saurashtra Agro-climatic Zones and part of North-West and Bhal & Coastal Area Agro-climatic Zones of Gujarat. The research activities leads to varietal development and generate production technologies of mandated crops of the region. As an outcome of the research **61 varieties** of different crops were released and **512 technologies/ package of practices** recommended for the benefits of the farmers and 232 recommendations were made for scientific community. To strengthen the location specific research **62 Plan, 26 Non-Plan, 20 AICRPs and 57 external funded research projects** are functioning in the University.

- **Extension:** Extension activities through Sardar Smriti Kendra (SSK), **seven KVKs**, CoC, Farm Advisory Service Center, T&V Scheme, ATIC, Agriculture Diploma course, Agro based ITI, Bakery, Mali and Fisheries Training are carried out for the benefit of farmers and stake holders. Community Radio Station **"Janvani 91.2"** is broadcasting extension programmes.






JHUM-BASED FARMING SYSTEM: Converting Challenges into Opportunities

G. Kaito Aye
Hon'ble Minister of
Agriculture, Nagaland

Nagas are basically an agrarian society with Agriculture as the main source of livelihood especially in rural areas. According to the latest report, about 73% of the state population is involved in agriculture contributing a major share in GSDP. Two types of farming systems are practiced in the State, namely shifting cultivation (Jhum cultivation) and WRC/TRC. Rice is the staple food and occupies 70% of the total cultivated area and constitutes 75% of the total food grain production in the State. Other crops include maize, oilseeds, pulses, tapioca, potato, sugarcane and spices. However, Nagaland still continues to be food-deficit depending mostly on import of food items, especially rice from other states. The main reasons are continued subsistence farming, poor infrastructure and topography.

On the other hand, Nagaland is blessed with a very congenial climatic condition from Sub-tropical, temperate, sub temperate zones with well distributed rainfall and favorable agro climatic condition for growing wide range of crops.

Therefore the major challenge is how to adapt its land use pattern and production systems to the increasing population, changing lifestyle and growing market demand.

Jhum-based Farming system occupies the major chunk in the land use scenario of Nagaland. Annually land use for Jhum is over 90,000 Hectares which comprise of 70% of the total crop of the State. It is a highly complex system of farming which integrate indigenous agricultural wisdom passed down from generations of farming experience by the tribal communities. Majority of the food and nutritional requirement of a household in a village is met through this system of cultivation. Therefore it acts as a lifeline for rural people for meeting their livelihood. One of the main reasons why Jhum has been viewed as unsustainable is that, till now very few or no technology has been developed to enhance or

Improved Jhum Practices

Alder Based Jhum practice

Innovative contour bund

assist this system of farming. Rather, it has been portrayed negatively and labelled as destructive and primitive, in spite of the fact that it is practiced in over 10 million hectares in South-East Asia meeting nutritional requirement of almost 400 million farmers of this region.

Land and water are the two critical resources for survival of life and environment protection. Soil erosion is a serious threat to the preservation of quantity and quality of these resources. The root cause of soil erosion stems out from a combination of factors: Agriculture intensification, rolling topography, soil degradation and high rainfall. The problem is more pronounced in hilly and mountainous ecosystem like Nagaland where high amount of runoff and concomitant losses of soil and nutrients result in fast degradation of land resources. This situation is more significant where Jhum system of farming is more prominent. Therefore, this is one of the main reasons why Jhum farmers have to look for fresh forest land for next Jhum causing immense pressure on land and its resources, leading to shortening of Jhum cycle and finally resulting in degraded soil and poor productivity.

Of late, there is a growing realization among the scientific communities that with certain modification in the Jhum system, it can be made more productive and sustainable. A number of innovative technologies have been developed which can well fit in the system and if well-adopted can bring significant increase in production and productivity level of any given crop in a season.

Watershed approach for resource conservation: The concept of soil conservation, of late has been expanded to:

a. Protect soil against physical loss by erosion or excessive loss of fertility either by natural or artificial means.
b. Safeguard the soil depletion by natural or manmade factors
c. Create awareness of resource conservation
d. Develop community based approach for resource conservation and livelihood improvement

The basic principle of watershed is to achieve agricultural development in harmony with nature; it has to be understood that nature does not recognize administrative or political boundary. Earlier, planning was done taking into consideration the manmade boundaries such as district, block or village as a unit for development. But such units are heterogeneous in its resource endowment, therefore optimum utilization of these resources and integration of mutually dependent components are not achieved. Whereas within a watershed boundary, an independent system consisting of dynamic and interrelated physical, social and economic factors exist. Thus the effective conservation and management of land, water and vegetation resources aimed at obtaining optimum and sustained return from these resources without degrading them can be achieved by adopting watershed as a basic unit of development.

In shifting cultivation most of the farm operations are labour-intensive and performed mostly by using small traditional hand tools. Improved hand tools and implements are not used on these areas. Though the existing farm tools suit the existing farming system of this area; the human drudgery, long working hours and low output are the main problems. Drudgery of farming in hilly areas is largely shared by women. Improved tools and implements and partial mechanization will confer definite benefits in terms of increasing efficiency, reducing drudgery and enhancing the economy which will also help attract younger generation to farming.

The Jhum cultivation still depends on availability of manual work and human labour. Introduction of improved technology in Jhum

demands a set of small improved tools and implements which are light weight, energy-efficient and suitable for type of operations being performed in these areas. The advantages of farm mechanization are:

a. Reduced cost of operation
b. Reduced level of drudgery
c. Reduced Time of operation: Mechanization of farming operations help to complete work in time. During the peak farming period, the need to employ extra farm labour are drastically reduced which will help in completion of farm operations in time thereby increasing farm productivity and profitability.
d. Farm mechanization has indirect benefits such as replacement of animate power source, ecological protection and technology movement in the village, promotion of self-employment.

The focus until nineties was on increasing food production. After the advent of World Trade Organization (WTO), there is a sea change in the direction of farming. Hence there is need to change the farming approach from production-led farming system to market-oriented farming system. Farmers, particularly in Nagaland, are not in position to accept farming as a business venture due to various factors including alienation from market information and market hub. There is no risk coverage of their produce and no storage facilities. Credit facilities and suitable investment opportunities are absent and the farmers of the state are still reeling through subsistence farming and revolve around securing household food security. Therefore, there is a need to break the ice by mobilizing resources, including reorienting the agricultural technology transfer to absorb the shock imposed by trade agreements *viz.,* agreement on agriculture, market access and at the same time tapping the resources without causing damage to the natural resources and diversifying agriculture for taking advantages arising out of the multi enterprise and reducing risk.

CLIMATE PROOFING

As far as climate change is concerned, problem is not restricted to Nagaland alone but is spread across the world. Food production, particularly in rain fed conditions, is highly subjected to climate variability. IPCC has projected 2.5-10% decrease in the crop yield in Asia due to climate change by 2020 as compared to 1990 level. Minimum temperatures have gone down over the last 20 years with 80% of soil being found to be deficient and erosion emerging as a big problem. Moreover, farmers experiencing climate change see a decline in rainfall and change in seasons, which affect their cropping pattern adversely. Against this backdrop, agricultural planning in the state has to be tuned accordingly so as the climate change adaptation as regard to crop production and food security is addressed.

In order to double farmers' income, there is need to decrease inputs and opt for value addition, which is far more applicable to Jhum. In fact, it is advisable that different slope areas must opt for different cropping patterns such as water harvesting structures, fisheries and linings to reduce evaporation of water. Accordingly, the two approaches that have been adopted in the Nagaland revolve essentially around the extension of the Jhum cycle to reduce the area deforested annually and the transition to a sedentary and permanent form of agriculture. In recent years, there has been a lot of debate around the relevance of improving Jhum and ensuring its sustainable development so that livelihoods can be preserved.

In recent years, Jhum has come under stress owing to industrialization, impact of climate change, altered land use patterns and a growing disengagement of youth, who are moving to alternate professions. Further, in the absence of effective market linkages and infrastructure, economic conditions of Jhum farmers are deteriorating. These are all causes of immense concern and if remedial steps are not taken, not only will the region's rich biodiversity be under threat but also livelihood opportunities will shrink, hurtling a large part of the population towards abysmal levels of poverty and deprivation. Therefore, use of innovative technology and more research on improving and enhancing our traditional Jhum practice, particularly in our State will help create positive impact on rural livelihood, rural economy and the region's rich biodiversity. ■

Innovative Agriculture Technologies available for Commercialization

NRDC is engaged in the development, promotion and transfer of technologies emanating from various national R&D institutions/universities. The Corporation offers its IPRs and Technology Transfer services in wide ranging areas like: Agriculture, Chemical, Agro & Food processing, Life Sciences, Mechanical, Electrical & Electronics, Energy and Telecom. It acts as an effective catalyst in translating innovative research into marketable industrial products. NRDC has the largest repository of Indian technologies and licensed about 2,500 technologies to more than 4,900 entrepreneurs/start-ups/ corporate in India and abroad. Some Agriculture technologies are available with NRDC for commercialization having great potential in India and Abroad:

- **Extraction of Azadirachtin from Neem Seeds Kernel and its Pesticide formulation**
- **High yielding variety of Ashwagandha**
- **Super Absorbent Hydrogel**
- **Biopesticidal NemaGel**
- **Potassium Humate**
- **Polymeric Seed Coat**
- **Nitrification Inhibitor**
- **Improved Neem Larvicidal Composition**
- **Slow or Controlled Release Mosquito Larvicidal Composition and Process of preparation thereof**
- **Jute-LLDPE Composite Based Tank for Consumer Application**
- **Low Cost Jute Based Sanitary Napkin**
- **Karnataka Rice Hybrid (KRH-4)**
- **Complete package of production of Stevio Glycoside**
- **Tea Leaf Pre-conditioning Machine for Withering**
- **Mobile Essential Oil Distillation Unit**
- **Technology Package for Palm Oil Extraction**
- **Extraction of Banana Fibre from Leaf over Trunk**
- **Automatic Rice Classification and Grading System**
- **Tractor Mounted Soil Conductivity Mapper**
- **Monitoring and Control Systems for Potato Storage**
- **Small Hydraulic Tractor**
- **Krishi Sakti (10 HP Tractor)**
- **Rotary Drum Washer for Ginger and Turmeric**
- **Inter-Row Rotary Cultivator for Wide-Row Crops**
- **Pneumatic Precision Planter for Vegetables**
- **Programmable Irrigation Scheduler**
- **X-ray imaging based Mango Sorting System**
- **Phosphate Rich Organic Manure (PROM)**
- **Coirret - Innoculant for Retting Coconut**
- **Mobile Coir Fibre Extraction Machine**
- **Cashew Nut Processing Unit**
- **Palm Oil Extraction Technology**
- **Cotton Production and Processing Technologies**
- **Biogas and Bio-Manure from Poultry Litter**
- **An Improved Green House Type Solar Dryer**
- **Hybrid Combine Harvester Machine**
- **Pneumatic Precision Planter**

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MAINSTREAMING AGROBIODIVERSITY – THE KEY TO FUTURE-PROOFING OUR FOOD SYSTEMS

OUR COMPLEX FOOD SYSTEMS NEED DISRUPTIVE CHANGE

In today's complex and interconnected world, what we eat and how we produce it are inextricably bound together. A focus on increasing food production without due concern for the environment is causing severe land and water degradation. A focus on addressing hunger without a focus on good nutrition is causing an epidemic of non-communicable diseases. A focus on increasing yields in a few staple food crops is contributing to loss of crop diversity. What we need is to be able to produce a wide variety of nutritious foods while having minimal impact on the environment – in other words, a sustainable food system.

We need to radically transform our food systems. Last year, the High Level Panel of Experts at the 44th Session of the Committee on World Food Security (CFS44) raised the alarm: "Carrying out superficial repairs to our existing food systems will no longer suffice. We need disruptive change within and across today's varied and complex food systems. To be sustainable, food system policy choices must focus on environmental as well as nutritional and health consequences".

This disruptive change needs to include agricultural biodiversity – the variety and variability of animals, plants and micro-organisms that are used for food and agriculture. It is the foundation of sustainable food systems. It boosts total productivity and quality of nutrition in the diet. It reduces risks, increases resilience, soil health and water quality while reducing the need for water, synthetic fertilizers and other costly inputs.

Using and safeguarding agrobiodiversity can help meet multiple Sustainable Development Goals and achieve Biodiversity Targets.

A GLOBAL NUTRITION PROBLEM

Poor diets are now the world's number one health risk. Two billion people on the planet lack vital vitamins and minerals such as vitamin

A and iron. Two billion people are obese or overweight. Eighty-eight percent of countries face two or three serious malnutrition challenges.

Higher incomes, urbanization, a growing population and changing dietary patterns are driving intensified demand for increased production of food. This puts pressure on natural resources, and leads to high and volatile prices for commodities (rice, wheat, maize, soy, meat, oils, dairy and sugar), exacerbated by growing demand for more homogenous Western diets and for processed convenience foods.

One major contributing factor to the malnutrition problem is that over the last century, our diets have simplified.On the one hand, within each individual country, there has never been so much choice. For example, formal supermarkets in countries around the world offer avocado, quinoa and kiwi, which were not available 15 years ago. However, diets from one country to another are actually becoming more similar to each other, converging towards a Westernized diet based on major cereal crops, such as rice, wheat and maize, as well as sugar and oil. These crops increasingly dominate our agricultural production and therefore global food supplies. Sustained investment in producing more high-yielding starchy staples has led to a situation where of the over 5,000 plant species documented as human food, only three – rice, wheat and maize – provide half the world's plant-derived calories.

In addition, whilst a diversity of vegetables exists in traditional food systems, many are poorly integrated in current markets and diets, and receive little attention from research and conservation initiatives.

MAINSTREAMING AGROBIODIVERSITY FOR SUSTAINABLE FOOD SYSTEMS

Agrobiodiversity provides tens of thousands of alternative crops that can substitute and complement these staples and provide diverse, high-quality diets all year round. Sorghum, millets and quinoa are examples of cereals that can grow in difficult environments, have high nutrient content and have potential to increase their yields. Diversifying diets through a greater use of often overlooked varieties of wild and domesticated fruits and vegetables can also provide missing nutrient needs – camu camu, a wild fruit from the Amazon has 35 times vitamin C than oranges.

THE CASE OF MAINSTREAMING MILLETS IN INDIA

For the last 15 years, Bioversity International has been working with partners such as the M.S. Swaminathan Foundation, to promote India's rich agricultural biodiversity resources, for example, millets – once a strong part of traditional diets in Southern India.

Millets are genetically diverse and adapted to a range of marginal growing conditions where grains such as wheat and rice are unsuc-

cessful. They mature quickly, are able to withstand climatic stress, and grow in a variety of soils. As they are high in a range of micronutrients, including calcium, iron and dietary fibre, millets offer a better balance of essential amino acids, and are therefore a more usable protein than wheat, rice and maize.

Linking millets to markets, for example through school meal procurement programmes, has given incentives to farmers to grow them. Thanks to access to improved millet varieties, yields have increased by as much as 77%, with a corresponding increase in net income of up to 50%. Increased markets for small-scale producers have seen restaurants adding millet-based dishes, and women producing millet-based snacks, which have led to increased consumption and demand. One study showed that school children eating millets for lunch had up to 37% higher levels of haemoglobin over students eating white rice.

India created an unprecedented opportunity to promote these highly nutritious and climate resilient crops by including millets in the Public Distribution System through the 2013 National Food Security Act.

In 2016, India hosted the first International Agrobiodiversity Congress, putting agrobiodiversity onto the world stage. Nine hundred delegates from 60 countries unanimously adopted the Delhi Declaration on Agrobiodiversity Management, which called for urgent action to mainstream agricultural biodiversity for sustainable development which Narendra Modi, the Prime Minister of India, described as "a treasure of valuable agrobiodiversity that we have not explored scientifically yet."

AGROBIODIVERSITY FOR SUSTAINABLE PRODUCTION

The simplification of the world's farming and food systems leaves farmers with a decreasing range of

resources to draw on to manage threats such as the risks of crop failure due to pests and diseases, declining soil fertility, or the impacts associated with increasing climatic variability. In order to address these and many other issues, sustainable practices are needed, and agricultural biodiversity is a key component of this. Scientific evidence and long-term experiments are revealing the complex dynamics of diversified systems and the multiple benefits both from biodiversity to agriculture and from agriculture to biodiversity.

Pests and diseases are a constant issue for farmers, and one of the major causes of crop loss. When crop diversity is reduced, the chances of crop pest and disease outbreaks increases. However, high levels of agrobiodiversity can help suppress or reduce pest and disease frequency and intensity.

For instance, increasing the number of crop varieties or crop species in a field or farm (e.g. through intercropping, rotation or diversification at the field scale) can reduce the chances of pests finding the target crop plants, reduce movement of pests, increase the numbers and diversity of predators and parasites that prey upon pests, and decrease the mobility of pests. All of these can lead to reduced damage to crops.

Agrobiodiversity can have beneficial effects on soil function. Planting several species (such as mixtures of grass and legume species) can increase soil nitrogen (which in turn can reduce the need for costly inorganic fertilizers), reduce weed invasion through increased soil cover, lead to higher moisture retention in the soil, stabilize the soil (thus reducing erosion), and increase soil biodiversity and the many useful

ecological functions associated with that (e.g. nutrient cycling).

Agrobiodiversity can also be beneficial for wild biodiversity. Farms with high agrobiodiversity tend to be more complex and therefore provide habitat and resources for wild species. Also, because agricultural biodiversity can help suppress pests and diseases, and provide natural soil fertility, this can reduce the need for agrochemical application, which can in turn reduce the impact on adjacent native vegetation, such as forests and wetlands. This can have positive feedback, with increased wild biodiversity leading to increased pollination rates.

All these examples show that managing farming systems sustainably means that agriculture needs to be about much more than yields of commodity crops in highly simplified and specialized landscapes. Agrobiodiversity must be included in sustainable production discourse, policy and management. There is also an urgent need to improve how we measure agrobiodiversity and its impacts, and how it can best be integrated into a range of farming systems.

AN AGROBIODIVERSITY INDEX TO MEASURE PROGRESS

Few decision-makers – governments, investors and companies – have well-developed policies to mainstream agrobiodiversity in food systems. In a review of 119 National Biodiversity Strategies and Action Plans, only 30% include detailed actions for agrobiodiversity conservation and use.

While agrobiodiversity potential benefits are multiple, mainstreaming agricultural biodiversity in food systems is a complex endeavor. It requires a systems approach and requires new ways of cross-sectoral working. Another crucial element for successful mainstreaming is having a standard way of assessing and tracking agrobiodiversity in sustainable food systems.

This need was also highlighted by the Delhi Declaration on Agrobiodiversity Management, which called for "an agrobiodiversity index to help monitor conservation and use of agrobiodiversity."

Bioversity International, with a wide range of partners, is developing such an 'Agrobiodiversity Index' to help governments, investors and companies to measure agrobiodiversity and identify concrete actions to achieve diverse and sustainable food systems.

The Agrobiodiversity Index will contribute to sustainability through three pillars:

1. Diets and markets. The Index will monitor and measure to what extent and how companies, countries and projects contribute to ensure food biodiversity for healthy diets.
2. Production systems. The Index will monitor and measure to what extent and how companies, countries and projects contribute to agrobiodiversity for sustainable production.
3. Genetic resources. The Index will monitor and measure to what extent and how companies, countries and projects contribute to diverse genetic resources for current and future options.

With informed measurements, governments, investors and companies can compare strategies to select those that will deliver more sustainable, more nutritious food systems, built on agrobiodiversity. The Agrobiodiversity Index will track how agrobiodiversity contributes to meeting the many interconnected global targets to which countries have committed themselves.

THE AGROBIODIVERSITY INDEX MEASURES:

- Status – Provides the current state of agrobiodiversity using 7 indicators that measure diversity of crops, crop wild relatives, fish, livestock and pollinators at different levels (varietal and genetic, species, farm, landscape, ecosystem).
- Commitments – Using 21 indicators, assesses the level of commitment towards an agrobiodiversity outcome (e.g. maintaining livestock varietal diversity) in publicly available strategies, policies, declarations, guidelines for the country, company or project under review.
- Actions – Using 5 indicators, monitors policies, investments and practices at the institutional, production or market level that support biodiversity in food and agriculture.

These three levels of measurement will provide each country, company or project, scores for the use and conservation of agrobiodiversity that will be displayed as maps and graphs on an interactive portal, along with a short summary of how performance compares with other countries, companies or projects.

The Agrobiodiversity Index will allow clear, evidence-based decisions that favour the conservation and use of agricultural biodiversity, which in turn is essential to improve food and nutrition security, to boost human well-being and to safeguard the environment. ■

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DOUBLING FARMERS' INCOME

FARMERS AND MARKETS: HOW TO MOVE TOWARDS A MORE OPEN MARKET?

H.E. Marten van den Berg
Ambassadorof Kingdom of the Netherlands

India's agro and food future looks bright. The main reasons are domestic, as the consuming middle class is pursuing more healthy diet. Therefore investments are up, technology flows in and commodity prices are much more aligned with international market prices. The government targets a double of farmers' income. So will we have a third agricultural (r)evolution after the green revolution in the 1960s and 1970s and the white revolution after that? And if so, how will this consumer led (r)evolution affect the relationship between farmer and market?

Why do I talk about an (r)evolution? Because this time most of the developments will be depending on the purchasing power of the growing Indian middle class? As there is some macro-economic uncertainty worldwide, to a large extent linked to trade policy differences, it seems wise to project an evolution instead of a revolution for the development of the Indian economy in general and the middle class and its move to a more healthy diet, in particular.

While big steps have been taken already in opening up and modernizing the various agro & food markets, there remains a lot to be done. Just one example: 93% of poultry meat is still traded via so called wet markets, while only 7% is traded as processed –*i.e.*, more expensive and more food safe- poultry meat.

SO HOW DOES THE INDIAN AGRO & FOOD SECTOR LOOK FROM THE OUTSIDE?

In a recent joint study by the OECD (Organization for Economic Cooperation and Development) and ICRIER (Indian Council for Research on International Economic Relations) on Agricultural Policies in India, the authors occasionally allow themselves to express some emotion; like when they speak about "correcting the perverse incentives to continue to produce water-intensive crops" (p. 45). Similarly "there is a fundamental difficulty in trying to keep prices low for consumers while ensuring remunerative returns to farmers" (p. 54); subsidizing both producers and consumers is not only costly to the state and the taxpayer, it also gives contradictory market signals. Of course, it keeps numerous stakeholders relatively happy; but it

does not indicate a direction that will be viable in the long term.

So what to do? The OECD/ICRIER study gives a broad policy package and proposes to work towards:

- Supportive and predictable macro-economic and structural policy settings and not exclusively sector-specific interventions
- Coordination towards a common vision
- Changing the focus of policies for the agro and food sector, paying particular attention to the political economy involved
- Spending more on investments and on knowledge transfer to increase resilience and sustainability
- More open markets, both domestically and internationally; predictable policies as well

So how likely is it that the Centre, the Federal States, private sector, cooperatives etc., will be able to work together to implement these or part of these recommendations?

There are quite a few encouraging signs:

- the state government of Telangana has started a pilot to give direct money transfers to farmers, not related to the volume or price of their crop
- a number of Federal States are actively promoting technical vocational education and training (TVET) in the agro and food sector, targeting smallholders
- Indian companies are investing, followed more and more by foreign investors

Netherlands with its deep experience of being in the middle of value chain for most of commodities in the agro – food sector has worked closely with Indian organizations to enable them in being part of the global value chain. This is mostly true for in the propagation and planting

material side. Dutch companies with their strength in research and development in the seed sector work with Indian companies, where seeds are imported from the Netherlands and then through a process of tissue culture, plants are propagated. The saplings are then exported to around 80 countries globally. The companies KF Bioplants and Rise & Shine are just two examples. When it comes to seed potatoes, one of the Dutch seed potato companies has tied up with an Indian company to export seed potatoes to countries in South Asia region.

Grape is another story where Dutch retailers have become the largest importers of grapes from India in value terms. Having established strong trade links with the Netherlands, grape exporters and farmers have also learnt on how to set-up new markets for global trade.

(However India's high import tariff for food products and food ingredients discourage companies from first doing trade with India and then establishing a production center in India. If more Dutch companies are allowed to trade with India, then there are enough opportunities for India agro – food sector to participate in the regional and global value chains.)

In India, private investment in market infrastructure depends on two factors (i) public investment in infrastructure like road connectivity and electricity and (ii) strong market linkage. The Dutch government program, Partners for International Business (PIB) targets,clusters of Dutch SME companies working together on international markets in sectors like potato, fruits, vegetables and dairy and finding foreign partners including Indian companies. The main objective is to enable them to jointly invest in market infrastructure like cold storages, building up of handling, grading and sorting facilities.

The Food Safety and Standards Authority of India (FSSAI) and its Dutch counterpart Netherlands Food and Consumer Product Safety Authority (NVWA) already have been teaming up for a number of years. With consumers worldwide becoming more health conscious and more risk averse, their work is not only beneficial to food safety but also has the potential to increase international trade. Their efforts therefore should be strengthened.

To conclude, let us provide the right conditions for farmers to reach markets, for farmers to become entrepreneurs, for entrepreneurs to reach consumers. That would imply a third (R)evolution for the agro & food sector in India. ■

Martien Van Nieuwkoop
Director, Agriculture Global Practice, World Bank Group

INDIAN AGRICULTURE AT A CROSSROAD: SMART SOLUTIONS TOWARDS DOUBLING FARMERS' INCOMES

Over the past six decades, India has come a long way from being a famine-prone country to comfortably producing food for 1.25 billion people from finite arable land. Food security firmly in hand, the government is now targeting to double farmers' incomes by 2022. Today, with rapidly growing urban food markets, India is emerging as a global agricultural powerhouse.

At the same time, the comprehensive strategy put in place decades ago to usher in the Green Revolution is inadvertently fostering a "perfect storm". India is now confronted with the deadly troika of resource degradation, as well as water and air pollution. Given India's high vulnerability to climate change, these conditions threaten the future sustainability of its food production, the very objective that this bold strategy sought to achieve.

The northern states of Punjab and Haryana, which spearheaded India's food security, now face multiple environmental problems. Their resource intensive system of rice-wheat production has led to the over-extraction of groundwater, and their imbalanced use of fertilizers has added to soil and water contamination. Recently, the widespread burning of crop residues and its contribution to severe air pollution has attracted both national and global attention. The continuing public procurement of rice and wheat, together with subsidies for fertilizer and energy, and other dis-incentives to use water efficiently - all in the face of a changing climate - have put these states in the eye of a "perfect storm".

All the above echoes the need for urgent policy action towards a "paradigm shift" to put Indian agriculture on a more resource efficient and resilient path.

WHAT DOES THIS PARADIGM SHIFT WOULD LOOK LIKE?

First, measures to conserve natural resources, make agriculture climate-resilient, and reduce agricultural pollution must safeguard farmer welfare and contribute to doubling farmers' incomes. For states such as Punjab and Haryana which are at, or near, the production frontier for cereals, the priority is to shift to high-value agriculture and value addition.

Simultaneously, to maintain the country's food security, public procurement policy will need to be geographically reoriented to areas that are ecologically suited for the cultivation of these staples. The need for such realignment has long been recognized. The country's current push for "doubling farmer incomes" provides an opportunity to finally make this happen.

Second, technical solutions for conservation and climate-resilient agriculture are readily available. But more effort must be put into making sure that they are widely adopted. Leaders of farmers' associations reminded us that for farmers to embrace eco-friendly technologies, they need to see results on the ground quickly and, to do so, they need the right knowledge and incentives. Thus, to see real impact, any solutions that we offer to farmers must be sensible as well as scalable. On this, the World Bank has initiated new climate smart agriculture projects in several States (Maharashtra, Andhra Pradesh, Tamil Nadu, and Assam). These projects focus on providing locally-adapted support packages that promote diversification, make extension and knowledge transfer systems more effective, introduce ICT innovations and climate-smart technologies, as well as support enterprise-based models of value chains. They also promote higher value-addition through improved storage, packaging and processing.

Third, there is a need to revisit current policies so that appropriate incentives are provided to farmers to make the right choices on what to produce and how to produce it. To this effect, the distorting effects of water, energy and input subsidies, and price support for rice and wheat are widely acknowledged. It is now time to consider how the support provided to farmers can be redirected to transform the vicious circle of resource degradation into a virtuous circle of rapid and sustainable income growth. On this, India can draw upon lessons from countries that have walked this path before. In the European Union, for instance, the switch from coupled subsidies (earmarked for specific crops and distorted input prices) towards decoupled (income) support has resulted in better environmental stewardship and higher farm incomes.

Today, Indian agriculture stands at a crossroads. Inaction is not an option. The challenges are multifaceted, but at the same time, smart solutions are available that have the potential to generate triple-wins, that is, increase productivity, enhance climate resilience, and make agriculture climate-smart by reducing damaging emissions. These solutions can be deployed at scale if current farmer support programs are fully aligned with the government's target to double farmers' incomes. As at the time of the Green Revolution, taking India's food system forward will require bold decisions. Now is the time to take them. ■

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ROADMAP TO DOUBLE FARMERS' INCOME

When we talk about agriculture, it means different things to different sections of the society. For the government it is often about food security, for consumers it is about availability of food items at reasonable prices, for industry it means a source of raw materials as well as a buyer of agricultural inputs, but for more than 600 million people of the country it is a source of livelihood. With about half of our country dependent on agricultural income, this aspect needs some serious attention. It is more so because over the last several decades, the terms of trade have become unfavourable and a typical farmer's income is approximately one third of the non-farmer. Therefore, the rightly envisioned call given by the Hon. Prime Minister to double farmers' income by the year 2022 is critical for the well-being of the nation. There are no simple answers to the obstacles faced by the agriculture sector, and action is required on several fronts.

ROADMAP FOR DOUBLING FARMERS' INCOME

SOIL HEALTH MANAGEMENT

Compost techniques viz. NADEP, INDORE etc should be encouraged at village level to convert organic waste into good quality organic manure which also helps in sanitization. Crop residue management *insitu* should be facilitated by providing farm implements. Training programme to dairy farmers for making vermin compost/ vermiwash and other natural organic products should be provided. There is a high need to advocate fertigation and strengthen the soil health card programmme. There is a need to produce good quality micronutrient fertilizers and promotion of biofertilizers. The soil sampling must be based on scientific method and should be constantly monitored and results must be cross-checked. Soil Testing Laboratory should recruit at least one B.Sc. (Agri.) employee to look after soil analysis activities and provide proper recommendation to farmers.

Farmers should follow zero tillage or need based minimum tillage and use low cost bio inputs like organic manures, recycling of farm wastes, bio fertilizers, bio-degraders, vermicompost, green manuring etc. Seed treatment or need based foliar application of micronutrient and water soluble fertilizers instead of blanket soil application of bulk granular fertilizers.

SELECTION OF SEED AND PLANTING MATERIALS

The Government may consider an option of Contract Seed Production by advance indenting of the seed of desired improved varieties/hybrids to both public/private sector seed companies.

Promotion of hybrids/HYVs in major field crops should be given high priority and the seed sector could also consider

joining hands with other players in the agri-input. All quality assured seeds must qualify for seed subsidy. Subsidies need to be linked to promote area coverage under new HYVs and hybrids. Regional Seed Banks need to be established as a contingency measure. Modern Seed Processing and Storage Facilities both by the public/private sector, on a fixed charge basis need to be established. Supply chain of tissue culture raised saplings must be strengthened. Local and inferior quality seeds should be replaced with high quality seeds, and for that the "seed village program" needs a focused attention. Seed storage facility should be created at village level through FPO or other pertinent groups.

Establishment of nursery infrastructure for mass multiplication of varieties apart from root stock should be established at Taluka level.

Farmers should adopt area specific new high yielding varieties/ hybrids and participate in seed production/seed village programme for high value and low volume seeds of vegetable crops.

Commodity interest group for participatory seed production programs and establishment of region specific farmer's participatory seed banks should be established. Conservation of land races and traditional varieties and registration as Farmers varieties to PPV & FR authority should be emphasized.

WATER MANAGEMENT

More emphasis should be given to adoption of micro irrigation system. Mulching and technologies that enable and guide the farmers for site specific and crop specific water management need to popularized. Encourage use of information technologies, particularly mobile

as a tool of "On the Spot" decision making for water management. Higher water demanding crops like sugarcane and banana must be irrigated through drip system only. Crop like paddy should be promoted to cultivate through SRI; wherever possible. Deepening and renovation of existing farm ponds and village ponds and farm bunding system and pukka outlet to be promoted to retain farm water in farm itself. Capacity building programmes on *in-situ* and *ex-situ* rain water harvesting measures and agronomical interventions must be intensively executed.

WEED MANAGEMENT

Prerequisite slat fan nozzle for herbicide spray along with Holo cone nozzle with new sprayer pump at selling point should be made compulsory for industries/ manufacturers of sprayer pumps to achieve higher herbicide use efficiency. More emphasis should be given on farmers training/awareness programme for integrated weed management to minimize crop yield losses due to heavy weed infestation. Farmers should be encouraged to keep their field weed free during critical period of Crop-Weed Competition and Integrated Weed Management strategies must be recommended.

PLANT HEALTH MANAGEMENT

Central diagnostic laboratories and plant health clinic at district/regional level and more effective insect pest and disease surveillance and expert systems should be developed. A balanced look for reorientation of research priorities is needed with emphasis on generating data for pest risk analysis (PRA) with respect to all important pest. National standards for survey, surveillance and pest free areas (PFA)need to be developed.

Mass multiplication of biopesticides at farmer's level and creation of the association- "Honey producing farmers, Mushroom growers," for exchange of knowledge and doubling the income of the farmers would be much welcome. Value addition of mushrooms by effective processing techniques to minimize post-harvest losses and fetching higher returns is another possible venue for doubling farmers' income. Creation of Mushroom Development Board (MDB) like Coffee Board and Coir Board for promotion of mushroom processing and marketing industry in India will also be welcome.

HORTICULTURE

Providing quality planting materials of fruit crops and flower crops, promoting tissue culture plants and establishing tissue culture labs, adopting hitech production technology such as HDP, canopy management, mulching, fertigation, IPDM, INM etc., promoting greenhouse/polyhouse cultivation for off season cultivation, rejuvenation of old and senile fruit orchards, promotion for integrated crop cultivation, intercropping, multi-storey plantation and multiple variety cultivation, Including the spices and condiment crops in integrated cropping system, value addition of local flowers, promotion of medicinal and aromatic plantation through contractual farming and intervention of agro and farm forestry in farm as border plantation are suitable measures to increase incomes from horticulture sector.

FARM MECHANIZATION

Adoption of reduced/minimum tillage, deep ploughing, raised bed planting techniques, precision agriculture technologies and more emphasis on mechanization of operations like transplanting, weeding, harvesting of horticultural and vegetable crops can save in input costs. Promotion of local manufacturers/artisans, establishment of more number of testing centers and generation of trained manpower for operation, repair and maintenance of farm implements are necessary. Creation of regional centers of agricultural mechanization and promotion of custom hiring centers help in promoting agricultural mechanization.

Adoption of weeding equipments can save 10-20% input cost. Similarly, adoption of mini tractor drawn semi automatic potato planter can save about 40% cost of potato planting as compared to medium size tractor operated planter and adoption of paddy transplanter can reducein10-20% input cost as compared to manual transplanting

POST-HARVEST MANAGEMENT AND VALUE ADDITION

Establishment of Minimal Processing Centers at village level in the production catchment, taluka level cold chains and rural godowns helps in storing excess production and control low market price. Establishing primary processing centres close to the farms and linking them with clusters through hub and spoke models are important. Empowering farmers with knowledge on price forecasting, high price period, best priced market, quality parameters, pre & post-harvest technologies and value addition for different agricultural commodities and export opportunities for doubling their income through Market-led Agriculture are also critical. The role of biotechnology in post- harvest management and value addition deserves to be enhanced.

Farmers need to be educated on the available schemes of the Government. More multi purpose market yard complexes, comprising of godowns, warehouses, cold storages, farmers service centres etc. needs to be setup for farmers to directly participate. Women can be considered to be a valuable resource and need to be organized and should be recognized in the field of entrepreneurship. Making effective changes in the approach of APMCs in dealing with farmers, particularly on perishable commodities, especially auction system through legislative/ administrative orders coupled with appropriate investment in PHM. The APMC licensing should be liberalised for farmer groups, Agri Startups, FPOs and other entities.

Farmers should adopt modern post-harvest handling, storage, packaging, handling and transport systems to reduce the post-harvest losses, there by increasing availability of farm produce by 20-40%, to generate additional income. Famers should adopt appropriate agro processing and value addition technologies including those developed by state agricultural universities, such as grain cleaners, fruit graders, pulpers, dryers, etc. to get higher monetary benefits.

LIVESTOCK AND POULTRY PRODUCTION

Majority of farmers keep one or more categories of animals-cattle, buffalo, goat or poultry to get supplementary income. Income from animals is proportionately higher for small land holders. Major areas to increase income from animal husbandry are:

- Nutritional intervention
- Reproductive intervention
- Disease control
- Climate resilient housing and management
- Poultry farming

NUTRITIONAL INTERVENTION

Establishment of efficient plant for production of Total Mixed Rations and Ration balancing should be done. Area specific chelated mineral mixture should be produced in adequate quantities and added in the ration of livestock. Popularizing of feeding by pass fat and by pass protein during last one month of pregnancy and first two months of lactation in cows and buffalo can

increase milk yield. Small scale silage making in plastic bags in lots of 500 to 1000 kg should be encouraged.

REPRODUCTIVE INTERVENTION

Farmers should encouraged to rearindigenous cattle and upgrade non descript animals using semen of high genetic merit bulls of indigenous breeds. AI coverage should be increased among local breeds and measures to encourage estrus synchronization (using reproductive hormones) with fixed time AI and early accurate pregnancy diagnosis (by 40-42 days) by which 50-60% infertile animals can be made pregnant. The INAPH (Information Network for Animal Productivity and Health) field data recording network be expanded to cover the indigenous breeds in the entire state to conserve and propagate the local breeds.

DISEASE CONTROL

State level projects on mastitis control and clean milk production should be launched. Special drive for deworming and vaccination against major diseases at regular interval should be taken up on mass scale. Diagnostic services need to be improved by strengthening existing disease diagnostic laboratories.

CLIMATE RESILIENT HOUSING AND MANAGEMENT

Measures to provide animal shelters as per BIS specification using locally available materials should be taken to minimize heat stress and sustain production. The shed should have pakka manger so as to avoid wastage of feed due to spillage. Measures to create awareness regarding summer management (nightfeeding, proper housing, provision of adequate water) which prevents drop in production by about 10%

POULTRY FARMING

Government should promote replacement of desi type birds (production potential of 50-60eggs/ annum) reared by rural poultry farmers with the improved strains/

breeds developed by ICAR and state agricultural universities (production potential of 160-170 eggs). Flock strength should also be increased upto 50-100 birds and reared under semi- intensive system. Measures to encourage supplementary feeding to the improved chicken varieties with locally available cereals and 100% effective vaccination programme against major diseases for proper health care will result in around 25% increase in income of farmer. Mother units for rearing of chicks up to 4-6 weeks of age must be established for easing management, reducing mortality and enhancing the acceptability by the rural farmers.

INTEGRATED FARMING SYSTEM: DEVELOPMENT THROUGH DIVERSIFICATION

Diversification, intensification of cropping, Solar Farming and GOCHARI and and other cultivable waste land should be brought under cultivation is recommended to double the income of the farmers.

AGRICULTURAL PRODUCE MARKETING

Given the success of AMUL in Gujarat, it may be asked to expand its business in crop sector, particularly in fruits and vegetables. Awareness among farmers for e-NAM needs to be increased. Farmers' should do sorting, grading and simple packaging at farm level. Farmers' should get registered under e-NAM in an APMC. Farmers should sell their produce through nearest farmers' market *(khedutbazar)* and should get united through cooperatives Quality control, logistics and auction need to be performed only by the independent third parties at the APMCs. Permanent places should be given to the farmers for direct marketing at urban and peri-urban centers.

ICT-ENABLED AGRICULTURAL INFORMATION SERVICES NETWORK

Dissemination of Agricultural Commodity Price Information, Weather Information and other Farm Advisories to subscribed farmers; Aggregation of agricultural information repository; Providing a web based and video based Agricultural support desk; Enrolment of buyers in key markets; Enrolment of agricultural input providers, Logistics services support providers and Banks & Insurers; Establishment of a robust IT enabled platform; Creation of a responsive farmer community; Application of mobile technology and increase the use of social media in extension activities and for expanding the extension activities are some of the important measures.

The proposed strategy and roadmap would help to double the farmers' income if implemented in true spirit by all the stake holders at all the levels. ■

RURAL NONFARM EMPLOYMENT AND POVERTY IN INDIA

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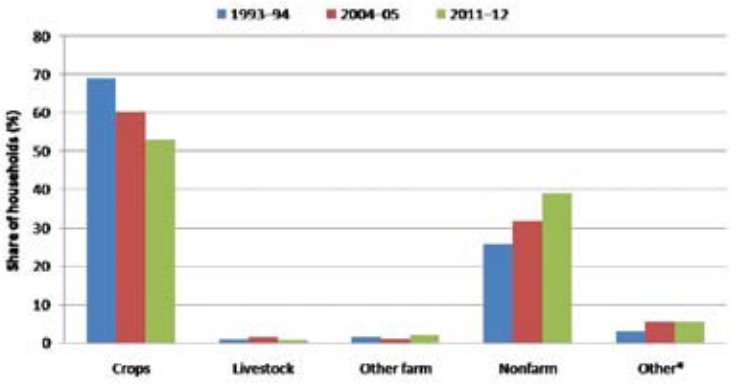
Agriculture has played a significant role in India's economic development as still majority of people are dependent on it for their livelihood. The sector provides employment to over half of the workforce. This share, however, has been falling consistently over the years mainly due to occupational diversification from farm to the nonfarm sector. Estimates suggest that the share of the workforce in agriculture shrank from 70 percent in 1951 to 52 percent by 2011. This contrasts with the fall in agriculture's share in GDP from nearly 55 percent to less than 15 percent during the same period.

Technological progress and urbanization on the one hand, and emerging rural distress due to lack of opportunities in the farm sector on the otherhand, have been instrumental behind the growth of rural nonfarm employment (RNFE) in India. Diversification of India's rural economy towards non farm sector gained momentum during the past three decades. Earlier, the share of the non farm sector in rural income increased from 35 percent in 1980–81 to 62 percent in 2004–05. Similarly, the share of RNFE in total rural employment increased from 22.3 percent in 1983-84 to 31.5 percent in 2004–05. By 2011–12, this share rose to 38 percent. The expansion of non farm sector has thus brought to the fore several research and policy questions as follows such as (a) Whether the farm and non farm sectors are complementary or substitutable from a development perspective? (b) Whether this transformation is neutral to scale and status? and (d) Is this transformation effective in reducing poverty. This paper highlights some of these issues in the following sections.

RURAL EMPLOYMENT DIVERSIFICATION: GENERAL TRENDS AND PATTERNS

In 1993–94, over 68 percent households were dependent on crop husbandry; this share declined to 60.3 percent by 2004–05, and further to 53 percent by 2011–12. In case of livestock, the share increased from 0.90 percent to 1.45 percent during the first period (1993–94 to 2004–05), followed by a decline to 0.60 percent by 2011–12. The share of households that reported

CHANGES IN PROFILE OF RURAL HOUSEHOLDS BASED ON THEIR PRINCIPAL INDUSTRY OF ACTIVITY, 1993–94 TO 2011–12



**Denotes the households that have not reported any particular principal activity as a source of income.*
Source: Authors' calculation based on NSSO data.

"other farm" as their principal industry of activity increased from 1.5 percent in 1993–94 to 2 percent by 2011–12, though with a slight dip to 1.12 percent in 2004–05. This transformation underscores the emergence of the non farm as a crucial sector for a sizable number of household sas a primary source of livelihood. However, the pace and pattern of non-farm diversification is not similar across different categories of households.

The participation of households in rural non-farm employment depicts a positive relationship with income. We observe an increase in employment in the non farm sector on moving from lower quintile groups to higher ones, in any year. This is because poorer households tend to concentrate more on lower-pay, freer-entry agricultural labor market and less on unskilled, labor-intensive non agricultural wage employment as well as non farm self-employment. The upshot is that employment diversification over time has been uniform across income (expenditure) profile of the people, though the effect diminishes with increase in income.

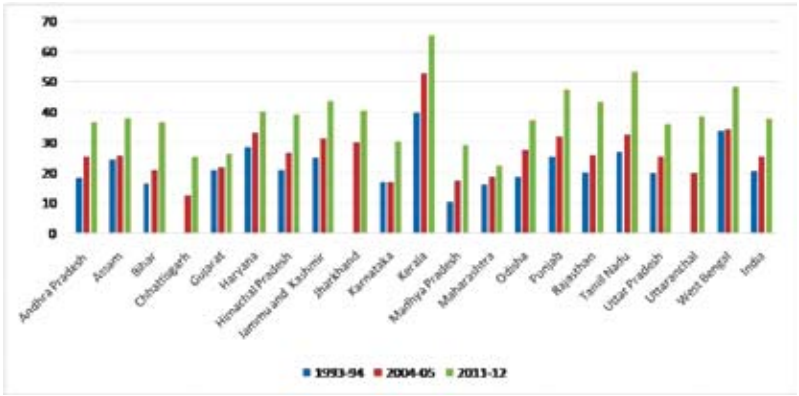
The trends of employment participation across farm-size groups exhibit a very important relationship; smaller farmers are more inclined to employment in the non farm sector. The non farm participation rate of the sub marginal farm group is 48.7 percent in 2011–12, while that of the large farm class was merely 16.1 percent. The general trend of farm to non farm diversification in employment is pervasive across farm-size classes, akin to the pattern across quintile groups based on expenditure. Notably, employment participation in nonfarm sector increases considerably in all farm-size categories, the most striking being in the case of large farm class (89.4 percent), followed by sub marginal class (70.3 percent) reflecting a unique bipolarity.

The share of non-farm sector in providing employment has been growing across all the states. But the pace and pattern of RNFE depicts stark inter-state variations. In 2011–12, the states with a high share of farm

CHANGES IN EMPLOYMENT PARTICIPATION RATE (USUAL STATUS) BY SECTORS IN RURAL INDIA ACROSS EXPENDITURE QUINTILES, 1993–94 TO 2011–12

Employment participation rate (%)—Usual Status							
Household expenditure categories	1993–94	2011–12	Change, % (1993–94 to 2011–12)	Farm-size categories	1993–94	2011–12	Change, % (1993–94 to 2011–12)
Lowest quintile	14.5	33.9	133.8	Sub marginal (<0.5 ha)	28.6	48.7	70.3
Second quintile	18.4	36.4	97.8	Marginal (0.5–1.0 ha)	15.0	24.6	64.0
Third quintile	20.9	37.2	78.0	Small (1.0–2.0 ha)	11.8	18.8	59.3
Fourth Quintile	23.4	39.7	69.7	Medium (2.0–4.0 ha)	9.6	16.0	66.7
Highest quintile	29.8	45.0	51.0	Large (>4.0 ha)	8.5	16.1	89.4

Source: Authors' calculation based on NSSO data.



Trends in share of non-farm sector in rural employment

employment included Maharashtra (77.8 percent), Chhattisgarh (74.7 percent), Gujarat (73.8 percent), and Madhya Pradesh (70.9 percent). On the other hand, states like Kerala (34.9 percent), and Tamil Nadu (47.0 percent) were characterized by low farm sector employment. The pace of non farm diversification is most remarkable in states like Bihar, Madhya Pradesh, Odisha and Rajasthan. In these states, the share of non farm employment increased by more than 100 percent during the reference period.

DISAGGREGATED PATTERNS WITHIN THE NON FARM SECTOR

The disaggregated patterns within the non-farm sector reveal different trends over time. In 1993–94, the manufacturing subsector witnessed the highest participation (32.2 percent); followed by community, social, and personal activities (24.3 percent); trade and hospitality (20.2 percent); construction (11.4 percent). In contrast, electricity and water subsector employed the least number, with only 0.9 percent share.

By 2004–05, the share of manufacturing declined to 28.8 percent, whereas the share of community, social, and personal services declined to 15.7 percent. Mining lost its share marginally, while the share of electricity and water narrowed further to 0.5 percent. On the other hand, the share of construction grew considerably to 20 percent, while the share of trade and hospitality; transport, storage, and communication; finance, real estate, insurance, and others increased by narrow margins.

By 2011–12, the sectoral shares of employment changed

EMPLOYMENT PARTICIPATION RATE (USUAL STATUS) IN NONFARM SECTOR BY ITS SUBSECTORS IN RURAL INDIA, 1993–94 TO 2011–12

Sector	Employment participation rate (%)—Usual Status			Change, % (1993–94 to 2011–12)
	1993–94	2004–05	2011–12	
Mining	2.9	2.0	1.1	-62.1
Manufacturing	32.2	28.8	20.9	-35.1
Electricity and water	0.9	0.5	0.5	-44.4
Construction	11.4	20.0	39.9	250.0
Trade and hospitality	20.2	22.5	15.8	-21.8
Transport, storage, and communication	6.7	8.8	7.2	7.5
Financing, real estate, insurance, and others	1.4	1.8	1.0	-28.6
Community, social, and personal	24.3	15.7	13.5	44.4

Source: Authors' calculation based on NSSO data.

drastically with notable gain for the construction subsector; it expanded significantly to 40 percent, a 250 percent increase relative to 1993-94. Construction sector employment expanded during 2004–05 to 2011–12. Except transport, storage, and communication, which gained by 7.5 percent, all other subsectors depict decline in their employment participation rates in relation to the base-year.

The above findings conform the casualization of workforce and marginalization of employment as indicated in some other studies. In general, the households belonging to lower quintile groups exhibit greater gains in employment share in the construction sector over other subsectors during 1993–94 to 2011–12. Similarly, resource-poor households are more likely to move from service sectors and other secondary sectors to the construction sector.

RURAL NON-FARM EMPLOYMENT AND POVERTY IN INDIA

Rural poverty decline in India from the mid-1960s to mid-1980s was strongly associated with agricultural growth, particularly due to Green Revolution. Post-1980s, government intervention to bring about economic growth has shifted focus and tried to become more broad-based. An important objective of development planning in the 1980s and thereafter has been to create employment opportunities in the rural nonfarm sector. The employment growth strategies emphasized public investment in rural areas to absorb both disguised unemployed in the agricultural sector as well as unemployed rural youth. Technical and financial assistance, low-interest bank loans, provision of tools, and training programs were extended and expanded to encourage self-employment for educated youths. Large-scale employment was created in sectors such as construction, agro-processing, and rural services for both skilled and unskilled labour. The RNFE diversification seems to have made a dent on poverty reduction.

Evidence from several developing countries suggests that diversification toward non farm activities has considerable potential to augment income and reduce poverty. RNFE diversification overcomes land constraints (particularly relevant for India), enables farmers to cope better with income shocks in agriculture, and improves their capacity to invest. At a macro level, a growing rural non farm economy can absorb surplus labor, slow down rural-urban migration, and promote farm-nonfarm linkages.

In India, also the available evidence supports the positive relationship between RNFE and poverty reduction.Many of these findings indicate complementary roles of agriculture and non-agriculture sector to reduce rural poverty in India and efforts should be made to improve rural-urban linkages.

The policy makers aiming to alleviate poverty should continue their efforts to expand the rural non-farm sector at an accelerated pace. The efforts should also focus on removing barriers to entry into gainful non-farm employment opportunity. Human capital development is crucial to job seeking and income earning. A well designed technical programme based local conditions would go a long way in strengthening the skills of rural youths which in turn enhance their possibilities for employment in non-farm sector. The National Skill Development Mission is a good initiative in this direction. ■

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SUSTAINABLE AGRICULTURE SYSTEM FOR DOUBLING FARMERS' INCOME

At the dawn of independence, India was dependent on US for feeding its population by importing food under PL 480 programme. However over the years, we became self–sufficient, self–sustainable and self–dependent in food production, and today we are exporting the surplus production. But despite being an agrarian country, we are unable to give due importance to the sector by streamlining the entire process chain that will benefit both farmers and actual consumers. There have been numerous factors being ignored which are not only affecting the process of agriculture production, but are adding on to every day distress among our farming community - the biggest being heavy dependence on monsoon for agriculture and failure of govt mechanism which could purchase the produce on promised MSP rates.

The need of the hour calls for a change in cropping pattern. While on one hand, we produce surplus of wheat and paddy, on the other hand, deficit in production of oil seeds makes it imperative to invest Rs.70-80 thousand crores on import of edible oils. The ground water level in north Indian states are at alarming stage, still states like Punjab, Haryana and Rajasthan are sowing water intensive crops like paddy and sugarcane. This can be replaced with such crops which are not water based and hence need to be produced more. Water, being most precious, must be used judiciously both in agriculture and in every day consumption. Apart from drip irrigation under govt scheme of ' Per Drop More Crop', we must focus on rainwater harvesting for agriculture by creating more ponds in every field and more Talabs in every village. Again, due to usage of R. O system in cities, today 75% of water is wasted. Those if preserved, can be used for other requirements.

Recently, Tata Strategic Management Group presented a report which mentioned that 35-40% pesticides available in markets are spurious

/ sub-standard / fake / duplicate. Today, there are 4669 agro chemical companies registered with CIB & RC (as shown on their website). It needs to be checked about the credibility, manufacturing standard and capability, genuineness of these companies who are applying for registration. Moreover, apart from these registered companies there may be a large number of bogus companies also, operating even without any registration, on false names and addresses, cheating the farmers by marketing fake products. Further, out of the total registered companies, only 314 such companies have given their import, export, purchase, sales and production data. It makes one wonder if the Law is applicable to only these 314 companies and remaining 4355 companies are free to do all sort of nefarious activities. The central govt should ask the state to share the copy of manufacturing license issued to each company who have received such license.A high level team at central level must monitor it just the way in past where through similar mechanism fake pharmaceutical companies were eradicated.

The quality control system under the existing insecticide act is also doubtful. It empowers the insecticide inspector of a state to send the sample of any insecticide for quality check to Insecticide analyst. The license is granted after licensing officer is satisfied with product quality, manufacturing facilities, laboratories facilities and competent manpower etc. The insecticide officer is supposed to inspect it twice a year and share detailed report with the licensing officer. Instead of following the requirements, the State Governments have fixed target for each Inspector now for drawing particular number of samples in Kharif and Rabi season.Rather than drawing the samples as per the guidelines in the Act, the Inspector picks up required number of samples from a dealer of a good company to achieve the targetand defeats the basic intention of the Act i.e.,quality control. "Since the sample is not collected from doubtful companies, there is no control on spurious pesticide products as the report shows that the products available in the market adhere to quality norms."In one recent incident, when the Rajasthan govt collected data of last 5 years (2012-13 to 2016-17), it was found that maximum sample were collected only from category- A and B companies and the doubtful categories C, D & E companies were left unchecked. Total percentage of category A and B Company was 87.73% (A Category – 76.13% and B Category – 11.60%) and other category companies (Category C, D & E) were only 12.27%. Therefore sampling should not to be done for fulfilling the targets but it should be quality based, where all companies will be covered for minimizing the spurious product in market. Central government should categorize and grade the companies with A, B, C and D and categorize on lines of Rajasthan Government. This would facilitate sampling in future to proceed on qualitative lines rather than quantitative or for fulfilling the target only.

Another important factor is that none of the Government labs including SPTL, RPTL and CIL which test statutory samples have proper calibrated instruments and standards to check the quality and also are not NABL accredited. They also lack trained manpower. It is ironical that despite this they fail the samples of companies whose

labs are NABL accredited and the products are exported and gladly accepted in countries such as US, Europe, Japan, Australia etc. This is definitely affecting our export growth as it sends wrong message to international markets through competitors.

The latest PMB (Pesticide Management Bill) will not be equipped to resolve the issues and problems of the last Insecticide Act, unless it incorporates proper guidelines with reference to registration, manufacturing licenses, analysis and prosecutions etc. Although the existing Insecticides Act has provisions for the above, yet they are not followed in the true spirit / sense. In the new PMB, there is no provision to prevent / check the vicious action by Government inspectors, Analysts and other authorities who are issuing manufacturing licenses by violating the Insecticides Act. Further, the current bill suggests the same punishment for spurious, substandard and misbranded pesticides. Spurious products harm crops and can also pose a threat to human life. However, misbranded products just have minor variations in product composition, which should be punishable but not to the same extent as the spurious one. In such cases they should be compounded only. Recently, Government has proposed changes in Companies Act, wherein the Government has proposed compounding instead of prosecution for minor variation. Same needs to be implemented on insecticide industry as well.

The innovation of a new molecule takes approximately 11 years and more than 300 million dollars. Given the huge cost, as a country we are unable to discover/ develop new molecules. Beyond that, the registration of any such molecule, being imported also takes time. This process needs to be simplified and streamlined. In order to encourage R&D in crop protection products and to combat menace of spurious pesticides, there is an immediate requirement of data protection law in our country which should not be less than 5 years. It will allow the new technology to be available in our country as well.

The farmers also lacks guidance and supports from government for improving agricultural practices. Since, Government alone cannot reach 14 crore farmers in 6.5 lakh villages,this job should be taken up by private partnership so that better extension services can be provided.

The government is definitely focusing on the welfare of farming community by increasing the budget allocation on agriculture and by giving MSP + 50% on cost. But farmers need further support in their skill development and training, so they can produce as per market requirement to get better prices and also to use products rightly to increase the production. Our agricultural systems have to be sustainable since the area under agriculture is decreasing slightly year by year and population is increasing so we have to adopt such policies which can manage our food and nutrition requirement and can turn India as a food hub for world. ■

YOUTH AND WOMEN IN AGRICULTURE

M.Jhunjhunwala
PRAGATI PIPE INDUSTRIES PVT. LTD.

Agriculture and the Generation Problem: Rural Youth, Employment and the Future of Farming

Youth unemployment and underemployment are serious problems in most countries, and often more severe in rural than in urban areas. Small-scale agriculture is the developing world's single biggest source of employment, and with the necessary support it can offer a sustainable and productive alternative to the expansion of large-scale, capital-intensive, labour-displacing corporate farming. This, however, assumes that a generation of young rural men and women who want to be small farmers, while mounting evidence suggests that young people are uninterested in farming. The young amongst the farming communities are hardly interested in agriculture, even a majority of students who graduate from agricultural universities prefer to switch over to other professions. It is called the "great Indian agro brain drain."

For long, the agricultural sector has been neglected. Though 80-90 per cent of students studying agriculture belong to the farming community, most of them prefer to choose a different career. At present, around 0.4 million students are enrolled in agricultural universities and institutes. But sadly, only 0.1 million students manage to graduate. Most of them (between 70 and 80 per cent) join the banking sector in institutions like the National Bank for Agriculture and Rural Development (NABARD).

There are many ways to enhance job opportunities for students of agriculture.

Both the government and the corporate

sector must increase the number of scholarships for agriculture students to enhance research and development. This will help them become better professionals and improve their earning capacities. The government must also enhance their professional status so that more youth take up jobs in this sector.

The youth are not attracted to this profession as there is neither guarantee of income nor enough institutions that provide jobs. At present, only a few crops get a Minimum Support Price (MSP) guarantee from the government. This has created a vicious cycle. Farmers are growing the same crops every season to sustain their livelihoods. It is time to break this cycle and think beyond this stunted vision. The government must assure MSP for other crops as well. This will encourage the youth to take up farming without bothering about the market risks.

We must also move away from monocropping and invest in the diversity of crops that are indigenous to various regions of the country. It is a pity that we have to import wheat, even though we have the capacity to meet the growing demand.

The youth should also be taught about profitable farming techniques and systems so that less land and resources are used. They should not only be taught about integrated farming, but also about latest techniques in mushroom farming, freshwater aquaculture and dairy farming. They should also be given subsidy or loans to start food processing units.

Attractive loan schemes will go a long way in strengthening the hands of the farmer. Farmers must also be provided with proper insurance policies as we are already in the middle of a climate change era.

It is common knowledge that students of agriculture rarely utilise their knowledge in practical farming. This must change. We must emulate the success stories in Maharashtra and Punjab, where agriculture students have taken up farming and are using proper seeds, machinery and agro management techniques. Agriculture is the biggest sector in India, yet the sector and its workforce are not valued. This, too, must change. ■

Youth and Indian Agriculture

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Agriculture is the major livelihood for the rural community in India. Most of the rural poor depends on agriculture and forests for their livelihoods. More than 70% of the rural population still practice agriculture as their occupation. A survey conducted across 18 states of India by the Centre for the Study of Developing Societies (CSDS), Delhi between December 2013 and January 2014 revealed that 72% farmers are still interested in farming. India is losing more than 2,000 farmers who are leaving farming every day and since 1991, the total number of farmers has reached 15 million in 2013. The same trend is continuing because the farmers are incurring loss in agriculture and poor economic benefits in the farming practice. Only few youth are coming forward to take up agriculture as age old practice of faming is being continued. India is a land of the youth and the population including adolescents is around 550 million as per 2011 Census. As the population is increasing, there will be huge demand for food grains for which we need more food production. However, majority of youth are coming out of agriculture. One of the reasons is many are small and marginal farmers with less than 1 ha of land and the income from the small landholding is not sufficient to run the family. Apart from this, erratic rainfall, diseases outbreak, poor yield, fluctuations in the market and demand and declining profits in agriculture are the other reasons of farmers leaving farming. Hence, most of the rural youth are migrating to urban areas for eking their livelihood. In addition to the facilities, livelihood opportunities and amenities also attract youth towards the urban area. According to the UN World Health Organization (WHO) by 2030, 60% of the 10 people will live in a city, and by 2050, it will be 70% indicating that more youth would be migrating to urban areas leaving only few behind to work in rural areas. As many youth are leaving agriculture, there will be huge implications on the food security in India in future. Therefore, it is important to make

agriculture profitable in order to keep the farmers continuing farming. Retaining youth in agriculture and making agriculture more profitable are the major challenges for which the government of India has taken a number of steps like Farmers FIRST, Student Rural Entrepreneurship and Awareness Development Yojana (READY), ARYA etc, to attract youth to take up agriculture.

STRATEGIES TO ATTRACT YOUTH TOWARDS FARMING

ACCESS TO RESOURCES

Land is one of the important resources to start farming and agro industries. Youth practicing agriculture in own farms need assistance to make agriculture profitable. Large land holding requires assistance such as machinery - tractors, planters, weeders and harvesters - for agriculture practices. Similarly, the small landholding youth also need assistance particularly, credit support, seeds, fertilizers etc. The landless youth interested in farming has to either lease a piece of land or buy a piece of land which is very difficult as the land prices are soaring very high. Hence, the government has to provide assistance for the youth to take up agriculture. The government agencies, particularly the revenue department has to give the government lands to the youth to take up agriculture. Most of the government lands in the rural areas are barren with scrubby forest. These lands could be cleared and given to the landless youth to take up farming. Co-operative farming with financial support, market linkages, subsidies and crop insurance are the other important assistance needed the youth to take up agriculture as a profession. Cold storages and ware houses are also essential to store the produce for which the government has to provide facilities.

TRAINING AND CAPACITY BUILDING

Training and capacity building of educated youth is very important component in attracting and retaining youth in agriculture. Skill development improves the confidence levels of the youth to take up agriculture as profession. It also generates employment opportunities, particularly for the rural poor and unemployed youth. The trained youth become role model for other youths to demonstrate agri-based enterprises and also give training to other farmers. Indian Council of Agriculture Research (ICAR) is implementing a program on Attracting and Retaining Youth in Agriculture. The main objective is to attract the rural youth under the age of 35 years into agriculture. It also aims to prevent migration of rural youth towards urban areas. KVK provides necessary training and skill up gradation programmes.

The recent innovations like promotion of high value agriculture, precision farming, organic cultivation, Hi-Tech horticulture using green (poly) house, micro-propagation, Integrated Pest Disease and Nutrients Management, Post-Harvest Management need trained young farmers. Using the above technologies, farm productivity could be enhanced. In most of the developed countries, mechanization and innovative agriculture practices make agriculture profitable. The rural youth are the right choice for skill training in these new areas of agricultural growth. Besides developing entrepreneurship capabilities, the youth shall be trained on the essential skills as per the requirement of selected enterprises and entrepreneurial units shall be established at their location depending upon market potential of the enterprise and

availability of fund.

AGRI-CLINIC AND AGRI-BUSINESS CENTRE

The public extension services to the farmers under the Village Level Worker (VLW) and Community Development Block manual extension system have become weak. The system has outmoded as it is not effectively responsive to the changing agricultural scenario resulting from not economic globalization. Some alternatives have to be found out, besides making the public extension services more effective with existing infrastructure and human resource. Moreover, the information needs of the farmer have become varied in changing atmosphere from sustenance farming to commercial farming. Our agriculture is fast changing from being a 'a gamble in the monsoon 'to one of being 'a gamble in the market'. The extension network has to take into consideration variation in degree of sophistication and attitude of farmers and other administrative and institutional structures of the region. There is need for a demand driven system. The Agri-Clinic or Agri-Business Centre offers professional extension services to innumerable farmers. Many farmers in the rural areas still depend on the pesticide shop owners for identifying suitable pesticide/fungicide for their crops. The agriculture graduates can establish Agri-Business Centre to provide expert advice and services to farmers on various technologies including soil health, cropping practices, plant protection, crop insurance, post-harvest technology and clinical services for animals, feed and fodder management, prices of various crops in the market etc. which would enhance productivity of crops/ animals and ensure increased income to farmers. The Ministry of Agriculture and Farmers Welfare, Government of India, in association with NABARD has initiated Agri-Business Centre to take better methods of farming to each and every farmer across the country.

Figure-5.1. Technological and Management Upgrading of Small Farm Agriculture

1. Support group
NABARD (existing)
SFAC (existing)
Inter-agency Action Council for Rural Technologies and Its Virtual College (proposed)
Technology Mission for Farmers' Well-being (Proposed)

II Instruments

A. Agri-clinics ⟷ Self-help Groups	⟷ B. Agri-business Centres
* Soil Health (particularly micronutrients) * Wasteland development	* Harvesting, drying and storage (ruralGodowns, Save Grain scheme)
* Water harvesting and saving	* Processing and Value addition
* Efficient Water use	* Biomass use
* Pest proofing farming systems (Integrated pest management)	* Packaging, transport and marketing (with special arrangements for perishable commodities)
* Diesease management in animals	* Linking urban chain stores with rural producers
* Crop and animal nutrition (conventional and non-conventional)	* Quality control; testing for aflatoxins.
* Seed and feed for inland and coastal	

AGRICULTURE AS THE ENGINE OF JOB-LED GROWTH

Recent media reports suggest that increasing demands for reservation in the public sector may be linked to the stagnation of agriculture and growing agrarian distress. Agriculture promotes job-led growth, if there is integrated attention to on-farm and non-farm employment in rural areas. In the Sixth Five Year Plan (1980-85), I had introduced a sub-chapter on 'A New Deal for the Self Employed'. Unless opportunities are created for economically rewarding and intellectually satisfying self-employment for youth, competition for jobs in the organised sector will grow, as will the clamour for reservation.

PUBLIC POLICIES TO PROMOTE REMUNERATIVE SELF-EMPLOYMENT FOR EDUCATED YOUTH:

For employment to rural youths, government already has several programmes but these programmes do not attract the educated rural youth. Besides, the ongoing programmes have the limitations in availing of facilities only for certain activities which generally require less capital investment. The ventures/ enterprises established with small capital would not be attractive enough to generate adequate employment opportunities for a large number of persons. Therefore, whereas the self employment

programme is to be taken up on a mass scale, attractive credit support facilities with low interest rate and longer period of repayment will have to be introduced. Proper policy measures to ensure unrestricted movement of agri-commodities, rural roads and godowns, encouraging livestock enterprises, agro-forestry, tree farming, freedom for cutting/ logging all trees species grown on farmers lands etc. have to be introduced to attract rural educated youth in setting up agri-business centres/enterprises. Public policies for providing economic space for successful self-employment are urgently needed.

AGRICULTURE ENTREPRENEURSHIP

National Commission on Farmers (NCF), suggested every scholar should become an entrepreneur. Hence there is a need to change the curriculum in such a manner that the scientific discipline and business management principles are taught together, for example - Seed Technology and Business. In the digital era, youth can use the modern ICT technologies like internet, email, social network platforms like face-book, whatsapp etc., in making agriculture entrepreneurship successful. The entrepreneurial activities may be in the area of Apiary, Mushroom, Seed Processing, Soil testing, Poultry, Dairy, Goatry, Carp-hatchery, Vermi-compost etc. Young farmers could be trained in the production of the biological software essential for sustainable agriculture, such as bio-pesticides, bio-fertilizers and vermi-compost. Youth can organize Seed Villages like Pulses Seed Villages to produce high quality seeds at low cost. Decentralised production of hybrid seeds by young farmers will help to reduce the cost of seeds. Many such services can be provided by educated young farm women and men. Agriculture in green houses can help to popularize drip irrigation and fertigation methods. In the case of aquaculture, there is need for certifying seed and feed, so that there is quality assurance.

Entrepreneurship development: Agriculture in India is mostly dependent on monsoon and hence most of the area is mono cropped. It cannot sustain the livelihood of the farm family. Resultantly, the rural youths migrate to urban areas in search of job. Developing entrepreneurship among these youths by imparting training on different agro based enterprises and entrepreneurial skills will help in checking the rate of migration from rural areas, assuring at the same time, availability of working force for agriculture.

The following will be the ideal strategies to involve youth in taking up agriculture

- Assistance to youth practicing agriculture in their own farms (farmers with large and small holdings need different types of assistance)
- Youth educated in agriculture and allied enterprises to provide agriculture advisory services
- Youth to provide agriculture implements and equipments on a custom-hire basis
- Landless agriculture labour whose children can be trained to manage farms in land taken on lease and as well as in non-farm enterprises.
- Educated youth from urban areas who are interested in promoting urban and rurban agriculture, including green house horticulture.
- Young farmers who will be able to operate Farm Schools in their farms in order to promote farmer to farmer learning. ■

Gender Gap in Agricultural Education and Research in India

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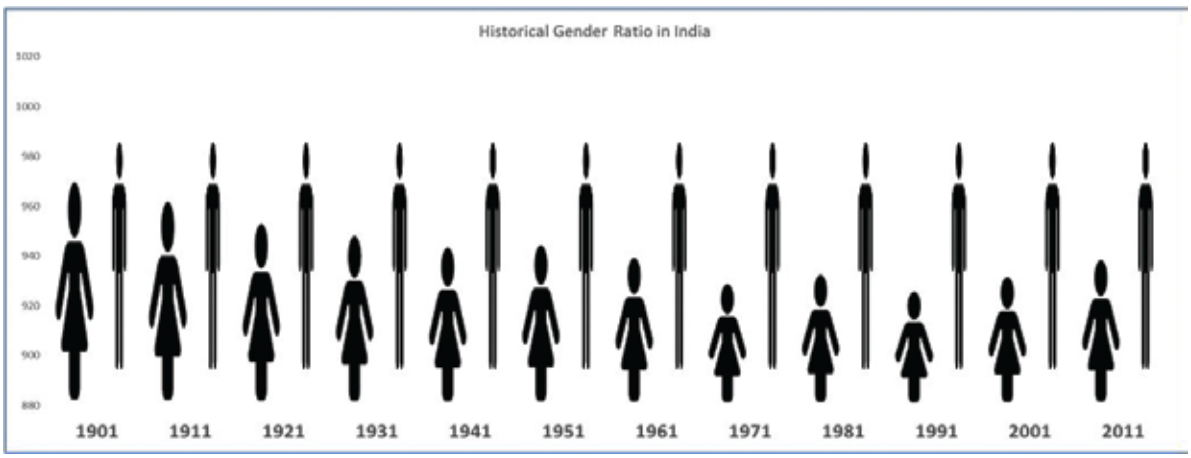
It is not anybody's concern; it's concern of all of us…male-female, men-women, boys-girls. There are several indices to measure gender gap *viz.* Global Inequality Index (GII) of United Nations Development Programme (UNDP) and Global Gender-gap Index (GGI) of World Economic Forum (WEF). The GGI was launched in 2006 and is based on annual assessment. It includes 4 sub-indices and 14 indicators. The four sub-indices are namely-i) economic participation and opportunity, ii) educational attainment, iii) health and survival, and iv) political empowerment.

HISTORY AND DISTRIBUTION OF GENDER BIAS IN INDIA

Gender inequality in India refers to health, education, economic and political inequalities between men and women. Unfortunately, there is no systematic data on this in India. We have been always biased leading to a gap. And this gap starts in the population ratio itself. As a country we have never had women more than men at least in the last century. Child-birth preferences worsened the situation towards the end of the last century. But recent decades have seen a slight reversal of the trend. Gender bias varies from states and districtsin India. While Kerala and Puducherry boast of a female-heavy population, the rest of the states are male-heavy. Many states have gone much below the average female to male ratio. Even at districts level, the situation is similar. But certainly there are few communities where the fairer gender is abundant. For example, in Maharashtra there are 1123 females per 1000 males in Ratnagiri district.

HOW DOES GENDER GAP WIDEN?

India is rapidly improving its gender parity. Accordingly, its GGI rank has improved from 114 in 2016 to 108 in 2017. But the fact that this rate is not enough is clear as this rank is among 144 countries. From the numbers in population, the gap further widens in the social and economic spheres of population. Patriarchy as a social system leads to male domination: as against North-Eastern Region and other hilly tribal areas where women dominate. Even in the fisheries and a few agricultural sectors, women outwork men.

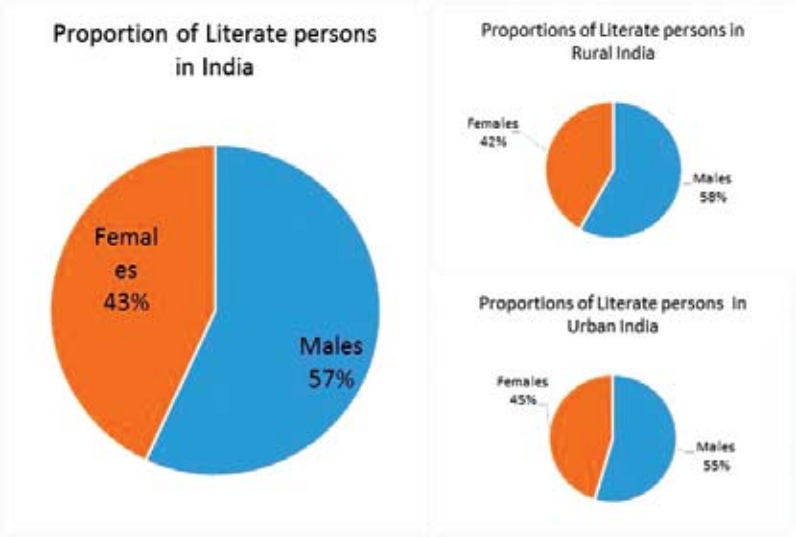


Our society has history of gender bias since inception

Natural differences differentiate the roles of genders viz., housekeeping by women v/v outdoor activities by men. Monetary conversion of work favours outdoor activities. But the same is not visible (in most of the cases non-existent) in the household work whereby home-making is devalued resulting in a loss of self-esteem among women. Household duties also suffer from restricted access to resources.

Even when the women have started taking part in outdoor activities and even becoming an integral part of the workforce in industrial and service sectors, the gender gap keeps widening. The early career women earn roughly 90% of their male counterparts' incomes at corresponding age. But the share declines to 82%, when they turn 40. The wage gap between male and female workers starts widening at around age 32, the same time that women start to become underrepresented in managerial ranks. Modernization in true sense necessitates involvement of female force without gender discrimination at workplace.

The low GGI rank of India is a result of poor performance in providing equal opportunity in all these spheres. However, there is a silver lining. In areas of political empowerment in India, many women in the rank of Chief Ministers, President, Prime Minister, party chiefs have shone. The sports personalities in the women group are also rising. For example, in recently concluded Jakarta Asian Games – 2018, the Indian tally of 69 medals included 26 medals in women's events.



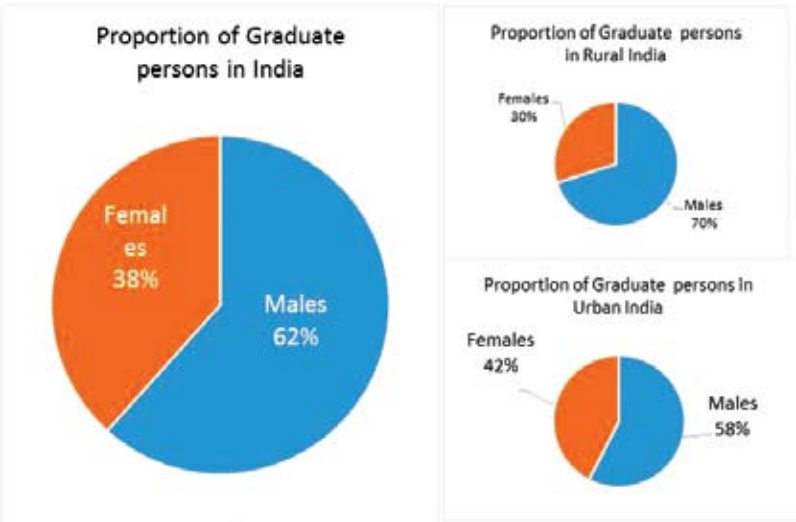
Literacy and basic education: Gender gap: primary to higher secondary education

GENDER-GAP IN EDUCATION

Education and literacy should not be used synonymously.Education includes the processes by which societies deliberately transmit their accumulated information, knowledge,understanding,attitudes, values, skills, competencies and behaviours across generations. It involves communication designed to bring about learning. Literacy is most commonly understood as 'a set of tangible skills — particularly the cognitive skills of reading and writing'. Indian national census defines literate person as person having the ability to read and write in any language.

India improved from 12% literacy in 1947 to 74% in 2011. At the state level, Kerala is good, while Maharashtra requires to improve. There is lot of scope for improvement in rural India. Interestingly a travel from Kerala to Rajasthan indicates a gradual decrease in the rate of literacy. In urban India, Mizoram, Himachal Pradesh and Kerala are better than Bihar.

In literacy we tried to understand the difference from Primary to higher education sector and the gender



Gender-gap in agricultural research

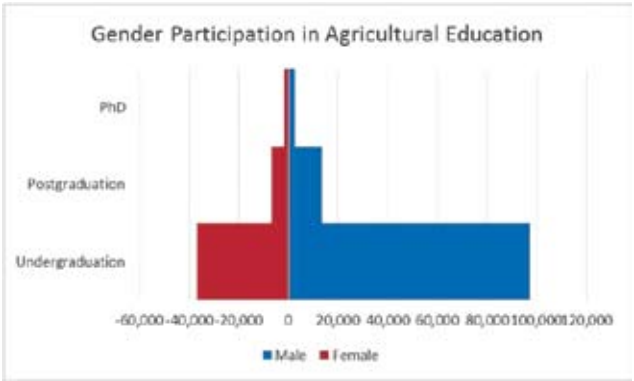
gap. Literacy and basic education, although enumerated separately in census, have a high correspondence. The rural populace is not much behind.

Females fare better in higher education. However, as we go into employable or entrepreneurial education, the female gender suffers heavily; and more so in rural areas.In technical skill development spheres, however, women are much behind. This might be due to lack of opportunity, education and other reasons.

"If women are considered incessantly inquisitive, if enquiry is essential to science, if science is gender neutral, why are so few women in the laboratories of the world".....Iseley, 1988.

The students join professional courses with different intentions, whatever may be the advice of their research guide. Generally more boys enter in undergrads and post graduate agricultural courses. However very few opt for research especially for Ph.D. programmes. This may be the reason that many bright students are not enthused to carry our agricultural research. And out of those few who opt, the ratio is skewed towards male. Proportion of girl students increases from undergraduate, to graduate and to PhD studies in agriculture (AISHE 2016). Yet they are not represented by equal or higher numbers in research jobs in agricultural universities in India.

Of all University enrolment in India, roughly 0.5% comes in 67 agricultural universities. Total intake capacity of agricultural education sector is close to 1.5 lakhs.Gender-gap in agricultural education and research in Under Graduates in Agricultural and allied sciences is 46. Gender-gap in agricultural education and research in Post Graduates in Agriculturaland allied sciences is reduced to 28% while in PhDs the gap is 24%. In the Indian Council of Agricultural Research (ICAR), the gender gap of scientists over a period of nearly 40 years has gone up from a mere 2 to 54 %, while the average participation of female scientists is still hovering around 35%.Participation of female scientists in Research and Development (R&D) units in India indicates a range of 10 to 27%.



Participation in agricultural education: gender bias (X axis no. of students)

GLOBAL SCENARIO

If women had the same access to productive resource as men, they could increase yields on their farms by 20–30%, raising total agricultural output in developing countries by 2.5– 4%. This gain in production could lessen the number of hungry people in the world by 12–17%, besides increasing the income of women….. (FAO, Rome)

Employment related gender gap has closed by only 0.6 percentage points since 1995, with an employment-to-population ratio of 46 per cent for women and ~72 per cent for men in 2015. In 2015, 586 million women were working on own-account and contributing family workers.

INDIAN SCENARIO

As we go from entry to executives, female participation decreases from 24 to 14 %. This is alarming. Women earn 56% of what their male colleagues earn for performing the same work. The more educated a woman is, the wider the gender pay gap. The gender pay gap increases as women advance in their career. Happily gender pay gap has narrowed over the years from 70% before 2008 to almost 40% in 2011.

SUGGESTIONS

Fewer women enter the world of higher education despite almost equal participation upto secondary education, higher performance in SSC and HSC and the probable reasons are i) domestic expectations, ii) safety concerns, and iii) infrastructural barriers. Fewer women enter the world of agricultural research despite their fairly good representation in the higher education. Their performance in graduation, and post-graduation is appreciably good. However this huge female human resource just vanishes in jobs of higher positions!

One of the first steps towards gender-neutral society is over-all education. Women folk, especially in the rural areas, should be encouraged to opt for agricultural education with basic objective for the educational attainment at hierarchical levels. The target should orient around the basic skills and/or competencies. Women need more of professional advocacy rather than role models. ■

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REFORMING AGRICULTURAL EDUCATION TO MEET EXPECTATIONS OF SOCIETY

The present agricultural education in India is not fully meeting the requirement of retaining graduates as agri-businessman in farming due to limited exposure of working in real world situation in rural areas, and limited opportunities of vocational trainings for school dropouts in agricultural universities. Hence, students do not acquire confidence and skill to practice knowledge gained during undergraduate program for their living. Further, there is no focused institutional mechanism available to provide background support, and handholding to such students after graduation program. The present system has largely succeded in producing manpower efficient in doing research and makes graduates aspirant of further higher studies after graduation. Hence, the graduates are becoming job seekers than job providers.

The gap in skills training is enormous, and skills required to become successful in real working situations, including life skills, like problem solving, logical reasoning, language comprehension, communication, and interpretation are provided at limited scale. Further, the issues of education and self-employment are more complex. The employers are finding it more and more difficult to get suitable candidates for the kind of work available with them. Hence, it is essentially desired that building professional skills should be given high weightage in higher education, particularly at graduate level.

Curricula and programmes are hardly in line with the demands of industry and present social life. The future is of fourth industrial revolution based on cyber physical systems characterised by the technologies integration and blurring of lines between physical, digital and biological aspects of life. There is also a need to ensure that everyone can continue to learn, adapt and apply relevant technologies to the dynamic learning and work environment, and re-adjust to cultural, economic, political and social advancements. However, our social infrastructure has failed to be quick in adapting to the technological advances and their influence on our work and

social life. With the massification of education worldwide, the design of both traditional and present education systems failed to warrant access to quality, relevant education for everyone, not just the younger generation. Therefore, it is essential to re-work the present graduate education system into an adaptable, flexible and socio-economically relavant education for everyone.

Transformation of higher education system and reorientation and reassessment of all academic programs is required so that students are enabled to develop skills that have economic value content beyond the specialized knowledge and expertise. In order to address these issues and make the universities socially relavant, and as new age universities, also called University 4.0, we must recognise employability as an important objective of education. It will require more flexibility with on-campus, online, onsite and on-the-job learning systems in university. It will also require to build in multiple path ways of vertical and horizental connectivity between certificates, diplomas and degrees, because students needs different levels of knowledge and skills.

In view of the changing agriculture and food systems and needs of society, universities have to play twin role of knowledge creation, and value creation in society through students' entrepreneurship. Universities have to think beyond knowledge generation now. Restructuring education at graduate level is also important since the number of students are increasing rapidly, and only 20-30% students can get opportunity of doing masters and Ph.D.Hence, we need to change the way of teaching and

learning at graduate level, so that agricultural students acquire the desired skills and are retained in the farming profession. In USA, the Morril act in 1862 emphasized on "Teaching of practical agriculture", however, in India we still need to do more so that grass-root practitioners can be prepared.

Therefore, it is required to develop new ways of teaching, and learning to transform students as agri-businessman, and to retain in farming profession. The agricultural activities are village centric, hence creating enabling environment in universities is needed. An out of the box methodology of teaching and learning at graduate level is requiredto change the way of education, with new models of teaching and learning, which provides sufficient room for practicing agriculture and addressing real world issues.

A serious relook on our courses and curriculum is also very essential. Our graduate curriculum is such that it makes student aspirant of further higher education, and not as grass-root workers. Further, it is difficult for present day teachers to teach agribusiness to students, since they are also not trained in doing so. It is also a matter of concern that the same teacher who is not trained in agri-business, prepare/ updates the curriculum. One very practical and effective way may be allowing teaching by successful agri-businessman, whether they are farmers, entrepreneurs, or untrained persons managing successful agri-business. These success stories or business plans can be made part of curriculum. Hence, the undergraduate curriculum need to be modified in such a way which helps in developing 70% students as successful grass-root innovators/ professionals. It is also important to provide support to those students who wish to establish themselves as agri-businessmen after completing the formal degree program, so that their skills and knowledge are continuously updated. An institutional mechanism is needed for this purpose.

Agriculture and food systems are socio-economically and environmentally complex systems. These complex situations cannot be experienced in classrooms and instructional farms. Involving students with community is an attractive and one of the most effective options for this purpose. Programs with such components

will help universities in preparing better graduates for the future, with deep social concerns.

Innovative process of Teaching, Learning and Practicing Agriculture and Food Systems to transform graduates into agro-professionals: "Chalo Gaon Ke Ore" (Back to Villages)

In order to address these issues an education reform plan named "Chalo Gaon Ke Ore" was prepared by Indira Gandhi Krishi Vishvavidyalaya, Raipur and is being implemented from 2018-19 session. It is an out of the box thinking new methodology of teaching, learning and practicing agriculture, which will create opportunity of long term exposure to real world. This is an experimental and participatory learning methodology which will transform students into smart agri-businessmen and future leaders of agriculture and rural development. An institutional arrangement, "Gurukul" was also conceptualized to provide background support and handholding to students who wish to continue in farming business after degree program. The "Gurukul" will work as village knowledge, training and service center. The proposed concept is convergence of formal degree program with vocational education for imparting skills for life during their degree program and will radically change the way of agricultural education.

HYPOTHESIS

The present degree program of agricultural is four-year program. In first three years, students are taught in colleges in usual manner. During this period we try to simulate real world situations on university farms where farming is done in absence of farmer and the conditions are very different than that existing in rural landscape.In final year,students are given hands on learning opportunity in campus in first semester, and attached to a village/ industry in final semester.

Agricultural graduates can be transformed as agro-professionals, if sufficiently long period of time is provided to students for working on farms, and with agri-business enterprises together with farmers. Further, they can be mainstreamed in agribusiness, if a supportive network is put in place to develop them as service provider, or entrepreneurs after completion of degree program, along with farming. This institutional support may develop their farms/ homes as village knowledge centers which can work as "Gurukuls". The farms of student can become model center of training, and demonstration of knowledge based, and technology led sustainable farming. They may serve as live forms where concepts of sustainable farming, like integrated farming, ecological and organic farming are practiced, and made available for adoption by other farmers. Such agro-professionals will not only provide technical leadership, but will also become job providers in rural areas, and will help in overcoming the weakness deeply inherited into our present system of agricultural education,extension and rural development.

CONCEPT OF "CHALO GAON KE ORE":

"The students will be involved in scientific planning, development and operation of their own, or, other farmer's farms/ enterprise during degree programwith regular courses (Lab to Land & Land to Lab). A micro watershed, near college, consisting of few villages will be selected for those students who do not have their own farms. Each student will be attached to one farm family during entire degree program. Student will carry out all activities, in similar manner, as carried by the students with own farm. Suitable institutional mechanisms will be developed for their mainstreaming in agricultural profession after completion of formal degree program by transforming their farms/ homes

into village knowledge, training and service center as"Gurukul" (Land to Land). Suitable help will also be provided to other farmers, with whom students were associated, to establish "Gurukul". This new institutional mechanism will further help in establishing graduates as agro-professionals and will create better opportunity for skilling the rural masses."

OUTLINE OF "CHALO GAON KE ORE"

The concept of Chalo Gaon Ke ore will be implemented in three stages, namely

- Transforming students into smart agri-businessman through planning, development and operation of their own farm/ farmers' farm.
- Developing support system for this way of education based on ICT platform, development of curriculum and content, developing new rules and regulations, tools and techniques etc.
- Transforming farm of student/ farmers into village knowledge, training and service center named "Gurukul".

EXPECTED OUTPUT/ OUTCOME:

This concept will create opportunity for students to work in real world situation with farmers and rural communities and will help in acquiring the knowledge and skills required in managing the farming as business.This new way of education will help in integrated use of multiple methodologies of teaching & learning, and involving hard and soft skills, since major emphasis is on working on farms with farmers. It will help in developing the qualities of leadership, creative thinking, self-learning, problem solving and entrepreneurship in students, as on farm program will be implemented by the students.

Students will also learn to manage the complex situations in real world. The proposed method will allow considerably more time for learning since student will be applying the knowledge acquired in the classroom in his farm (lab to land). In doing so students will get an opportunity of modifying knowledge and exploring new knowledge while practicing resulting in grass root innovations. This method will also give opportunity of discussion of field problems in class room and real time delivery of solutions, as students will frequently and regularly travel between campus and farm. In turn, the teachers will also have a better connectivity with rural environment. It will be a very effective model of "land to lab".

Agricultural graduates will be transformed into agro-professionals during the degree program itself with desired vocational skills. As a result, their employability will also increase and they will be tuned to the needs of development departments, industry and society. It will have profound impact on quality of graduates, whether they opt for agri-business, jobs in service sector, or, research. If they are retained in farming, they will become a modern farmer, and better service provider in villages. If they join jobs, they will prove to be better extension worker, due to their real world experience of working on farm along with fellow farmers.

The experience of continuous teaching and learning in real world situation will help faculty in reorienting and updating learning focused and career-oriented curricula. It will raise the standard of campus teaching and learning. This method will also provide more real world experience to faculty to improve their capabilities of teaching, and delivering things in new way. This will also improve their effectiveness in research and extension as well. This novel concept will not only provide a model to translate science, knowledge, and technologies into innovations, and generation of wealth in society, but will also provide a globally workable solution for agriculture, and rural development, and will place Indian agricultural education on global platform. ■

DAIRY, POULTRY AND AQUACULTURE

Dairy Sector Production in India

India has a bovine population of 300 million according to the 19th livestock census of 2012. India is the largest milk producer in the world consituting both cow and buffalo milk. In terms of cow milk production, India ranks second in the world. The estimated milk production in 2017-18 is 176.35 million tonnes (Fig 46) which is about 7% more than the previous year and accounts for nearly 18% of the total milk production in the world.

Looking at the seasonal pattern of milk production, total milk production has increased from 51.33million tonnes during 2016-17 during the summer to 53.77 million tonnes during the summer of 2017-18. This translates into a growth of 4.7%. The same is comparatively higher than the growth rate of summer season 2015-16 to 2016-17 which was 3.9%. It is a positive fact that even during the summer season 2017-18 the growth rate is higher and sustained.The top five milk producing States during summer season 2017-18 are Uttar Pradesh, Rajasthan, Gujarat, Madhya Pradesh, and Andhra Pradesh.

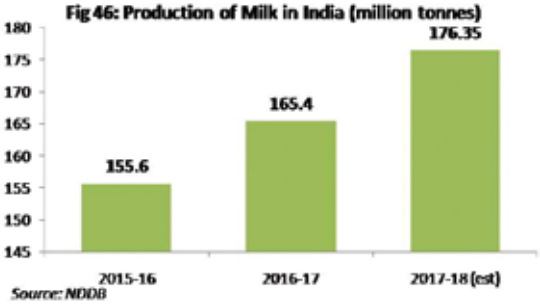
A study of the decadal trend of per capita milk production in the country as depicted in Fig 47reveals the consistent growth pattern in the country. Over a period of ten years, the per capita milk production has registered a considerable growth of 36.5%. From 260 gms/day in 2007-08, the per capita milk production in 2016-17 has increased to 355 gms/day. This sustained increase in milk production is a result of various effective steps taken up by the Government in recent years. Some of the factors behind this success are:

- Integrated co-operative system of milk collection, transportation, processing and distribution
- Enhanced conversion of the same to milk powder and products thereby minimising seasonal impact on suppliers and buyers
- Increased retail distribution of milk and milk products
- Increased profit sharing with the farmer which in turn is ploughed back to enhance productivity

In terms of per capita milk availability as seen in Fig 48, Punjab has a per capita milk availability of 1075 gms/day and tops the list. While Uttar Pradesh is the largest milk producer in the country, it ranks 10th in terms of per capita availability as a result of its large population. Rajasthan is the second largest milk producer in the country and in terms of per capita milk production, it ranks third with 785 gms/day of milk production. Gujarat is the third largest milk producer of the country and it ranks fourth in terms of per capita milk production.

Per capita milk however needs to increase further in the country considering its growing population and need for nutritional security, particularly for women and children. India is also the largest consumer of milk in the world and as such, more concerted efforts are needed to further increase the milk production. The country has set a projected milk production of 254.5 million tonnes by 2021-22 as per the vision 2022 document. ■

Fig 46: Production of Milk in India (million tonnes)



Source: NDDB

Fig 47: Decadal Trend of Per Capita Milk Production in India (gms/day)

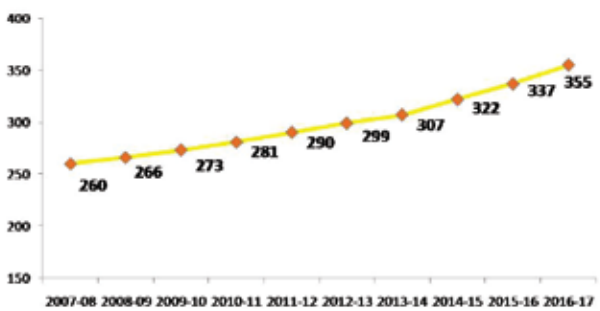
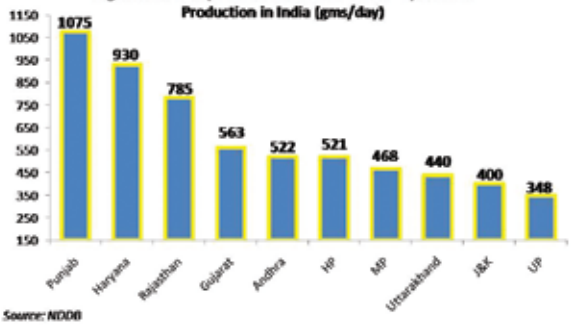


Fig 48: India's Top 10 States in Terms of Per Capita Milk Production in India (gms/day)



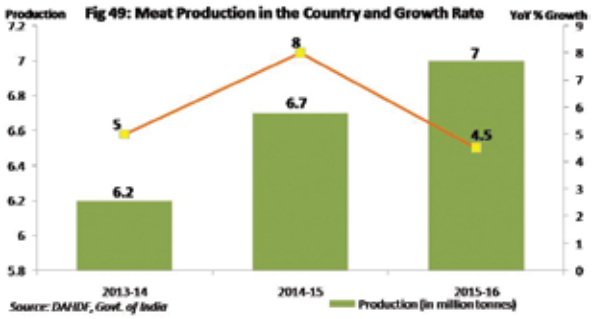
Source: NDDB

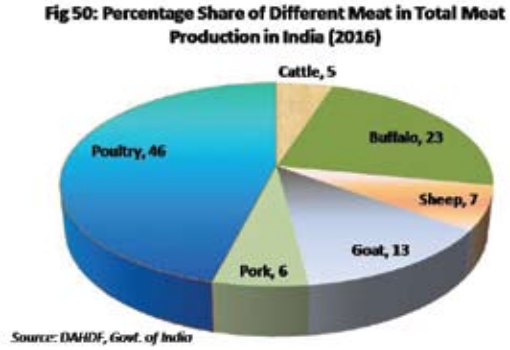
Meat and Egg Production

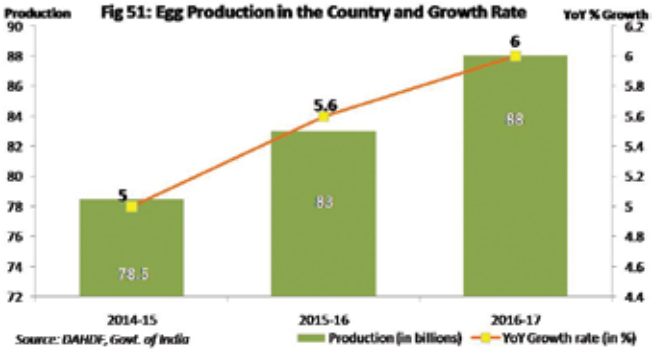
Meat production in the country in the recent years have comparatively slowed down as far as the annual growth rate is concerned. The country produced about 7 million tonnes of meat in 2015-16 which is marginally more than 6.7 million tonnes in 2014-15 (Fig 49). Among the States, Uttar Pradesh, Maharashtra, West Bengal, Andhra Pradesh and Telangana are key meat producers. India'stotal meat production constitutes just about 2% of the world's production whereas the potential is higher. Despite big potential owing to the large livestock population, the meat industry in India has not taken its due share. Apart from systemic weaknesses in the entire production system and across the value chain, of late certain socio-political factors have dampened the production scenario of meat in the country. However, the major problems are inadequate infrastructure facilities and poor post-harvest management of the meat sector along with preference of domestic consumers to buy freshly cut meat from the wet market, rather than processed or frozen.Most of the abattoirs in the country are far from being hitech and are actually outdated. Slaughtering facilities in various parts of the country are inadequate and even today in the age of modern infrastructure facilities, animals are slaughtered in the most primitive manner.

In terms of the percentage share of different animals as sources of meat production in the country, poultry meat constitutes the maximum share and in 2016, share of poultry meat was 46% of the total meat production of the country (Fig 50). This high share of poultry meat is mainly due to factors like its popularity, affordable price, easy availability and that poultry meat has very less religious taboos and acceptable to many unless someone is a strict vegetarian.Egg production in the country is exhibiting an upward growth curve but similar to the meat production scenario, it is also experiencing relatively lower growth rate in the recent years. As seen in Fig 51, India produced about 88 billion eggs in 2016-17 at a year on year growth rate of 6%. In 2015-16, production of eggs in the country was 83 billion, where as in 2014-15, it was 78.5 billion. The layer segment of the poultry industry in the recent years is witnessing a slow but definite structural change. Small layer units are becoming unviable and these are making way for the large units with million birds and 100,000 birds in one house. States like Andhra Pradesh, Tamil Nadu, Maharashtra and Karnataka in south and Punjab in the north is home to almost 70% of the layer birds in the country. In the recent years, considerable number of production units is coming up also in Uttar Pradesh, West Bengal and Bihar. The need is for the North eastern states to have more number of poultry units which will enable them to have fresh eggs at reasonable prices.

With regards to seasonal estimation, the total egg production has increased from 26.03 Billion during the summer of 2016-17 to 27.95 Billion during the summer of 2017-18. This translates into a growth of 7.4%. The same is comparatively higher than the growth rate of summer season 2015-16 to 2016-17 (5.5%). Thus, even during the summer season 2017-18 the growth rate is higher and sustained which is an encouraging indicator for the poultry sector. The production of egg is largely contributed by commercial poultry farms with nearly 80.83% and remaining production is from household/backyard poultry. ■







Fisheries Sector in India

Potential of fisheries as a sector for a country having adequate resources is unquestionable. There is very few other sub-sectors of the agriculture sector or even among other major sectors of the economy which has tremendous potential to provide profitable livelihood to people, contribute in foreign exchange earnings and play a critical role in providing nutritional security to the people. In comparison to other non vegetarian foods, fisheries as a sector is much cleaner and environment friendly.

India's fisheries sector has come a long way and now the sector is not only meets the domestic demand, but also adds substantially to the foreign exchange earnings through export of fish and fisheries products. In 2017, India emerged as the second largest fish producing country in the world. For too long, the fisheries sector has been termed as a sunrise sector but to help it realise its fullest potential, Government launched the Blue Revolution scheme with the outlay of Rs Rs.300 crore.

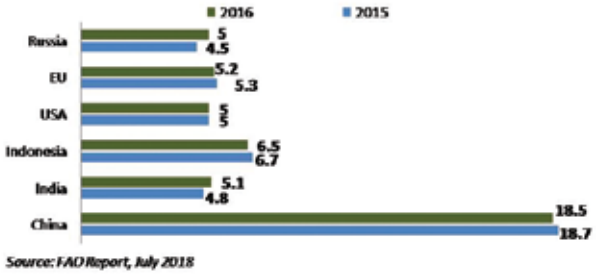
Globally Indian fisheries sector is considerably behind the Chinese, which currently produces more than 18 million tonnes of fish and fish products from capture fisheries. India's production is behind Indonesia and at par with EU, USA and Russian Federation.

Combining the production of all types of fisheries that includes capture and culture, the total fish production in the country reached about 11.41 million tonnes in 2016-17 (Fig 53). The rate of growth is however decreasing over the years which indicate the need forsome immediate remedial measures. Fish production in 2014-15 and 2015-16 was 6.5 million tonnes and 10.8 million tonnes respectively. This translates into a year on year growth rate of 5.8% between 2014-15 and 2015-16 and a further decreased growth rate of 5.6% between 2015-16 and 2016-17. The recently launched Blue Revolution aims to increase the growth rate of fish production to 8% and achieve a total fish production of 15 million tonnes by 2020.

Fisheries engages over 14.50 million people at the primary level and additional people along the value chain. Indian fisheries sector has been able to bring about a transformation from traditional to commercial scale. This has led to an increase in fish production from a meagre 7.5 lakh tonnes in 1950-51 to 107.95 lakh tonnes during 2015-16. Fisheries is also a vital foreign exchange earning sector. The export earnings from the sector in 2015-16 were US$ 4.69 billion. The sector contributed to about 0.9% to the National Gross Value Added (GVA) and 5.43% to the agricultural GVP in 2015-16.

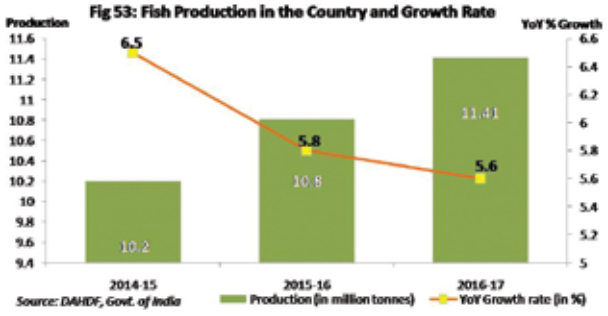
In 2016, India produced a total of 5.7 million tonnes of fish and fish prodcuts from aquaculture segment of fisheries sector.As a result of the 'Blue Revolution'scheme, overall fish production has registered an increase of about 18.86% in comparison to the last three years, whereas inland fish

Fig 52: Status of India among Major Capture Fisheries Countries (million tonnes)

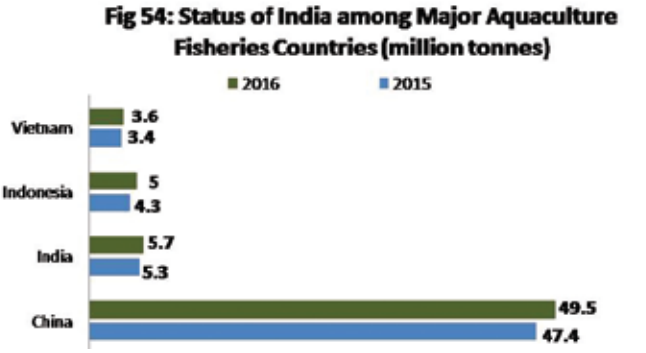


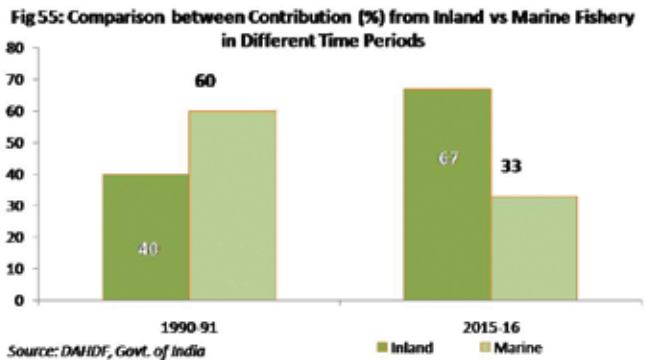
Source: FAO Report, July 2018

Fig 53: Fish Production in the Country and Growth Rate



Source: DAHDF, Govt. of India





production has registered a growth of more than 26%. Combining the production of all types of fisheries (capture and culture), the total fish production in the country has reached about 11.41 million tonnes in 2016-17.India has a fleet of 2.48 lakh fishing vessels, and the country has exported fish products amounting to US$ 5.78 billion (Rs. 37,871 crore) during 2016-17, which is the highest export from the country so far. Globally, the value of export of annual fish products ranges from 85 to 90 billion dollars.

It is encouraging to note that the percentage breakup between inland and marine fisheries in the total fisheries sector of the country has witnessed a gradual role reversal. During the early nineties, marine fisheries used to contribute 60% of the total fish production as against 40% contribution of the inland fisheries in the country. Fifteen years later in 2015, the scenario has been reversed and the share of inlandfisheries is 67%, while marine fisheries contribute 37% of the current total fish production in the country. This is a welcome change as even though marine fisheries is pro poor and easier to do, it poses danger to the marine ecosystem and also depletes the fish population as a result of indiscriminate fishing in the seas.

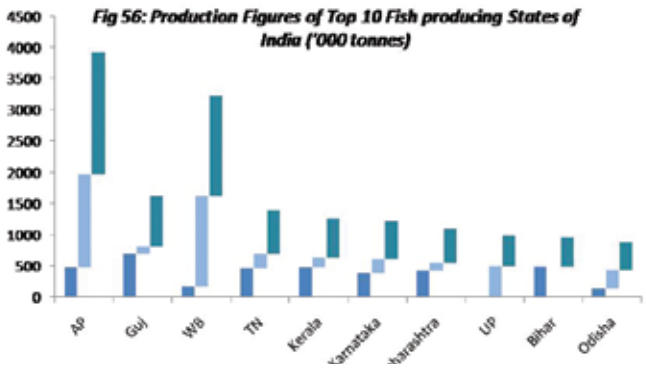


Table 1: India's Global Ranking in Production of various Important Agri Products

India Ranks First in...	1. Anise, badian, fennel, coriander
	2. Bananas
	3. Chick peas, pigeon peas
	4. Ginger
	5. Dry chillies
	6. Millet
	7. Milk
	8. Buffalo meat
India Ranks Second in...	1. Dry beans
	2. Cashew nuts, with shell
	3. Garlic
	4. Groundnuts with shell
	5. Lentils
	6. Onions
	7. Green peas
	8. Potatoes
	9. Rice
	10. Tea
	11. Sugarcane
	12. Wheat
India Ranks Third in ...	1. Coconut
	2. Oranges
	3. Pepper
	4. rape seed
	5. Safflower seed

Source: FAOSTAT

In terms of status of important fish producing States of India, Andhra Pradesh accounts for over 19% of the total fish production of the country with about 20 million kg of total fish production (Fig 56). Out of this, 475000 kgs are marine fish and the remaining 1489000 kgs are from inland fisheries. Gujarat is the second largest fish producer of the country but the highest producer of marine fisheries. In 2014-15, Gujarat produced 698000 kgs of marine fishes along with 111 kgs of inland fishes. It is interesting to note that together, the top 10 fish producing States in India constitutes 82% of the total fish production of the country. ■

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Role of Poultry in Composite Farming for Increasing Small and Marginal Farmers' Income

As the per capita availability of land is getting reduced progressively, horizontal growth in agriculture has very limited scope in future. Animal husbandry activities require much lesser space in comparison to farming. Animal husbandry generates more income per unit of land when compared to crop agriculture. Livestock and poultry production is less water intensive in comparison to traditional agriculture and thus when taken as an ancillary activity also, they fulfil the goal of 'per drop, more crop'.

In 2016-17 the annual income of farmers was about Rs. 97,000 per year or Rs. 8083/ month. At present, the farmers in our country concentrate mainly on crop production which is subjected to a high degree of uncertainty in income and employment to the farmers. In this context,integration of various agricultural enterprises *viz.,* agriculture, animal husbandry, poultry, fishery, horticulture, forestry etc. have great potential in the agricultural economy. These enterprises not only supplement the income of the farmers, but also help in increasing the family labour employment.

AVERAGE FARM HOUSEHOLD BREAK-UP OF INCOME AS AVAILABLE IN 2012-13:

PARTICULARS	AMOUNT IN RS. PER MONTH	% OF INCOME
Cultivation	3078	48
Livestock	765	12
Wages/Salary	2069	32
Non-Farm Business	514	8
Total farmers income	6426	100

Thus, Livestock contributes nearly 12% to rural household Income.

No. of Agricultural Land Size and Agricultural Families according to the Agricultural Census of 2010-11

Sl. No.	Criteria	Marginal farmer	Small farmer	Semi-medium farmer	Medium farmer	Large farmer	Average size
1	Average size of agricultural land (hectare)	0.38	1.42	2.71	5.76	17.37	1.16
2	Number of agricultural laborers	67.04	17.93	10.05	4.25	0.73	100
		84.97					
• 85% of the total cultivation is by small and marginal farmers. This is 44% of agricultural field.							
• The marginal farmers do not have any marketable product due to their agricultural holdings and family size.							

SOME OF THE ADVANTAGES OF COMPOSITE AGRI-ALLIED SECTOR FARMING ACTIVITIES:

- Increased farm income through proper residue recycling and allied components
- Sustainable soil fertility, environmental protection and productivity through organic waste recycling
- Integration of allied activities will result in the availability of nutritious food enriched with protein, carbohydrate, fat, minerals and vitamins
- Reduced production cost of components through input recycling from the by-products of allied enterprises
- Regular stable income through products like eggs from the linked activities in integrated farming
- Inclusion of biogas & agro forestry in integrated farming system will help in energy generation
- Cultivation of fodder crops as intercropping and as border cropping will result in the availability of adequate nutritious fodder for animal components like milch cow, goat / sheep, pigs etc. Generation of regular employment for the farm family members of small and marginal farmers.

POULTRY BASED INTEGRATED FARMING SYSTEM

Agriculture is an important sector in our country, with seventy percent of the total land area is cultivated under rain-fed situation. Small and marginal farmers with one or two acres of rain-fed land holding cannot rely on agriculture alone throughout the year. By adopting agriculture with allied enterprises, they can generate self-employment and income throughout the year. It will increase the economic status and standard of living of the farmers.

Therefore, if farmers undertake country chicken rearing under integrated farming system, they can use it as a cash crop anytime and this will provide static income which enhances their standard of living. Traditionally, farmers grew the country birds under integrated farming system at the pond bank and integrate with fisheries. By this, water and landmass is fully used. The birds growing in the bank of pond, will provide fertilizer and enrich pond's nutrient status and increase the yield. Integrated farming system generates employment opportunity with reduction in cost.

INTEGRATION OF FISH AND POULTRY FARMING

Integrating country chicken with fish farming can be done in two ways.

Through direct Integration poultry shed is built on top of the tank and hen waste automatically falls into the pond to fish as feed. In the other indirect integration system, country chicken are reared at the pond bank, hen shed is cleaned weekly once and the excreta are spread on top of the pond or kept as heap in every corner of the pond.

The application of poultry manure in the pond provides a nutrient base for dense bloom of phytoplankton, particularly nano-plankton which helps in intense zooplankton development. The zooplankton has an additional food source in the form of bacteria which thrive on the organic fraction of the added poultry manure. Thus, suitable variety of phytoplankton and zooplankton-feeding fishes can be stocked in the pond. The semi digested excreta of this fish forms the food of bottom feeders. Therefore expert advice can be taken by the farmer on the varieties of fishes to be stocked with proper ratio of surface, column and bottom feeders alongwith optimal stocking density and right season for stocking etc.

Benefits to farmers are productivity improvement, balanced diet for the family and higher living standards, supplementary income generation, recycling of farm waste, optimal land use.

Country chickens rearing in the backyards seldom follows any scientific approach. However, with better germplasm, like low-input technology birds, the productivity increases manifolds. With balanced feed and preventive measures against pest and diseases, country chicken rearing can make a very profitable business.

INTEGRATED FISH CUM

DUCK FARMING

Water surface of ponds can be put into full utilization by duck raising. Fish ponds provide an excellent environment to ducks. Ducks feed on predators and help the fingerlings to grow. Duck raising in fish ponds reduces the demand for protein to 2 – 3 % in duck feeds. Duck droppings go directly into water providing essential nutrients to increase the biomass of natural food organisms. The daily waste of duck feed (about 20 - 30 gm/duck) serves as fish feed in ponds or as manure, resulting in higher fish yield. By virtue of the digging action of ducks in search of benthos, the nutritional elements of soil get diffused in water and promote plankton production. The feed efficiency and body weight of ducks increase and the spilt feeds could be utilised by fish. Ducks serve as bio aerators as they swim in the pond.

Ducks can be raised in large group of ducks in open water. The ducks are allowed to graze in large bodies of water like lakes and reservoirs during the day time, but are kept in pens at night. Alternatively, ducks can be raised in centralised duck shed in the vicinity of fish ponds with a cemented area of dry and wet runs out side. Ducks can also be raised in fish pond. The embankments of the ponds are partly fenced with net to form a wet run wherein the fish can enter into the wet run while ducks cannot escape under the net.

Duck droppings and the left over feed of each duck can increase the output of fish to 37.5 Kg/ha. Ducks keep aquatic plants in check. It results in high production of fish, duck eggs and duck meat in unit time and water area.The stocking densities of 200-300 ducks/ha gives 10,000 - 15,000 kg of droppings and are recycled in one hectare ponds every year. The droppings contain around 80% moisture, 0.90% nitrogen and 0.4% phosphate on dry matter basis.

The stocking rates may vary from 6000 fingerlings/ha and a species ratio of 40 % surface feeders, 20 % of column feeders, 30 % bottom feeders and 10-20 % weedy feeders are preferred for high fish yields. In the northern and north - western states of India, the ponds can be stocked in the month of March and harvested in the month of October - November, due to severe winter, which affect the growth of fishes. In the south, coastal and north - eastern states of India, where the winter

season is mild, the ponds may be stocked in June - September months and harvested after rearing the fish for 12 months. However, expert advice should be taken depending on local conditions.

SOME SUCCESS STORIES OF COMPOSITE FARMING AND INDIGENOUS KADAKNATH BREED

Annamalai University demonstrated integrated rice–fish poultry farming system on 430 farm holdings in 12 villages of Cuddalore, Villupuram, Nagapattinam and Thiruvannamalai districts of Tamil Nadu. The intervention included transplanted rice in 200 m^2 area, 20 poultry birds kept in cages and 100 fingerlings (Rohu, Mrigal, Catla, Common Carp) in trench of 20 m^2 area. The results indicated annual increase in net return per household by Rs. 33,000/- to Rs. 50,500/ha/year for two and three crops, respectively. Poultry manure addition due to poultry dropping was 11.4 to 19.6 tonne/ha and also pest suppression ranged from 17 to 27 percent.

Banamali Das resides in Gayadham village of West Bengal. He started in 0.25 acres of land with pond and homestead garden and 0.33 acre of lowland. He adopted suitable complex farming design with rice-fish-duck-azolla during kharif. His trial farm is free from any chemicals. He cultivates fishes such as Rohu, Catla, Bata, Minor carp and catfishes in his pond, which has become more productive. For fishfeed, he uses only left over fodder, domestic waste, cowdung and sesame cake. For chicken and ducks, he uses rice grains, husk, residues of the paddy harvest and small snails from the pond. He has transferred the hencoop on his pond so that the droppings from the hen may directly fall into the pond. Due to the presence of zooplankton & phytoplankton, droppings are a good source of food for the fish.

Kadaknath farming: Kadaknath is a unique indigenous breed of fowl found in Jhabua and Dhar district of Madhya Pradesh. It is also locally known as Kalamasi because the bird is black inside–out skin, feathers, legs, meat, blood, etc. The black colour is because of high melanin pigmentation (Fibromelanosis). Flesh is rich in protein (25-27%), with low fat (0.1-1%). Kadaknath chicken contains many kinds of amino acids and vitamins and are a powerful source of protein. Kadaknath chicken contains Vitamins B1, B2, B6, B12 and E, niacin, calcium, phosphorus, iron, nicotinic acid, etc.

Many initiatives are taken by State Government, University and NGOs for conservation and promotion of this high value Indian poultry breed. Low cost shed, technologies for scientific poultry production, balance feeding, handling of feeder and drinkers, health management and marketing are key to promote production of these birds. This has reduced the mortality rate from more than 50% to 10-12 percent. The birds gained the body weight in faster way and attained saleable weight and on an average, it is recorded that an individual beneficiary starting with 100 birds under one programme got the net income of Rs. 90,000 to 1,00,000 / year.

Integration of poultry with aqua-culture - agriculture - horticulture system holds immense promise to increase small and marginal farmers' income. Integrated poultry-fish-crops is not only technically feasible but is also economically viable. Extensive efforts can be made to transfer this technology among the farmers for uplifting the economic status of rural poor households. Recycling of organic residues in the form of poultry wastes could be beneficial in improving the soil health and productivity over a longer period with lesser environmental effects. Only 3-4 important interventions in terms of replacement with suitable indigenous or low-input technology breed, health-care/ vaccination, balanced feeding and suitable night-shelter, coop or shed can help increase the income from poultry alone or in composite farming system. Sustainability of small and marginal farmers could be ensured by adopting integrated organic farming methods on a larger scale. ■

IMPORTANCE OF LAYING HENHOUSING SYSTEM ON ECONOMICS AND WELFARE

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POULTRY FARMING PLAYS A VITAL ROLE IN RURAL-AGRARIAN ECONOMY

Poultry Farming is efficient in producing high value nutrient-rich eggs and meat for human consumption using low-value agriculture feedstuffs and by-products. Indian poultry industry is estimated to consume ~23 million MT of feed, which is manufactured using low-value agriculture feedstuffs.The industry is estimated to have produced broiler meat valued at Rs 730 billion and table eggs valued at Rs 420 billion in CY 2017. The conversion of feed to meat and eggs in 2017 amounted to value addition of Rs 690 billion in monetary terms. Indian agriculture sector accounts for 17-18% of gross domestic product (GDP) and employs 50% of total workforce. Since poultry industry is vital cog in agriculture value chain, slowdown in the growth of poultry industry is likely to have impact on wider agriculture sector in terms of rural employment generation and valorisation of agriculture by-products.

TABLE EGGS AND NUTRITION SECURITY

India is estimated to have population of 729 million birds, which comprises 480 million broilers (meat-producing birds) and 215 million layers (table-egg producing birds). The egg production in the country was 88 billion and per capita egg consumption was 69 in 2016-17. Egg provides high quality of nutrients, including well balanced amino acids and energy, at less cost. Nutrients in eggs are highly bioavailable, consumption of eggs is likely to decrease incidence of protein-energy malnutrition in children and women in low income group. The Indian Council of Medical Research recommends per capita consumption of 180 eggs per year whereas the actual per capita egg consumption is just 69 eggs in 2016-17 (only 38%!). Therefore, Egg production must

be increased several folds to ensure food security in growing population, particularly in vulnerable segments, such as children and women in lower economic strata that are most prone to protein-energy malnutrition.

EVOLUTION OF INTENSIVE POULTRY FARMING

Large scale intensive poultry farming has grown manifold in the country over the last few decades to meet the consumer demand for protein-rich, hygienic and chemical-residue free table eggs and chicken meat. In intensive poultry farming, broilers are raised in deep-litter system of housing (Barn and aviary system) and laying hens are raised in conventional cages. Cage rearing of laying hens has been adopted to reduce the incidence of diseases such as Salmonella, coccidiosis, intestinal parasites and to reduce injuries due to pecking. Cage rearing improves the efficiency of husbandry practices such as healthcare, feeding and egg collection. Intensive poultry housing systems make economical use of scarce land resource, which is also required for essential activities such as agriculture, human habitation and industry.

HOUSING SYSTEM AND WELFARE OF LAYING HENS

According to American Veterinary Medical Association "Laying hen housing systems must provide feed, water, light, air quality, space and sanitation that promote good health and welfare for the hens. Housing systems should provide for expression of important natural behaviours, protect the hens from disease, injury and predation, and promote food safety." Indian poultry industry in consultation with poultry veterinarians provides well-balanced diet and healthcare to birds, which supports the genetic potential of laying hens to produce 320-330 eggs in a 50-week laying period.In a recent research article that reviews the poultry welfare in indoor and outdoor conditions, the authors conclude that Indoor systems, especially laying cages, provide the safest welfare protection. However, free-range systems are generally the most difficult to manage and pose the greatest welfare risks.

ALTERNATIVE HOUSING SYSTEMS IN EXTENSIVE FARMING

Common alternative housing systems are Litter (Barn) or Aviary, Free-range rearing and enriched cages. The alternative housing systems have been developed to provide additional provisions to improve the welfare of birds. The additional provisions introduced with good intentions have shown to have negative impact on welfare of laying hens. Each housing system has its advantages and disadvantages.

Litter (Barn) or Aviary: The laying hens are reared in sheds where they have access to litter and nest boxes. In addition, perches are provided in Aviary. Main advantage is that laying hens will have ample opportunities to move around freely. Disadvantages are that laying hens are likely to contact pathogens in faeces more often, which may require frequent handling for treatment and vaccination;access to perches is likely to make laying hens more prone to injuries; increased incidence of pecking injuries and pecking mortalities, which may be related to social hierarchies in large groups; poor air quality due to increased ammonia level may have negative impact on respiratory tract health.

Free-Range: The laying hens will have access to outdoor area during the day, it can be covered or uncovered. The main disadvantage is that outdoor conditions expose laying hens to predators, wild birds and their diseases and extreme changes in ambient climate. For instance, to prevent transmission of avian influenza between domestic and wild birds, the UK Government ordered farmers to keep their poultry indoors as it declared a "prevention zone" after the breakout of highly pathogenic avian flu.

Enriched or Furnished Cages: This housing system is like cage rearing, which provides additional provisions such as nest box, perches, scratch

pads and more space per hen. There are no standard recommendations on size of colony cages and birds per cage, type and construction of colony cages varies. The main disadvantage is that additional features in enriched cages may cause injury, harbour pathogens and faecal contamination of eggs laid outside the nest box is likely to compromise food safety. For example, improper design of perches can cause keel bone damage and bumble foot.

ADVANTAGES OF CAGE HOUSING

In this housing system, 3-6 birds are placed in wire enclosure having a sloped floor, which allows eggs to gently roll to the front of the cage so that it can be easily collected. Cages are suspended in the air, no bedding material is used in this system, which allows faecal material to drop through mesh to space below cages. There is no litter material in direct contact with laying hens and farm workers. It also eliminates the contamination of eggs with microbes in faecal material, hence, food safety is ensured in eggs produced in cage systems. The gap between elevated cages and collected droppings allows air movement across the house. Cross ventilation reduces the level of ammonia, dust and bacteria, which improves air quality. Birds are protected from threat of predators and from vagaries of external environment. Though conventional cages allow limited movement of birds, it is possible to monitor individual bird's health and wellbeing. Among the available housing systems, the cage rearing is the most economical and efficient way to support optimum performance of commercial laying hens.

Cage rearing is the most common housing system in the world. As per the report published in UK "More than 90 per cent of all eggs outside the European Union are still produced in cages – mainly conventional cages - according to research conducted by the International Egg Commission (IEC)". "Even within the European Union, more than half of all laying hens are kept in cages", says IEC statistical analyst Hans-Wilhelm Windhorst, who produced an analysis of egg production methods for the IEC's conference in Lisbon, Portugal on April 2015. "He said that the ethics on animal welfare developed in Europe could not simply be transferred to other parts of the world."

CONVENTIONAL CAGES, WELFARE AND SPACE ALLOWANCE

Central Government Act Section 11(1) in The Prevention of Cruelty to Animals Act, 1960, says that an animal is treated cruelly, " If any person— (e) keeps or confines any animal in any cage or other receptacle which does not measure sufficiently in height, length and breadth to permit the animal a reasonable opportunity for movement". To support optimum performance and welfare

of laying hens, Bureau of Indian Standards (BIS) recommends space allowance of 450-563 cm^2 for each bird depending on number of birds/cage. This recommendation on stocking density is in alignment with recommendations of other regulatory bodies and industry associations in different countries: United egg producers (USA) recommend 432-554 cm^2; Commission of European communities recommend 550 cm^2; Canadian Agro-Food Research Council recommend 432 cm^2 for White egg layer and 483 cm^2 for Brown egg layer. Based on the above recommendations, 430 cm^2 of cage space supports optimum performance and welfare and space allowance beyond 550 cm^2 is unlikely to have further performance and welfare benefits.

WELFARE ISSUES ARE NOT ALWAYS ASSOCIATED WITH HOUSING SYSTEM

Many conditions such as lameness and plumage conditions that generate concern for welfare of birds may not be intrinsically associated with housing system and space allowance. For example, high producing hens are more prone to osteoporosis, several factors such as feeding, pathogens, genetics play a role in bone health; with proper feeding, vaccination and other management practices it is possible to reduce the incidence of lameness. Similarly, feather pecking is induced by several factors such as poor balanced diet, ectoparasites, light intensity and duration; proper management and feeding practices can minimize feather pecking behaviour in high producing hens.

IMPACT OF SWITCHING TO ALTERNATE HOUSING ON COST OF PRODUCTION

A recent scientific study published shows that switching to alternative housing increases the cost of production. Based on the result of this study, the aviary has average operating costs about 23% higher and average total costs about 36% higher compared with the conventional house (cage). The enriched housing system has average operating costs only about 4% higher compared with the conventional house, but average total costs are 13% higher than for the conventional house (cage). Fallout of ban on battery cages in European Union (EU) confirms this: Egg prices have increased in EU as producers had to invest to convert existing cages to comply with the new legislation. Egg production in EU has decreased by 2.5% in 2012, which is attributed to legislation that required investment to upgrade cages when margins were poor. According to the Spanish Association of Egg Producers, the laying hen population decreased by 22% in Spain after EU directive to ban battery cages. Overall, increase in cost of production not only makes eggs less affordable but also there is a threat of slowing down the growth of Table Egg industry. This is likely to reduce farm income, rural employment generation and demand for agriculture feedstuffs. Especially in Indian context, the challenge of growing population versus the per capita land availability is critical making alternative housing an unrealistic option.

Any new guidelines on welfare of laying hens will not only have economic, nutritional and societal implications, but also financial implications for the commercial layer industry which has invested in building cage housing for egg production. These factors should be kept in mind while framing welfare policies. Hens experience stress in all housing systems. Our country has large number of children and women in lower economic strata who are most vulnerable to protein-energy malnutrition. Cage housing system is the most economical and efficient way to produce eggs and provide nutrition security at affordable price and to meet the demand of growing population for safe and nutritious eggs. BIS recommendation on cage space must be adhered, which ensures the welfare of birds while allowing economical production of eggs to achieve food security. ■

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EFFECT OF CLIMATE CHANGE ON LIVESTOCK HEALTH AND PRODUCTION AND WAYS TO COPE

Fast changing global climate of our planet is increasingly posing indomitable challenges and serious public health threats to mankind and every form of life. Special report on global warming warns that average global temperatures could breach the 1.5°C level as early as 2030. The mean global temperature is expected to increase by another 1.8 to 5.8°C by the end of this century. The overall effects of climate change are likely to be long-standing and remain harmful in terms of increased spread of diseases, heat-related deaths and air pollution. Climate change-induced natural calamities quite often disrupts the natural ecosystems by providing more suitable environments for infectious diseases, allowing the disease-causing bacteria, viruses and fungi to move into new domains. In short, climate change is strongly associated with fast changing disease dynamics favouring the emergence and re-emergence of animal and communicable diseases, including zoonoses; increase in the vector population and disease spread to newer territories; increase in the diseases causing potential of infectious agents, and thereby, inflicting more harm to hosts in wildlife, domestic species, as well as humans; besides compromising their body defence due to enormous stress caused on account of extreme temperatures as well as loss of shelters and food. While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries, who rely heavily on the natural resource base for their livelihoods. Resource poor communities in rural settings depend heavily for their survival on agriculture and livestock keeping that are amongst the most climate-sensitive economic sectors. Livestock production is likely to be adversely affected by climate change, as the competition for land, water and food security would increase, making

them the most indispensable.

IMPORTANCE OF LIVESTOCK IN INDIAN SCENARIO

Livestock is considered as the "bank-on-hooves", which over the time has proved itself as an important source of livelihoods and household income in rural segments of the country. India is bestowed with the highest number of livestock wealth (512.7 million) globally and 58% out of its total 72% rural population (over 100 million) consider the livestock farming as a central source of their livelihood (19th Livestock Census). Livestock sector by providing food (milk, meat and eggs) and non-food (fibre, wool, skins, dung, urine) commodities to the people and contributing 28.6% of value of agricultural output (DAHD&F Report 2017-18), has been playing an important role in Indian economy.

India continues to be the largest producer of the milk in the world by producing 165.4 million MT milk during 2017-18, and registering an annual growth rate of 6.37%. Livestock farming, as one of the key components of Indian farming has made significant contributions in terms of production of 88.14 billion eggs, 3.46 million tonnes poultry meat, 7.4 million tonnes meat from species other than poultry and, 43.5 million kg of wool during 2016-17 (DAD&F Annual Report, 2017-18).

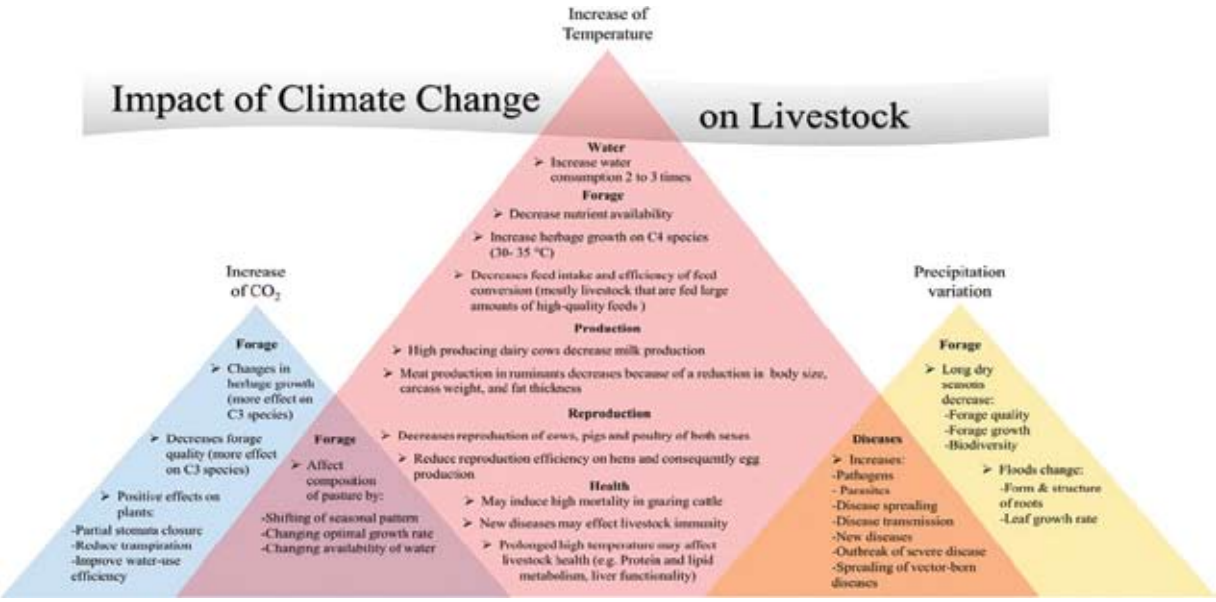
ROLE OF LIVESTOCK SECTOR IN CLIMATE CHANGE

The global warming is closely associated with emission of Green-house gases (GHG) and livestock supply chains. GHG are emanated primarily from feed production and processing (45% of the total), during digestion by cows (39%) and manure decomposition (10%).The remaining GHG production is attributable to the processing and transportation of animal products, which is estimated to be 7.1 gigatonnes (GT) of Carbon-di-oxide equivalent (CO2-eq) per year, representing 14.5% of all the human-induced emissions. Cattle-raising has been estimated to contribute 65% of the livestock sector's total GHG emissions; beef and cattle milk production accounts for 41 and 19% emissions, while pig meat and, poultry meat-cum-eggs contribute 9% and 8% to the sector's emissions, respectively.

IMPACT OF CLIMATE CHANGE ON LIVESTOCK

Climate change remains a threat to the livestock production because of its impact on the some of the crucial factors depicted below:

Effect on livestock health: Climate change, especially the rising temperatures, can affect animal health directly or indirectly. The direct effects are related to the increase in temperature, which increases the potential for morbidity and death. The indirect effects are related to the impacts of climate change on microbial communities (pathogens or parasites), spread of vector-borne and food-borne diseases, host resistance and, feed and water scarcity. Humans are also at an increased risk from insect-borne diseases such as malaria, dengue, and yellow fever. Some of the important factors linked to climate change and their implications on animal health are summarized below:



- Microbial evolution and stress response: Climate-induced changes in intrinsic factors may induce stress responses that make certain bacteria more resistant.
- Zoonotic diseases: Climate change is an important 'global change' driving the emergence and spread of diseases in livestock and the transfer of pathogens from animals to humans. Climate may have a direct or indirect influence on the susceptibility of animals to diseases.
- Vector-borne diseases: By definition, vector-borne diseases (VBDs) possess a vector stage, usually an insect, acarid, mollusc or crustacean that is poikilothermic (cold-blooded); and hence, are especially sensitive to changes in climatic variables. Of late, VBDs have emerged as serious public health problem in countries of the South-East Asia region, including India. Many of these diseases, particularly dengue fever and Japanese encephalitis now occur in epidemic form, almost on an annual basis, causing considerable morbidity and mortality.

Effect on livestock reproduction: Abrupt environmental temperature changes above critical level may be the cause of conception rate reduction, drop in fertility, early embryonic losses and silent heat in animals. The reproduction in females and semen quality in males also gets affected adversely.

Management strategies: Climate change is increasingly being recognized as the biggest global health threat and opportunity. Responses to climate change include (i) adaptation (to reduce the vulnerability of people and ecosystems to climatic changes) and (ii) mitigation (to reduce the magnitude of climate change impact in the long term).

i. Adaptation Strategies for Livestock to cope up with Climate Change

- Optimization of livestock production and management systems: In Indian conditions, due to the continuous shrinkage of government aided pastures or other community farming lands; poor or marginalized farmers are facing the difficulties for grazing their animals. In such situations following practices need to be adopted.

Diversification of livestock animals and crops by incorporation of livestock systems with forestry and crop production, changing the timing and locations of farm operations.

- Cultivation of water fern (Azolla caroliniana) in local ponds and drip irrigation model of Israel could be helpful.
- Making changes in mixed crop-livestock systems as an adaptation measure could improve food security.
- Improving feeding practices, e.g., making alteration in diet composition and feeding time.
- Use of State-of- the art Technology for offsetting stress and improving livestock production:
- Cutting-edge genomic tools for selective breeding and genetic improvement of best available germplasm of native animals (Gir, Sahiwal, Red Sindhi and Murrah etc.) that are already adapted to our specific climate zones, especially the heat-tolerant breeds of animals e.g., Tharparkar.
- Selection and development of disease-resistant native breeds and adaptable transgenic livestock, e.g., China developed a transgenic TB-resistant cattle breed by using CRISPR-Cas9 system.
- Formulation of designer diets and feed supplements for animals for ameliorating weather induced stress and improve reproductive performance
- Reducing weather stress in livestock by making use of water sprinklers in the animal houses, housing of animals in Kutcha house, covering of roof with plants or asbestos sheets, or creation of pond for wallowing etc.

Dissemination of quality services, technologies and skills to farmers:

- Universities must focus on applied research with transfer of technologies to field.
- Scientific trainings of farmers to equip them with modern technological advancements.
- Prophylactic measures to protect livestock from diseases under climate change scenario: During any calamity, it is necessary to take emergency steps for disposal of dead bodies and cleaning of the debris so as to prevent any disease outbreak or epidemic. New vaccines, diagnostic tests and practices can help farmers treat animal diseases, while reducing food borne pathogens at the farm level. Additionally, the animal health industry needs to develop treatments that can prevent and treat disease.

ii. Mitigation Strategies to lower

the Impact of Climate Change caused by Livestock

- Reduction in enteric methane emissions from ruminants: Reducing of GHG emissions from agriculture, especially livestock production should be a top priority, because it could curb warming fairly rapidly. Microbial intervention of the rumen ecosystem to inhibit methanogenesis must be achieved without adversely affecting the overall microbial processes responsible for feed digestion because this is the key to bioconversion of lignocellulosic feeds to utilizable nutrients for the livestock. Dietary lipids, improvement of the nutritive value of low-quality feeds,Ionophores(e.g.monensin), bacteriocins such as nisin, organic acids, (e.g. propionates) and, feeding large ruminants on by-pass energy and protein sources can also be used as alternatives to reduce methane production, however, these will increase cost of production.
- Manure management to reduce Methane (CH4) and Nitrous Oxide (N2O) production: Manure is composted before land application or anaerobically digested to produce CH4 as biofuel. Most methane emissions from manure management are related to its storage and anaerobic treatment. Majority of mitigation practices include reduction of storage duration, improving timing and application of manure, use of anaerobic digesters, covering the storage, using a solid separator, and changing the animal diets.
- Changing human dietary behavior: By changing feeding habits towards vegetarian diets and reducing meat consumption may considerably reduce GHG emissions, because beef accounts for a large portion of GHG emissions from the livestock sector, and it is the least resource-efficient animal protein producer, while the mitigation potential for the beef component of the livestock sector is high.

Plausible recommendations and way forward: Climate change has got insightful impact on the animal health and eventually on human health, either directly or indirectly *via* various ecological processes. Various study models have been carried out simulating the climate change and predicting the probable outcome (especially, disease outbreak), although only few could have controlled successfully the important socioeconomic and environmental influences. The gaps identified in this area would help to come up with some plausible practical recommendations that could be implemented in this arena and would serve as a way forward. Some of the important recommendations include:

- Interdisciplinarity: Global action involving all sector stakeholders is urgently required to design and implement cost-effective and equitable mitigation strategies, and to set up the necessary supporting policies and institutional frameworks. Recognizing, understanding and preparing for the impact of climate change highlights the need to promote collaborative and interdisciplinary approach of 'One Health' so as to address the challenges affecting various domains like food safety, infectious diseases given the inter-relationships among environmental impacts, human-animal-plant health impacts and food hygiene. International collaboration amongst researchers as well as interdisciplinary collaboration between specialists such as epidemiologists, climatologists and ecologists has become all the more important, in order to expand the breadth of information.
- Early warning and emergency response systems: Enhanced early warning systems are essential to reduce the risk of the lives and livelihoods of vulnerable people posed by climate change related natural disasters and emergencies.
- Use of predictive models: Models can be useful in forecasting likely health outcomes in relation to projected climatic conditions. Predictive modelling has potential to predict the probability of global climate change on ecological systems and emerging hazards.

In view of above, it becomes quite evident that the policies aiming at formulating the practical and sustainable mitigation strategies to minimize the adverse impact of climate change on animal health and productivity must be designed as per One Health approach and shared at regional, national as well as international level, since nature knows no boundaries. ■

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INTEGRATION OF AQUACULTURE IN FAMILY FARM FOR ENHANCING FOOD, NUTRITION AND INCOME SECURITY

Today capture fisheries and aquaculture provide 3.0 billion people with almost 20 percent of their average per capita intake of animal protein, and a further 1.3 billion people with about 15 percent of their per capita intake. This share can exceed 50 percent in some countries.

Surprisingly, despite its significant nutritional value, fish has received little attention in food security and nutrition strategies at national level. Although increased consumption of fish, and its addition to the diets of low income populations including certain target groups like pregnant and breastfeeding mothers and young children, have shown evidence of improving food security and nutrition. The bioavailability of fish protein is approximately 5–15 percent higher than that from plant sources. Further, the lipid composition of fish is unique, having long-chain, polyunsaturated fatty acids (LC-PUFAs) with many potential beneficial effects for adult health and child development. Besides, fish is an important source of essential micronutrients – vitamins D, A and B, minerals (calcium, phosphorus, iodine, zinc, iron and selenium) – especially so for many small fish species that are consumed whole. The potential contribution that fish (even in small quantity) can offer to address multiple micronutrient deficiencies, such as phosphorous deficiency in LIFDCs or B-vitamins deficiency, is now being increasingly recognized.

The fact that fish and all related economic activities in the "fish-chain" represent an important means to generate jobs, income and wealth, with positive effects from household level to broader economic scales facilitate access to food. Estimates of global employment in fisheries and aquaculture is particularly difficult and uncertain because of the high level of informal employment in the sector and also because of the

APPROXIMATE AVERAGE FARM SIZE BY WORLD/REGION

Country / Region	Farm Size (Hectares)
Africa	1.6
Asia	1.6
India	1.15
Latin America	67
Western Europe	27
North America	121

Source: Von Braun 2005, IFPRI

rapid growth of aquaculture, often as complementary to other agricultural activities. Official statistics indicate that 59.6 million people were engaged (on a full-time, part-time or occasional basis) in the primary sector of capture fisheries and aquaculture in 2016. It is estimated that nearly 14 percent of these workers were women and 85 percent of the global population engaged in the fisheries and aquaculture sectors was in Asia. In India over 14.5 million people are engaged at the primary level in fisheries and aquaculture and almost twice the number along the value chain. One fundamental contribution of fish to food security and nutrition derives from its "cash crop" function for fish-dependent communities.

FARMERS, THEIR CONCERNS AND PRIORITIES

Small farms measuring less than 2 hectares constitute 85% of the total operated farms in the world. Overwhelming majority of these small farms are located in Asia (87%) followed by Africa (8%) and Europe (4%). In Asia, China accounts for half of the world's small farms followed by India. Global trends indicate a decline in small farms in developed countries, while there is an increase in small farms in developing countries.

There is significant fragmentation of operational holdings in India. Around 85 percent of the operational holdings in the country are small and marginal, *i.e.,* holdings of less than 2 hectares each. Between 2000-01 and 2010-11, the number of small and marginal holdings have increased but by contrast, the medium holdings dropped by 3 per cent and large holdings by almost 11 per cent. It is estimated that the average size of land holding, which at present is 1.15 hectare, is likely to reduce further by 2020-21.

With the enhancement of national economy and its positive impact on the quality of lives of other sections of the society, majority of Indian farming communities also aspire for sustainable enhancement of income and better nutrition for the wellbeing of their family. In achieving so, farmers are now looking more seriously for possible ways and means and access to technologies and practices. However, they are also confronted with certain limitations on their part which include scarce cash surplus for mobilising external inputs, shortage of water, poor risk taking ability and problem in marketing of their small produce at reasonable return. With the growing incidences of climate change mediated consequences and uncertainty in prices and marketing problems they are left with limited options for interventions. During the course of transition from the traditional agriculture to commodity focussed farming practices, they have also lost their traditional knowledge and farming of climate resilient traditionally grown crops of a wide variety of coarse grains, many of which were flood and drought tolerant and relatively more healthy and nutritious.

NUTRITION – AN ESSENTIAL BUT HIGHLY IGNORED ASPECT

Detrimental and often undetected until severe, undernutrition undermines the survival, growth and development of children and women, and diminishes the strength and capacity of nations. In India about 20 per cent of children under five years of age suffer from wasting due to acute undernutrition. We also need to accept the fact that more than one third of the world's children who are wasted live in India.Forty three per cent of Indian children under five years are underweight and 48 per cent (i.e. 61 million children) are stunted due to chronic undernutrition, India accounts for more than 3 out of every 10 stunted children in the world. Undernutrition is also substantially higher in rural than in urban areas and undernutrition is more common for children of mothers who are undernourished themselves (i.e. body mass index (BMI) below 18.5) than for children whose mothers are not undernourished. Due to domination of carbohydrate in our diet protein malnutrition is considered to be a major concern.

If India is to continue its economic trend of growth, the problem of nutrition as a development imperative has to be tackled on top priority basis. Child undernutrition is a primary driver of reduced schools attendance, compromised cognitive or intellectual development and a massive loss of human potential with economic consequences for the individual and for the nation.The rate of improvement in nutritional status has not kept pace with India's significant gains in economic prosperity and agricultural productivity during recent decades. Stunning rates are likely to decline with economic progress, but economic growth, cannot, by itself, reduce undernutrition and may contribute to overweight and obesity.

AQUACULTURE FOR SUSTAINABLE INCOME AND NUTRITION ENHANCEMENT

It is now widely accepted that aquaculture is an effective and additional farming option with enormous potential for providing nutrition and food security, enhancing farmers' income, creation of gainful employment opportunity and overall positive impact on rural economy. Aquaculture is also highly compatible with other family farming components like livestock, horticulture, agriculture, social forestry, etc. Besides, pond aquaculture also promotes harvesting and storing of rainwater and flood waters which helps in recharging of ground water table, making water available beyond the rainy season for livestock, dyke cropping and other domestic purposes. Fish is a food of traditional choice of many people and because of its many valuable nutrients likeproteins, long chain Omega 3 fatty acids, fat soluble vitamins, minerals like, Iron, Calcium, Iodine, Zinc and Selenium fish has numerous health benefits.

Small-scale aquaculture is more appropriate for developing countries where farming is the primary source of livelihoods of large number of small- farming households and

also for supplementing diets and areas where traditional cropping systems do not generate much cash income. Another big advantage is that the crop can be harvested at any stage after two to three months of rearing to meet family needs and during emergencies, and spares other assets like livestock. It helps in diversification of staple crop systems by providing an additional low risk income and food source. There is a diversity among aquaculture systems itself with different scale of operation, different degree of intensity of capital and labour intensity. Some aquaculture systems can be quite intensive and very technologically advanced. Other systems offer strong linkages with agriculture, especially integrated systems and irrigated agriculture (such as rice-fish systems). As for livestock, some aquaculture systems are more directed towards export, other to local markets. As stated above aquaculture is practised at various intensities and scales ranging from extensive with little input and management where fish are fed on natural productivity of the pond; to semi-intensive in fertilised pond and sometime with supplementary feed at low density; and intensive where fish are fed with complete diets at relatively high density, thus fitting well to the capacity of various farming households. Aquaculture practice could be further intensified with provision of water exchange and aeration. Most important is the availability of stable and large market at village and town levels. Wastes and by products of staple crops and livestock emerging from family farming activities can be valuable inputs for aquaculture, while the pond humus obtained during periodical desilting of ponds could be a good source of rich manure for crops.

Integrated fish farming is a process of farming where fish is also farmed in combination with other family farm commodities like dairy, livestock, vegetables, fruits, centered around the fish farm. The system links each of the involved sub-systems such as fish, crops, and livestock, in such a way that the waste or by-products from one sub-system can be used as an input for the next system. An integrated agriculture system can ensure the maximum utilization of all resources, such as land, water, feed and water, and also minimizes building of wastes. Researchers have found that farms that grow only one type of crop tend to have more wastage, higher production costs and less benefits than farms that grow several types of crops in the same farm. In a properly integrated fish, livestock and crop farming system, the waste, excretion and manure from animals can be used as feed for the plants and the leftover waste from plants can be used to feed animals. Excrement from fish and livestock is high in ammonia and nitrogen, which acts as a high-quality fertilizer for farmlands. Water and the bottom silt of fish ponds are also rich in nutrients and can be good sources of fertilizer for irrigating the crop land. Therefore it is possible to integrate a variety of sub-systems in a small area to produce a variety of food items such as fish, meat, vegetables, fruits, eggs, fodder, etc. resulting in lower production costs and wastage and range of nutritious food items for family.

A populous country like India where human resource is the most abundant one the need to ensure proper nutrition for its growing population is of paramount importance. A healthy population with increased productivity and efficiency can significantly contribute to national development. Fish deserves a central position in food security and nutrition strategies. Fish may be made an integral element in inter-sectoral national food security and nutrition policies and programmes with special regard to promoting small-scale production and other policy tools, including nutrition education and inclusion of fish in the mid-day meal programmes and interventions aiming at tackling micronutrient deficiencies especially among children and women. ■

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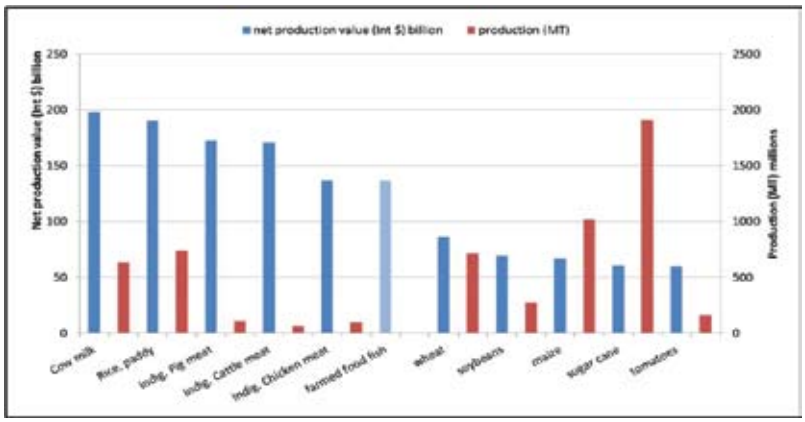
LIVESTOCK AND LIVELIHOOD DEVELOPMENT –KEY FOR EMPOWERING SMALL HOLDER FARMERS

The contribution of Animal Husbandry to the national economy and socio-economic development of the country is highly significant. In rural India, livestock remains as a main source of livelihood where about 80% of them belong to small and marginal farmer's category and 15-20% being landless farmers. Rural families, which are belonging to weak socio-economic conditions of the society, depend mainly on different livestock species to supplement their income.

Agriculture along with Animal Husbandry, Dairying and Fisheries activities continue to be an integral part of livelihood for most of the small holder farmers. Besides livelihood, livestock plays an important role in the maintenance of ecological balance. Livestock plays a significant role for income generation in rural areas, especially with relation to small, landless and marginal farmers and women. Because of this, it provides cheap and nutritious food to millions of people in the world. Agriculture and livestock production are inherently linked with each other, which makes them dependent on each other and it is crucial for food security. Among all the sub-sectors of agriculture, livestock play an important role in the Indian economy.

CONTRIBUTION OF LIVESTOCK FOR GLOBAL LIVELIHOODS

Globally, about 70% of the world's rural poor rely on livestock for their livelihoods. Livestock sector



employs more than 1.3 billion people. There are about 600 million poor livestock keepers, of which around two-third of the population are rural women. Livestock contributes about 40% of the Agriculture Gross Domestic Product (GDP) and about 17% of kilocalorie and 33% of protein are coming from livestock sector. When highest value global commodities are taken into consideration, five out of 6 commodities are from animal source origin and the total value of all five of them is around 715 billion International dollars.

There will be a global rise of around 2 billion human population by 2050. To feed them, we need regular production of around 1 billion tonnes of cereal and 200 million tonnes of livestock every year. Another important issue regarding livestock production is that there is an ever-increasing demand for meat, milk and egg globally. The demand will be comparatively greater in South Asian and Sub-Saharan Africa.

CHALLENGES IN LIVESTOCK PRODUCTION

The primary challenge is to ensure decent livelihood for livestock keepers and enhancing the productivity to narrow yield gaps within specific farm systems. Other important issues are adjusting to pressure on ecosystems, natural and genetic resources and tackling environmental externalities.Adaptation towards climate change and extreme weather events is necessary for sustainable livestock production. Reduction in Green House Gases (GHG) emission also has to be taken into consideration in livestock production. Emergence of various zoonotic and foodborne diseases should be contemplated. Livestock production is highly helpful in improving food and nutritional security. Identification of certain policies and actions that are necessary for the contribution of sustainable agricultural development is crucial. Spread and outreach of small-scale livestock holders are highly necessary for efficient livestock production. An important factor, which is very much obligatory in livestock production, is the technology mindset and understanding various developmental issues. Market access of rural livestock keepers is an important factor that should be taken into consideration so that the promotion of livestock production will be more.

DOMINANCE OF SMALL-HOLDERS LIVESTOCK REARER IN THE LIVESTOCK PRODUCTS IN MANY COUNTRIES

Region (definition of 'smallholder')	% production by smallholder livestock farms					
	Beef	Chicken meat	Sheep/ goat meat	Milk	Pork	Eggs
East Africa (≤ 6 milking animals)				60-90		
Bangladesh (< 3ha land)	65	77	78	65	-	77
India (< 2ha land)	75	92	92	69		71
Vietnam (small scale)					80	
Philippines (backyard)		50			35	

(Source: BMGF, FAO, ILRI)

TRENDS AND TECHNIQUES FOR THE ADVANCEMENT OF LIVESTOCK PRODUCTION

ANIMAL GENETICS

Rates of genetic change have increased in recent decades in most species in developed countries for several reasons, like use of more efficient statistical methods for estimating the genetic merit of animals, the wider use of biotechnological intervention technologies such as artificial insemination and more focused selection on objective traits such as milk yield, etc. The greatest gains have been made in poultry and pigs, with smaller gains in dairy cattle,

particularly in developed countries and in the more industrialized production systems of some developing countries. Some of this has been achieved through the widespread use of breed substitution that led to the predominance of a few highly specialized breeds, within which the genetic selection goals may be narrowly focused.

Because of the advancement in animal genetics and breeding, apart from increase in production and productivity, there will be a gradual improvement in other strategies which includes disease resistance, quality livestock product production, increasing animal welfare and reduces the environmental impact.

DISEASE SURVEILLANCE

Animal diseases have got a greater impact of generating various socio-economic impacts and losses, both to the country and globally, as well. These impacts may be either direct or indirect. Direct impact indicates the morbidity and mortality of the animals and direct loss in production strategies and livestock population. Indirect impacts include various disease outbreaks which lead to suppression in immune response and also there will be decrease in production. There was a decline of disease burden in livestock, because of the greatest improvement in diagnostic technologies and improvement in vaccine production and development of effective drugs. But at the same time, there is a greater increase in the emergence of new diseases which are of global concern. Most of the newly emerged diseases are of high concern because about 75% of them are zoonotic in nature. However, in many developed and developing countries, several deadly diseases have been eradicated because of their quality veterinary services including vaccination.In various developing countries, the greatest difficulty in assessing the impact of various deadly diseases is mainly because of reduced availability or lack of disease strategy data.

Another important strategy which should be taken into consideration associated with disease transmission is import and export of livestock products. Trade, travel and migration tend to promote gradual increase in the transmission of various diseases. Trade associated with exotic species has got an increased impact of transmitting various deadly diseases. Trade associated with large scale animal production systems are highly suitable for transmitting various deadly pathological diseases.

For the future, various strategies and factors should be taken into for emergence of unexpected deadly diseases that can affect the livestock population and production strategies.Those advancement in the diagnostics should include various strategies including the adaptable, flexible and easily accessible techniques. When developing countries are considered, these diagnostic techniques should be easily accessible and cheaper.

CLIMATE CHANGE

Climate change has got a greater impact in the animal production system. Because of the sudden changes in the climate and environment, there is a decline associated with animal production systems.The productivity of animal can be affected both indirectly and directly by the climatic conditions. Indirect factors include temperature, relative humidity, air movement, solar radiation, barometric pressure and rainfall. Direct factors include the stimulation of neuro-endocrine system and loss or conservation of heat to maintain the body temperature. Environment can directly affect other endocrine and enzyme systems.

Milk yield of all mammalian species undergoes seasonal

variations. Decline is very high in high humidity areas when compared to areas with low humidity. Milk production decreases approximately 1 kg for each degree (^{0}C) rise above the normal range. Optimal environmental temperature for lactation is mainly dependent on species, breed and degree of tolerance to heat or cold. Milk constituents may increase or decrease when exposed to high environmental temperature with different levels of relative humidity.

Climatic conditions which include temperature, humidity, air movement and radiation may impose stress in the rate of prenatal, pre-weaning and post-weaning growth. Animal growth after weaning can be stunted by high environmental temperatures and the degree varies with breed, age, fatness, plane of nutrition and relative humidity. Animals lose more weight during the winter when kept out of doors than similar animals kept indoors. Nutritional requirements of the animal are highly dependent on environmental temperature. Reduction or cessation of body growth at high temperature is apparently due to a reduction in voluntary feed intake, increase in energy expended for heat dissipation, particularly through respiration enhancement, reduction in the amount of nitrogen, fat, or water stored and changes in the differential growth of body organs. Response of wool growth to the environment varies according to breed of sheep, physical condition of the animals, plane of nutrition, sex, shearing and seasonal and diurnal variation in environmental temperature and photoperiod. Quantity and quality of semen vary with the season of the year.

ANIMAL NUTRITION

The exact prediction of animal growth, animal performance, feed composition and expulsion of waste products are highly essential in analysing the nutritive requirements. These factors are highly useful for improving the efficacy and accuracy of analysing the nutritive requirements of the animals. However the advancement in the fields of nutritional proteomics, metabolomics and transcriptomics helps in getting the desired achievement of measuring different nutritional strategies. Better understanding of animal nutrition is highly recommended to understand the desired nutritional requirements of the animals and to prevent the unwanted economic loss because of high feed cost. At the same time, the minimum nutritional requirements of the animal has to be taken into consideration, otherwise there will be a greater decline in the normal production strategies.

When animal nutrition is taken into consideration, there are various strategies which act as a major hindrance. The main hindrance includes reduced availability of feed and fodder. Because of this, the landless farmers have to purchase the fodder. But it is highly complicated for the small scale farmers to purchase fodder and feed the animal. So they tend to allow the animal for grazing to a poor quality fodder or those fodders of not any nutritive value. This will obviously end up in

the reduction in the performance of animals. Another important factor is that some farmers tend to over feed the animals. This obviously ends up in the economic losses.

Various simple scientific techniques are available nowadays to enhance the nutritive value of poor quality roughages. This should be taken into consideration and the farmers must be made aware of these nutritional techniques, so that they can make use of that reduce the cost for feed. Likewise, various new varieties of fodders are available which yield more in a shorter time and also have got high nutritive value.

ACTIONS FOR TRANSFORMING LIVESTOCK AGRICULTURE

Ensuring livelihood security for smallholder livestock farmers, the transformation of livestock agriculture is of paramount importance. Another principle key factor for enhancement of livestock agriculture is attracting and retaining the youth population in agriculture. Skill and human resource development are the two important strategies that are needed for the diversification in employment. Linking smallholder farmers with the market facilities are highly advantageous in promoting more number of farmers to get engaged with livestock production. Intensification of livestock production for smallholder and landless farmers is also necessary for the promotion of livestock production. Management of natural resources and climate change remains as an important international perspective.

Group activities and group dynamics of smallholder farmers, Self Help Groups (SHG) and producer co-operatives are also to be taken care off. Small scale farmers must be made aware of mechanization and post-harvest technologies. Various policy issues should be created to ensure the protection of livestock farmers. Women empowerment in agriculture is highly crucial for the promotion and transformation of livestock agriculture. Credit flow and insurance support to farmers are also highly necessary to promote livestock production among rural population.

The requirements for livestock products will increase drastically in the future. Last three decades, there was a tremendous increase in livestock production, which is mainly because of the advancement in various fields which include animal genetics and breeding, animal nutrition and disease surveillance. In the future, the livestock production is going to change drastically, however there will be a greater difference between developed and developing countries; also between highly intensified production systems and small holders livestock production. Increase in livestock production may lead to the challenges or competetion of livestock with human for land, for feed and fodder and water. Smallholders play critical role in the development of sustainable and profitable livestock production system, which is very much necessary for creating an innovation in national and global livestock systems. Global livestock production scenario will be undergoing a drastic change in the years to come, which is very much essential for staple livestock production systems that is highly necessary to maintain the wellbeing of millions and billions of people. ■

CLIMATE CHANGE AND AGRICULTURE

CLIMATE CHANGE AND ITS IMPACT ON GLOBAL AGRICULTURE

Climate change has adversely impacted agriculture as a whole, the very foundation of food for human beings. Fig 10 shows how carbon dioxide as a green house gas emitted from burning of fossil fuel and some of the intensively polluting industrial processes is occupying more than 65% of the different green house gasses. Forestry and other land use is emitting another 11% of total CO_2. Similarly, Fig 11 and Fig 12 indicate how different countries and different sectors of the economy is adding green house gases. China as a country is the biggest polluter and agriculture, forestry and other land use activities of human beings across the globe is the second largest contributor in global emissions.

Following are some of the recent Studies Revealing the Alarming Impacts of Climate Change on Agriculture and Food Security:

- A recent study mapped the impact of the current global green house gas production to the global vegetable

Fig 25: Contribution of Greenhouse Gases

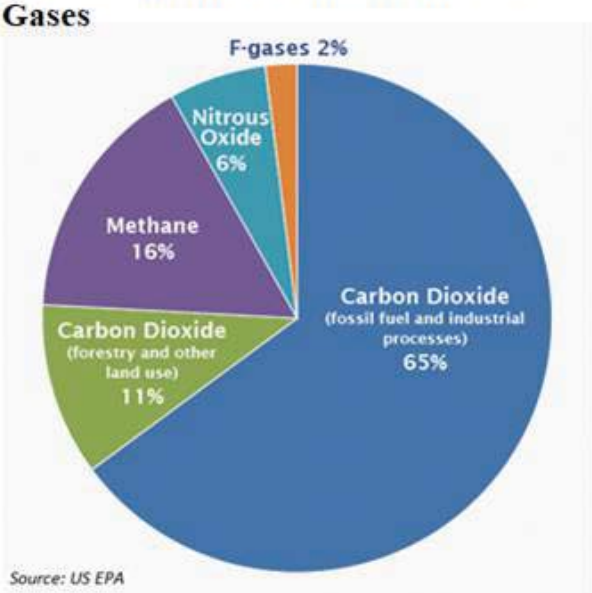
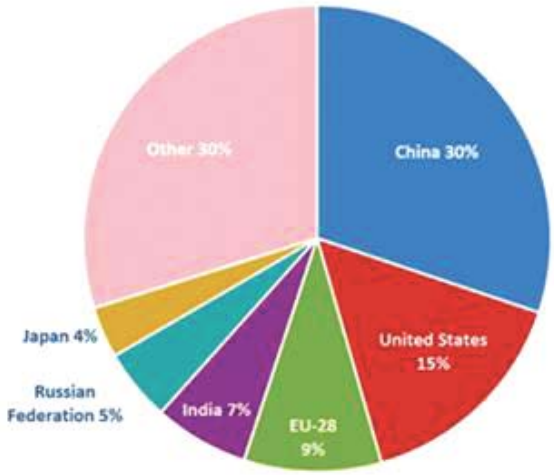
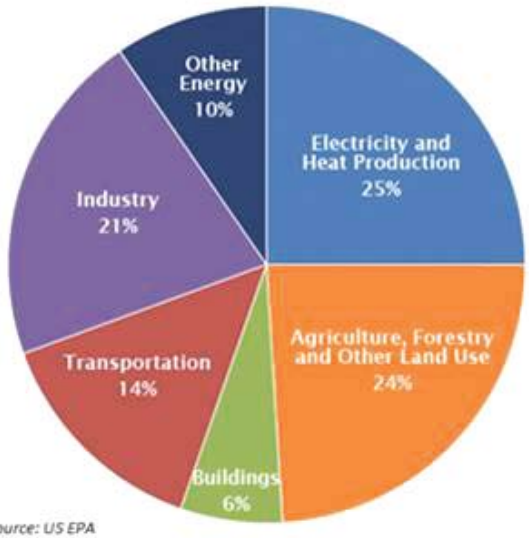


Fig 26: Global CO_2 Emmissions by Countries-2014 (from fossil fuel combustion and few industrial processes)



Source: US EPA

Fig27: Contribution of Different Sectors to Global Emissions (2014)



Source: US EPA

According to a report in 2011, for every degree Celsius that the global temperature rises, there will be a 5 to 15 percent decrease in overall crop production

and legume production. It was concluded that if the green house gases continue to rise at the current level, the world production of vegetables and legumes will come down by 35% by the year 2100.

- Findings of various scientific studies have one common conclusion about the rise of the world's temperature. The global temperature is destined to rise by about 4 degree Celsius by the year 2100. In such a situation, the global corn production could decrease by 50 %.
- Even if the rise of temperature is contained up to 2 degree Celsius according to Paris climate accord, still the production of corn will come down by 18%.
- Yields of various crops are decreasing as a result of climate change and rise in temperature. In addition, climate change is altering rainfall patterns around the world. Increased temperature leads to holding of more moisture by warmer air envelop, causing more intense precipitation. This is the reason these days extreme precipitation events are becoming more common, thereby directly damaging crops and resulting in decreased yields.
- Flash floods are becoming more common these days as a result of climate change which is damaging crops worldwide.
- Hotter air is also causing faster evaporation of surface water causing droughts and decreasing crop production.
- For an important crop like rice which is a staple food for more than half of the global population, drought and water shortages are expected to affect the production of rice.
- There are 23 million hectares under rice cultivation in South and Southeast Asia which are entirely rainfed. There areas are already subject to water scarcity. In the rainfed rice growing areas of Africa, recurring drought affects almost 80 percent of the area under rice cultivation.

Managing water in non-irrigated and irrigated cultivation

Hungarian technology's contribution to the climate change adaptation.

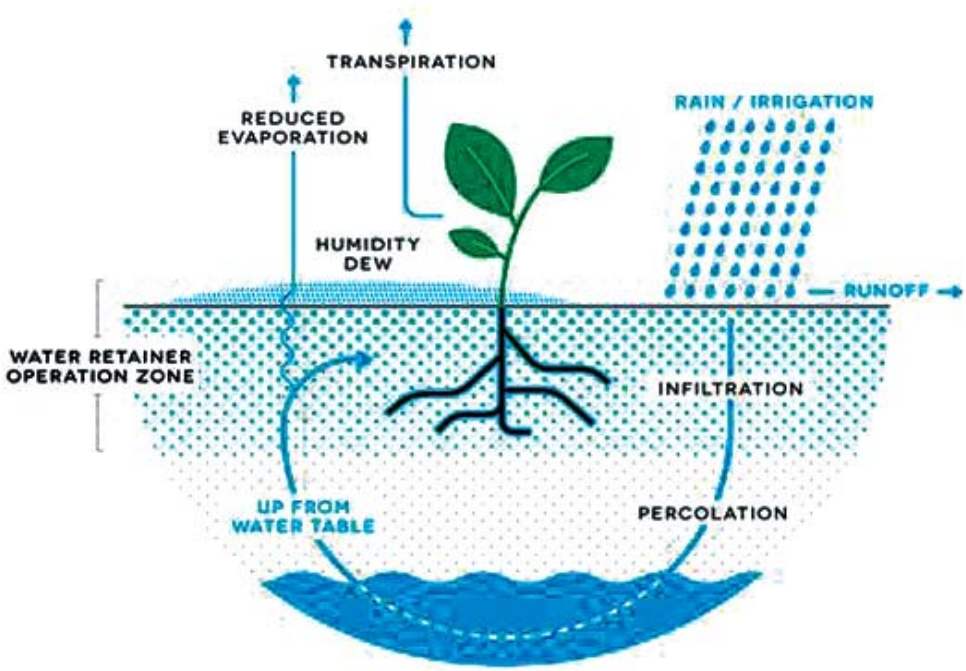
Richard Vattay
Director,
Water&Soil Ltd.

According to FAO data, 3.2 billion hectares of arable land globally are affected by water stress. At the same time, population growth is putting further pressure on agricultural production; more food will be required with less water available. As demonstrated across Europe, North America and Australia throughout 2018, drought is becoming more frequent and typically lasts longer. Economic losses originating from drought in just California in 2012 was estimated at $2.7 billion. Other adverse impacts of drought include soil erosion, degradation, and competition for scarce water resources.

Effective water management is vital for soil health and good crop yields. The WATER RETAINER is designed to achieve this. Topically applied as a physical soil conditioner, its efficacy is independent of the soil and plant type and it does not adversely impact either. The WATER RETAINER obtained from food industry is a by-product of vegetable origin, with high content of organic matter; absorbent, moistening and surfactant substances; protected mixture of water.

The WATER RETAINER offers the international agricultural market a safe, affordable and commercially attractive product to mitigate the increasing impacts of water stress and drought, and dramatically improve production yields. The WATER RETAINER is a novel liquid product that is applied by spraying to the soil surface, and without the need for specialized equipment. It reduces the irrigation water use by up to 50 % in irrigated cultivation or provides higher yield in not-irrigated cultivation as crops can survive the drought longer.

The Water Retainer has been developed and brought to market by Water&Soil® Ltd., Hungary.



THE TECHNOLOGY:

The WATER RETAINER:

- Is a water soluble liquid, which is sprayed onto the surface of the soil;
- Reduces evaporation loss whilst also absorbing humidity from the air to the soil;
- Is organic, and degrades without any residues within three months of application;
- Can be used as a repeated treatment.

When water rises through the capillary system and reaches the upper layers of the soil - where air is present - it changes from liquid to water vapour. Normally this is lost to the atmosphere *via* evaporation. The WATER RETAINER absorbs a part of this moisture, transforming it back in to liquid water, retaining it in the soil and thereby making it available to plants and microbes. In addition, it can draw humidity from the air above the soil surface (when humidity of the air is over 50%).

The photos below show

drops of WATER RETAINER under a microscope. The second photo was taken after one hour, showing absorption of humidity from the air.

The WATER RETAINER can be applied by either spraying on the surface or dissolved within irrigation water. Different levels of dilution are possible. Typically the dosage is 1 ml/m^2 on most of the plants (10 litres/hectare); grass needs 2 ml/m^2. No specialist application equipment is required. It may also be applied in combination with other treatments to save cost e.g., with pre-emergent herbicides.

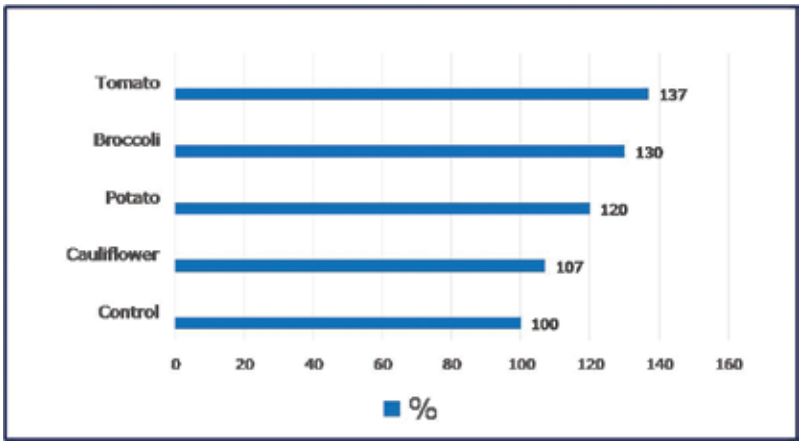
The WATER RETAINER will attach itself to both the roots of the plant and the soil particles, thus allowing water – either by rain or irrigation – entering the soil to trickle down to the water table, increasing the water reserve. The WATER RETAINER is activated when vapour moves upwards though the capillaries, becoming trapped in the soil voids and transforming into tiny water droplets. These droplets can be drawn upon by the plant roots to absorb water. Meanwhile, the product sprayed on the surface also absorbs humidity from the ambient air. Test shows that the WATER RETAINER can reduce the evaporation loss by 40%.

Generally, the effects last for 3 months, during which period – assuming appropriate application of the WATER RETAINER – the soil's water retention ability is substantially increased. Soil humidity may be increased by 40% for the favour of the Water Retainer treated. Application during the germination and developmental stage of plants, results in better hydration that will last longer in the cultivation period. Different climatic zones may require different dosages due to different evaporation pressure.

BENEFITS

- Reduction in irrigation water consumption by up to 50%, e.g. reducing water usage at every irrigation session, or increasing intervals between sessions. This creates huge cost savings in water, energy, labour, maintenance.
- Substantially lowers drought damage in crops. Plants may survive twice as long in drought conditions without serious damage, alleviating yield losses,

Figure 1: Yield Increase



(Source: individual growers data, aggregated by W&S)

while the lower stress level will result in better yield results.

- Reduces detrimental changes to soil condition caused by drought. Dried out soil can become water repellent, which in turn increases the chance of soil panning and causing an overall yield loss. The detrimental effects may be felt for years.
- Less soil compaction due to less irrigation.
- The better soil humidity results in more intensive microbiologic soil life and this results less soil degradation.
- Better soil humidity creates safer germination.
- Application can be beneficial for quicker and better quality reestablishment of vegetation, e.g. post forest fire.
- Registered for use in organic farming according to EU regulations.
- Less water use for irrigation helps saving the groundwater reserves. This is especially huge problem in India.

Independent field trails have been undertaken since 2013 in a number of geographies and across a broad range of crops. All have shown a significant benefit to the farmer in terms of improved yield, reduced costs and return on investment. For example, Figure adjacent, presents the results from trials in Hungary and Poland which indicated yield increases of up to 37 %, depending on the crop.

The Water retainer saved 50% of the drip irrigation water for two months with one treatment in Marrakech, Morocco. The area is very arid with less than 200 mm precipitation in a year. The tree dries if it is not irrigated for 5 days.

Germination and plant development showed significant difference in not irrigated oil pumpkin (similar to water melon) cultivation. This crop has high water demand.

Not treated

Treated with the Water Retainer

APPLICATION POSSIBILITIES:

- Arable (broad acre) agriculture: maize (corn), sunflower, cotton, sugar beet, etc.
- Vegetable growing: tomato, chilli, onion, potato, sweet potato (batata), carrot, beans, etc.
- Horticulture: flowers, seedling, sapling,
- Permanent orchard: citrus, olive, vineyard, tea, coffee, mango, peach, apple, etc.
- Grass (lawn): city parks, sport fields, grass growers, private gardens. ■

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Kaushal Jaiswal
Managing Director
Rivulis Irrigation India Pvt. Ltd.

WATER SCARCITY IN INDIA - A TICKING TIME BOMB

The issue of water scarcity was first raised in the United Nations Conference on Environment and Development at Rio de Janeiro, Brazil, in 1992. Since then, each year, March 22 is observed across the world to shine the spotlight on different water-related issues. A UN report on water conservation published in March 2017 reveals that due to its unique geographical position in South Asia, the Indian sub-continent will face the brunt of the water crisis and India would be worst affected.. By 2025, the report predicts, nearly 3.4 billion people worldwide will be living in 'water-scarce' countries and that the situation will become even more dire over the next 25 years.

We all know that water is the most critical input in agriculture. High quality seeds,goodnutrition and best of crop protection techniques will fail to achieve their full potential if plants are not optimally watered. India accounts for about 10.5% of the world's arable land and 17% of world population but only 4% of the world fresh water is available in India. Due to absence of integrated water resource management system and climate change, India faces a persistent water shortage.

India's annual rainfall is around 1183 mm, out of which 75% is received in a short span of four months during monsoon (June to September). India receives an average of 4,000 billion cubic meters of precipitation every year. However, only 48% of it is used in India's surface and groundwater bodies. Lack of adequate

infrastructure, inappropriate water management has created a situation where only 18-20% of the water is actually used. Official data shows that in the past decade, annual per capita availability of water in the country has plummeted significantly. As per the international norms, a country is classified as water stressed and water scarce if per capita water availability goes below 1700 m^3 and 1000 m^3, respectively. With 1544 m^3 per capita water availability, India is already a water-stressed country and is moving towards turning into water scarce.

It is not only agriculture but another area of concern is the water intensive Industries. India's economic growth has been gargantuan in the last decade. Steel and energy sector will need to keep pace in order to fulfill the demands of sectors like manufacturing and infrastructure.Water scarcity is an issue of increasing concern for India's thermal power plants as well. According to a report by World Resources Institute, researchers found that about 40 percent of the power plants in India that rely on freshwater for cooling purposes are in water-stressed areas and more are expected to move into that category in coming years.Fourteen of India's 20 largest thermal utilities experienced at least one shutdown due to water shortages between 2013-2016, costing the companies $1.4 billion, according to the report entitled – "Parched Power: Water Demands, Risks, and Opportunities for India's Power Sector." The problem is only likely to worsen with time unless the country takes some solid measures to address it. Currently, 83 percent of India's total electricity comes from thermal power plants that rely on freshwater for cooling purposes,

according to the report.

Indian agriculture is crucially dependent on favorable monsoon. Southwest monsoon is critical in securing water for irrigating crops. In some parts of India, the lack of monsoons result in water shortages, resulting in below-average crop yields. This particularly occurs in major drought-prone regions such as Southern and Eastern Maharashtra , Northern Karnataka , Andhra Pradesh, Odisha , Telangana and Rajasthan .

India has about 161 million ha of arable land. About 42% of the country's cultivable land lies in drought-prone areas/districts. The population of India is likely to be 1.6 billion by 2050, resulting in increased demand for water, food and energy. This calls for infrastructure expansion and improved resource utilization.

It is worth mentioning that climate change will have negative impact on agricultural productivity ranging from crop selection; time of cultivation, irrigation methods etc. Rice, wheat and sugarcane constitute about 90% of India's crop production and these are the most water consuming crops. Rice, which is an important crop, consumes as much as 3,500-4000 lit of water for a kilogram of grain produced.

Globally, about 40% of irrigation water is supplied from groundwater and in India more than 60% of irrigation is done by utilizing ground water. About 42 million ha of area is irrigated by exploiting ground water. The Central Groundwater Board has categorized 16.2 % of Blocks (Mandals or Taluka) numbering 6607 as 'Over-exploited'. It has categorized an additional 14% as either at 'critical' or 'semi-critical' stage. States with the highest dependency on ground water for irrigation include Punjab (79% of the area irrigated is by tube-wells and wells), Uttar Pradesh (80%) and Uttarakhand (67%).

At present, irrigation consumes about 84% of total available water. Industrial and domestic sectors consume about 12% and 4 %of total available water, respectively. With irrigation being the biggest user of water, the efficiency of water use must improve to expand area under irrigation while also conserving water.

Over the years, there has been significant shift in the sources of irrigation. The share of canal in net irrigated area has declined from 39.8 % in 1950-51 to 23.6 % in 2012-13. Alongside, the share of groundwater sources has increased from 28.7 % to a whopping 62.4 % during the same

period. Injudicious utilization of groundwater through the explosion of tube wells combined with flood irrigation has raised several sustainability issues.

Agriculture is the biggest cause of use and misuse of water. If we really want to correct the situation we need to address irrigation first because this one sector alone consumes more than 80% of water. Here comes the role of water efficient irrigation methods. The challenge is to educate farmers about judicious use of water and equip them with micro irrigation systems and do it in a sustainable manner. The government of India along with various state governments are trying hard to increase the adoption of micro irrigation .

The Government of India has been implementing Centrally Sponsored Scheme on Micro Irrigation with the objective to enhance water use efficiency in the agriculture sector by promoting appropriate technological interventions like drip & sprinkler irrigation technologies and encouraging the farmers to use water saving and conservation technologies.

The Scheme was launched by the Department of Agriculture & Cooperation, Ministry of Agriculture in January, 2006 as Centrally Sponsored Scheme on Micro Irrigation (CSS). In June, 2010, it was up-scaled to National Mission on Micro Irrigation (NMMI), which continued till the year 2013-14. From 1st April, 2014, NMMI was subsumed under National Mission on Sustainable Agriculture (NMSA) and implemented as On Farm Water Management (OFWM) during the financial year 2014-15. From 1st April 2015, Micro Irrigation component of OFWM has been subsumed under Pradhan Mantri Krishi SinchayeeYojana (PMKSY).

The study of NMMI was conducted by Global Agri. System and their Impact Evaluation Study report (June 2014) brings-forth that following benefits have accrued on adoption of Micro Irrigation—

- Saving of irrigation water from 20 to 48%
- Energy saving from 10 to 17%
- Saving of labour cost from 30 to 40%
- Saving of fertilizers from 11 to 19%
- Increase in crop production from 20 to 38%

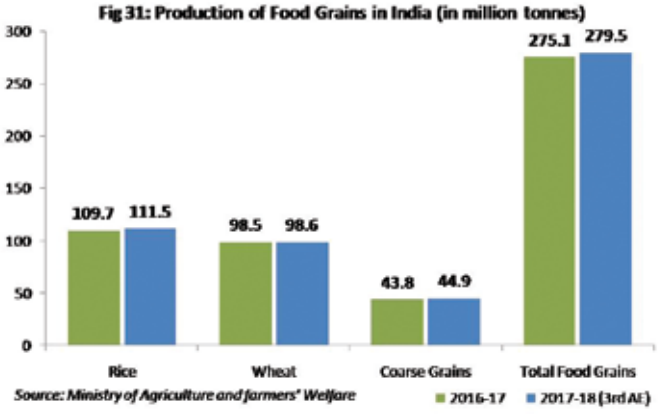
Several regions in the country are experiencing water stress. If water use efficiency does not improve, the country could suffer under water scarcity in the next 1 to 2 decades. This is the fact that there is decrease in available water resources that has implications on India's agriculture sector. Water situation in India need to be looked at more holistic manner. Apart from pushing the adoption of micro irrigation we must also review current trend of producing water intensive crops, such as sugarcane and rice in water scarce areas.

Agriculture Production in India

In the recent years, record agricultural production has considerably brightened the near-term outlook of the Indian economy as a whole. A total of 275.1 million tonnes and 279.5 million tonnes of food grains were produced in the country in 2016-17 and 2017-18 respectively, which is a record (Fig 31). Production of rice increased from 109.7 million tonnes in 2016-17 to 111.5 million tonnes in 2017-18. A normal monsoon for the third consecutive year should lift agricultural output even this year too. Imports resulted in excess supply conditions in key crops such as rice, wheat, pulses and oil seeds. This in turn has resulted in prolonged deflation in the prices of pulses and oilseeds. This has also led to record buffer stock levels of rice and wheat which is the highest in five years. Good production and sizable erosion in the terms of trade of the farm sector under the weight of this supply glut emerged as an area of concern for the economy for some time. Overall, agricultural production is likely to remain strong for the third consecutive year.

In 2016-17, India produced a total of 23.1 million tonnes of pulses which increased to 24.5 million tonnes in 2017-18 (Fig 32). Increase in production of pulses is a

Fig 31: Production of Food Grains in India (in million tonnes)



significant achievement and the 2016-17 production figure is higher by 3.7 million tonnes than the previous record production which took place in 2013-14.

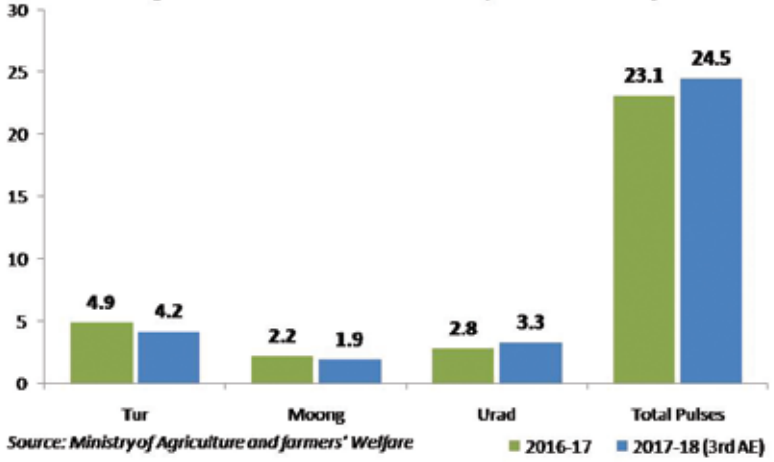
Various high-yielding varieties of pulses comprising 10 of chickpea, 6 of lentil, 4 of cowpea, 3 of mungbean, 2 each of pigeonpea, horse gram and field pea, 1 each of urdbean, rajmash and faba bean were released for different agro-ecological regions across the country.

When it comes to oilseeds, 28 high yielding oilseeds varieties comprising 8 of rapeseed-mustard, 5 of soybean, 4 each of groundnut and linseed, 3 of sunflower, 2 each of castor and niger were released for different agro-ecological regions in the previous year. Riding on a healthy and timely monsoon, India's total oilseed production may top 38.8 million tonnes in 2018-19. Total oilseeds production in 2016-17 and 2017-18 were 31.3 and 30.6 million tonnes respectively. The total oilseeds production in 2017-18 was driven particularly by increase in kharif peanuts production, which was about 6.6 million tonnes (Fig 33).

Production of cotton in 2016-17 was 32.6 million bales, 10.3 per cent increase than the previous year. In 2017-18, the production further increased to about 35 million bales (of 170 kg each). In the recent years, 13 new varieties of cotton were released for commercial cultivation. Even though crop damage occurred due to floods in Gujarat, the largest cotton producing state, India's cotton output in 2017-18 witnessed increase in overall production because of favourable monsoon in most parts of key growing states such as Maharashtra and Andhra Pradesh, and in North India.

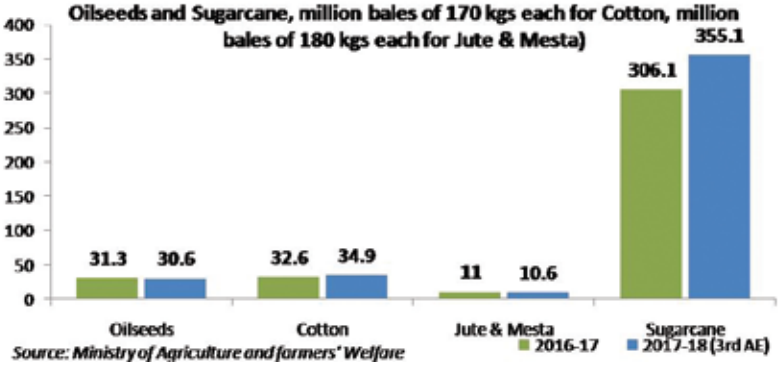
Especially of the eastern region of the country, jute sector has been playing an important role in the economy. Raw jute (jute and mesta) farming,

Fig 32: Production of Pulses in India (in million tonnes)



Source: Ministry of Agriculture and farmers' Welfare

Fig 33: Production of Other Major Crops in India (in million tonnes for Oilseeds and Sugarcane, million bales of 170 kgs each for Cotton, million bales of 180 kgs each for Jute & Mesta)

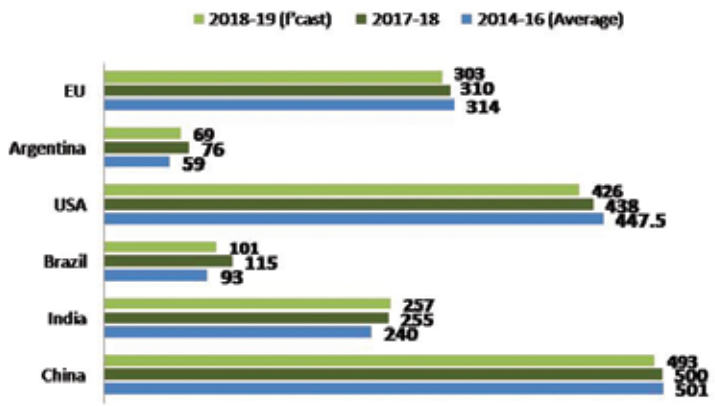


Source: Ministry of Agriculture and farmers' Welfare

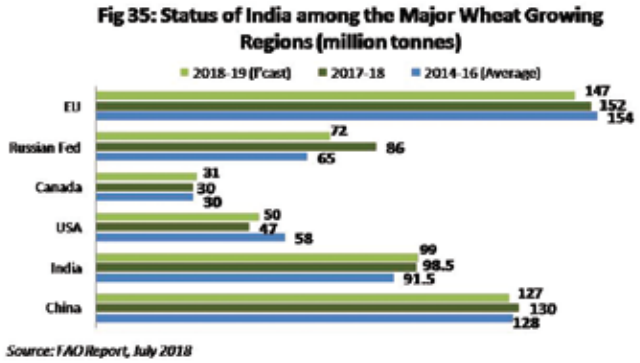
industry and trade provide livelihood support to about 5 million people in India and it is grown in an area of about 1.0 million ha. The current production of Jute and Mesta hover around 11 million bales of 180 kgs each.

Sugarcane is one of those crops which still have the potential to help in doubling farmers' income in areas where it is grown. Unfortunately, India's domestic sugar market is currently in the doldrums as the price of sugar in the international market has been falling. Year 2017-18 witnessed

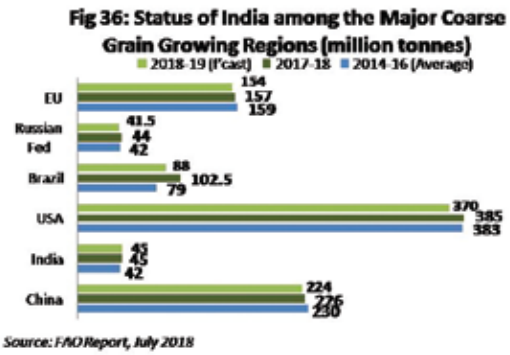
Fig 34: Status of India among the Major Cereal Growing Regions (million tonnes)



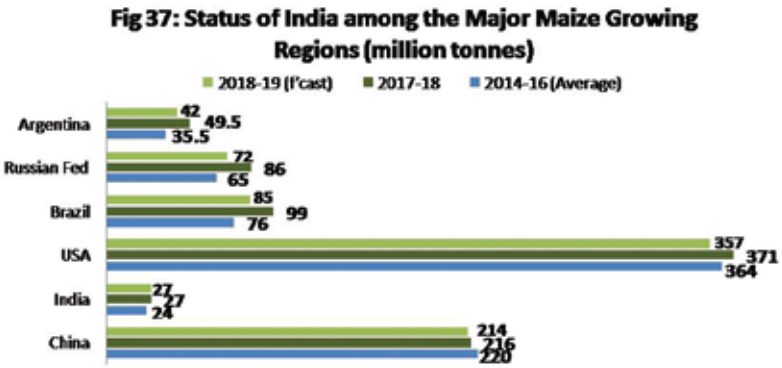
Source: FAO Report, July 2018



Source: FAO Report, July 2018



Source: FAO Report, July 2018



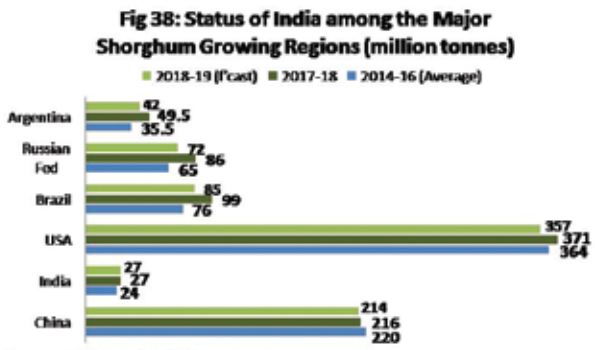
Source: FAO Report, July 2018

significantly higher production of sugarcane which increased to 355.1 million tonnes from 306.1 million tonnes in the previous year of 2016-17.

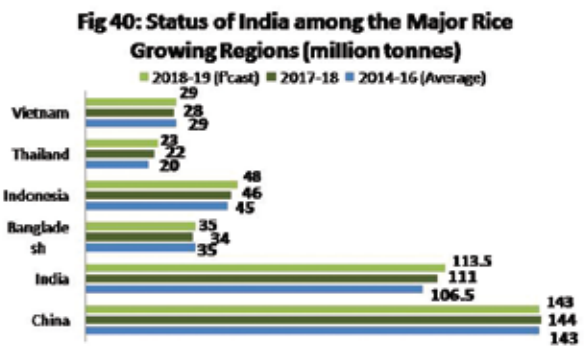
India is the second largest producer of cereals behind China. However, while the production of cereals is witnessing marginal decline in China over the past few years, India's production has been on the increasing path. The average total production of cereals in India from 2014 to 2016 was about 240 million tonnes. It increased to 255 million tonnes in 2017-18 and the production forecast for this year is 257 million tonnes (Fig 34). This is a CAGR growth of 2.3%. The production of rice in India can be expected to keep increasing driven by good monsoon this year and the increased MSP declared recently by the Government.

India is the third largest producer of wheat in the world. With China producing around 130 million tonnes of wheat, it has been the leading wheat producing country in the world. However, India's production of wheat (unlike China which has witnessed marginal decline in production) has increased significantly in the recent few years. The average production of wheat in India during 2014 to 2016 was 91.5 million tonnes. The forecast production this year in 2018-19 is 99 million tonnes. This marks a CAGR of 2.6% between these years.

India's position in the league of major coarse grain producing countries in the world is relatively weaker with current production figures of about 45 million tonnes. China (226 million tonnes), USA (385 million



Source: FAO Report, July 2018



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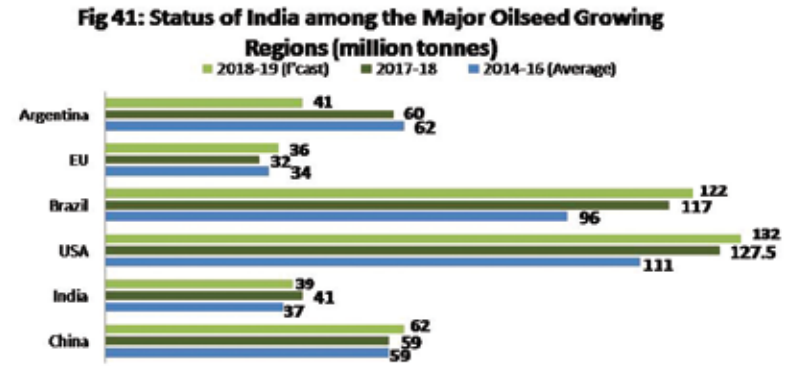


Source: USDA

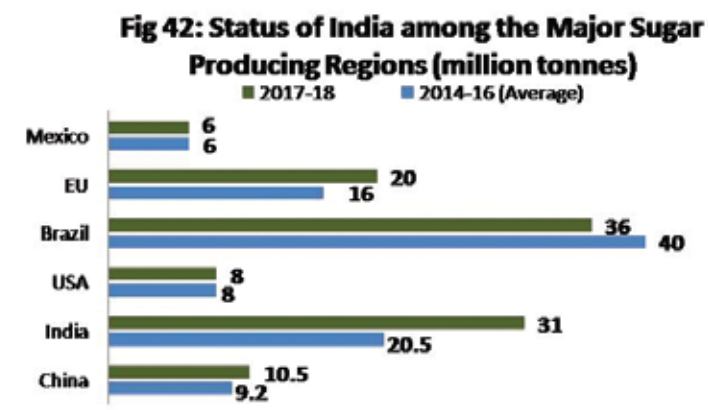
tonnes) and European Union (157 million tonnes) are much ahead of India in terms of coarse grains production. However, the positive thing is that while all of these major producers are witnessing a relative marginal decline in production in the recent years, India's production of coarse grains are is following an increasing pattern. Similar is the pattern with maize production in India when compared to the leading maize production countries of the world.

Sorghum is the fifth most important cereal crop in the world after wheat, maize, rice, and barley. It is cultivated for grain and as a major food crop in much of South Asia including India, apart from Africa and Central America. In USA, Australia and South America, sorghum is grown mainly for animal feed. USA is the global leader in sorghum production and in 2017-18, it produced a total of 371 million tonnes of sorghum. China follows USA in terms of sorghum production and in 2017-18, it produced 216 million tonnes. India's production is comparatively meagre and in 2017-18, India produced 27 million tonnes of sorghum. Brazil, Russian federation and Argentina are the other important regions.

India is the second largest producer of rice in the world. Production of rice in India in the recent years has been showcasing an increasing trend. The average production of three years from 2014 to 2016 was 106.5 million tonnes which increased to 111 million tonnes in 2017-18. The production forecast for this production year of 2018-19 is pegged at 113.5 million tonnes. China remains as the leading rice producing country on earth with a production of 144 million tonnes. However, the production forecast for China this production year will be marginally lower at 143 million tonnes.

India is comparatively still a lower producer of oilseeds, though the overall production has been increasing in the recent years. In 2017-18, total production of oilseeds in India was 41 million tonnes which was significantly more than the average production of 37 million tonnes from 2014 to 2016. USA is the leader in production of oilseeds in the world. In 2017-18, it produced a total of 127.5 million tonnes and the forecast production figure for the current production year of 2018-19 is 132 million tonnes. Brazil has been significantly increasing its oilseeds production in the recent years. As the second largest producer of oilseeds in the world, Brazil has increased its production from 96 million tonnes as the average total from 2014 to 2016 to a forecast production of 122 million tonnes this year. This marks a CAGR of 8% over the said years.

In terms of sugar production, India is just behind Brazil as the second largest sugar producing country in the world. In 2017-18, the total production of sugar in the country was 31 million tonnes which marks a significant increase from the average production figures of three years combined together from 2014 to 2016. World sugar production as well as consumption is set to grow in line with its long-term trend but the price will remain low because of significant increase in production in countries like India and Brazil. ■



Source: USDA

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EXECUTIVE EDUCATION PROGRAMME
Indian Institute of Management Ahmedabad

AGRICULTURAL INPUT MARKETING
January 21 - 26, 2019

The marketing of agricultural input, though having a huge potential is becoming increasingly competitive and challenging over the years. The main objective of the programme is to impart a clear foundation of professional marketing skills and knowledge to the participants for the marketing of agricultural inputs. Comprehensive marketing strategy formulation and effective strategy implementation in a competitive market are given substantial importance. This programme is designed for Executives/Managers/Officers dealing with marketing of agricultural inputs such as seeds, fertilizers, crop protection products, farm machinery and equipment, feeds, organic products, biotech products and other agricultural inputs.

Faculty Chair: Professor Poornima Varma https://web.iima.ac.in/exed/programme-details.php?id=NDc0

MANAGING CONTRACT FARMING
February 11 - 15, 2019

Contract farming has been receiving increasing attention from agribusiness firms as well as the government for more than a decade now. While agribusiness firms view it as a tool for managing raw materials, the government considers it as an avenue to develop markets, transfer technology, provide inputs including credit, etc. to small farmers. A large number of agribusiness firms have undertaken contract farming for a number of agricultural and horticultural crops/produce. Indian Institute of Management Ahmedabad's Centre for Mgt. in Agriculture (CMA) has conducted studies on contract farming operations across crops and regions and companies over the last decade to document the experiences of firms and farmers. This programme is focused on building skills and orientations for undertaking and managing contract farming as a strategic competitive advantage building function. The objective is to develop a broader understanding of the concept and develop skills in designing and implementing contract farming programmes based on Indian and global experiences. The program is suitable for executives involved in planning or managing contract farming or those interested in assessing its value for their business and understanding the regulatory and policy aspects around it.

Faculty Chair: Professor Sukhpal Singh https://web.iima.ac.in/exed/programme-details.php?id=NDc1

RURAL MARKETING
February 25 - March 1, 2019

Rural markets are gaining importance in emerging economies. A large number of businesses are involved in the marketing of various products in the rural areas of India and elsewhere. The main objective of this programme is to develop a strong foundation of concepts, approaches, applied knowledge and analytical skills in the participants for successful marketing of products and services to rural consumers and users. This programme focusses on segmentation, pricing, distribution, product planning and management, , promotion and new market exploration. Executives from companies/NGOs exploring new rural markets or trying new products in rural markets or marketing rural food/non-farm products in urban markets will find this programme useful.

Faculty Chair: Professor Sukhpal Singh https://web.iima.ac.in/exed/programme-details.php?id=NDc3

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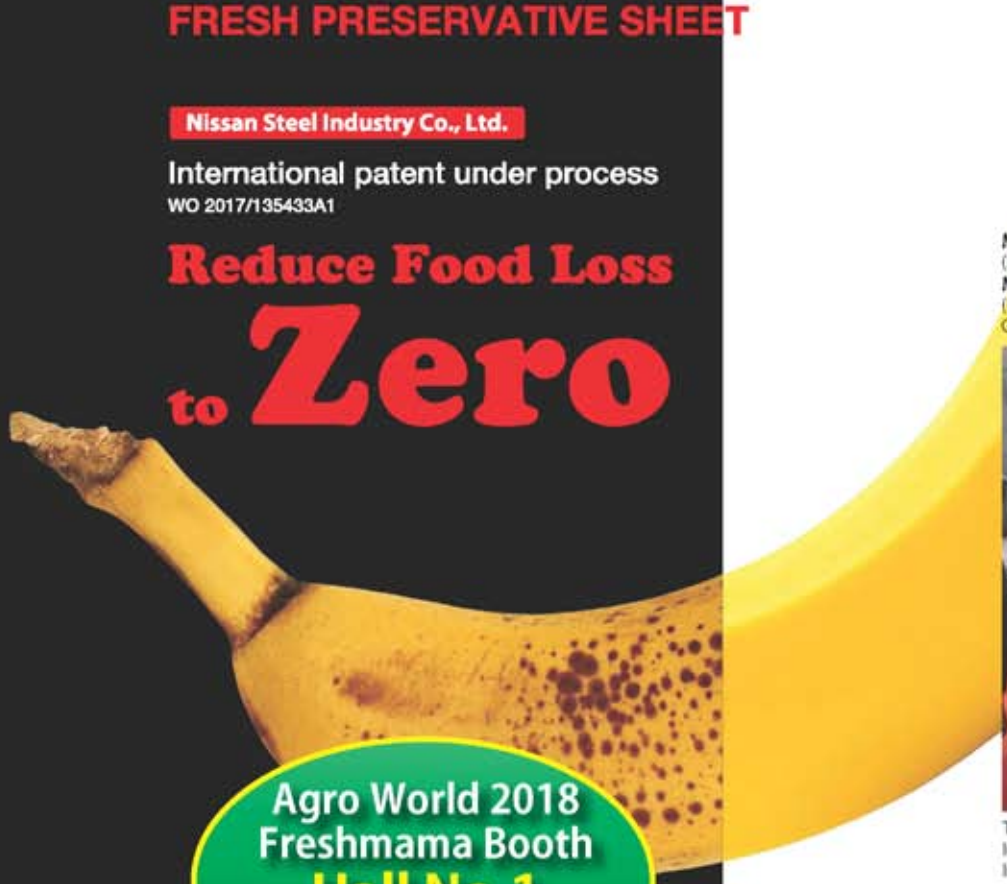

Agro World 2018
Freshmama Booth
Hall No.1
A-32 & A-33

Mr. Narendra Modi
(Honorable Prime Minister of India) &
Ms. Harsimrat Kaur Badal
(Union Cabinet Minister of Food Processing, Government of India) have visited.

They visited Freshmama booth in World Food India 2017 and appreciated our product to keep India`s fruits and vegetables fresh for longer term storage and reduce food loss.

CONFERENCE: At Theatre No.7
On 26 OCT, 3:00 pm to 4:00 pm

"New technology to keep green vegetables and fruits fresh for longer time"

PRODUCT SUMMARY

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