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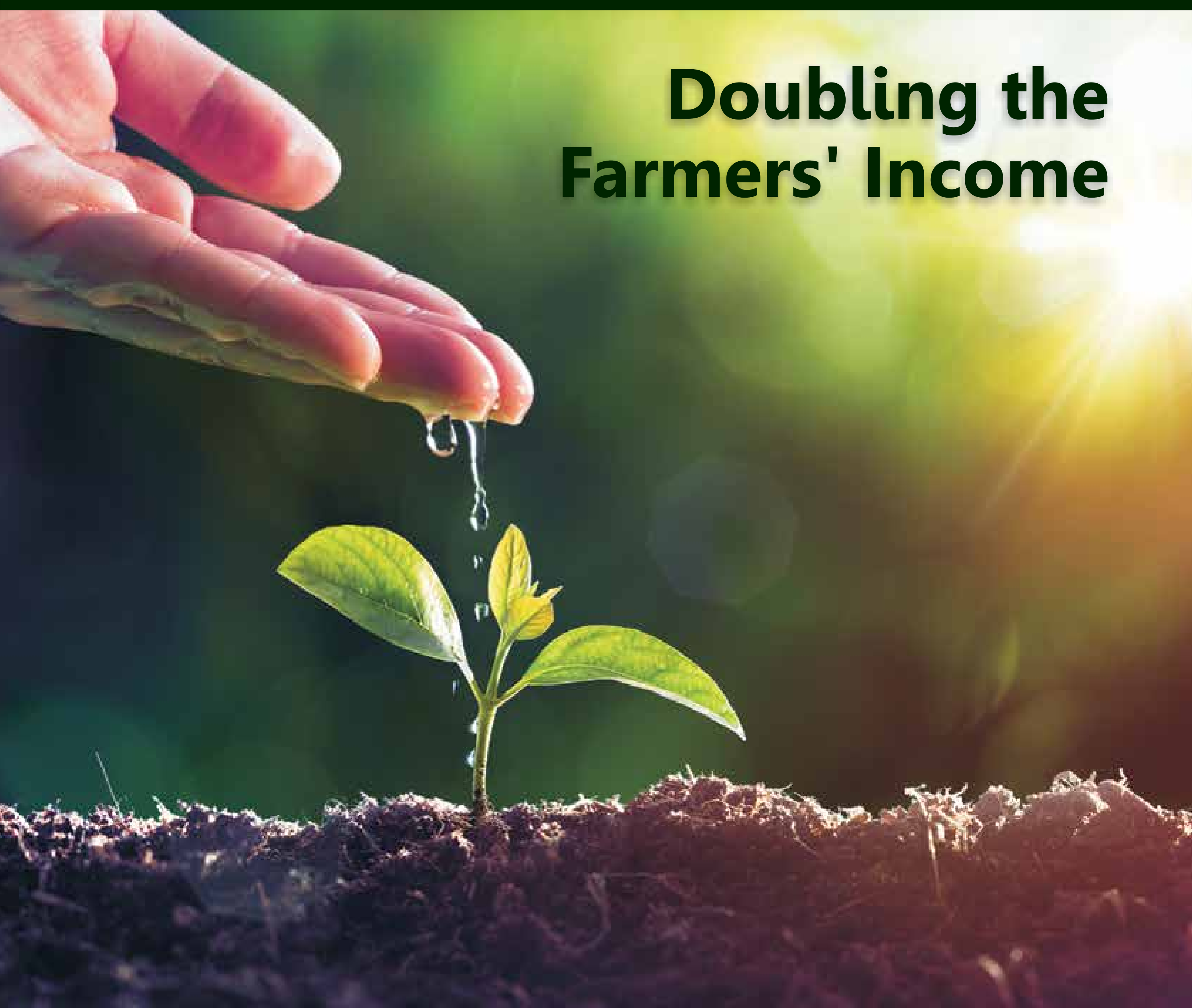
Seed Times

The National Seed Association of India Magazine

Doubling the Farmers' Income

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For further enquiries contact
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909, Surya Kiran Building,
19, Kasturba Gandhi Marg,
New Delhi -110001 (INDIA)
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ABOUT NSAI

National Seed Association of India (NSAI) is the apex organization representing the Indian seed industry. The vision of NSAI is to create a dynamic, innovative and internationally competitive, research based industry producing high performance, high quality seeds and planting materials which benefit farmers and significantly contribute to the sustainable growth of Indian Agriculture.

The mission of NSAI is to encourage investment in state of the art R&D to bring to the Indian farmer superior genetics and technologies, which are high performing and adapted to a wide range of agro-climatic zones. It actively contributes to the seed industry policy development, with the concerned governments, to ensure that policies and regulations create an enabling environment, including public acceptance, so that the industry is globally competitive.

NSAI promotes harmonization and adoption of best commercial practices in production, processing, quality control and distribution of seeds.

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Priyank Samuel
Asst. Manager - Brand Alliance & Communication

Deepanker Pandey
Research Associate

Neetu Thapliyal
Research Associate

Sher Singh
Office Assistant

Compiled & edited by: Deepanker Pandey and Neetu Thapliyal

Designed Coordinated by: Priyank Samuel G | Advertisements Coordinated by: Yashpal Saini

The editorial correspondence should be sent to, National Seed Association of India,
909, Surya Kiran Building, 19, Kasturba Gandhi Marg, New Delhi-110001 (INDIA); Ph.: 011-4353 3241-43 Fax : 011-43533248; E-mail : info@nsai.co.in

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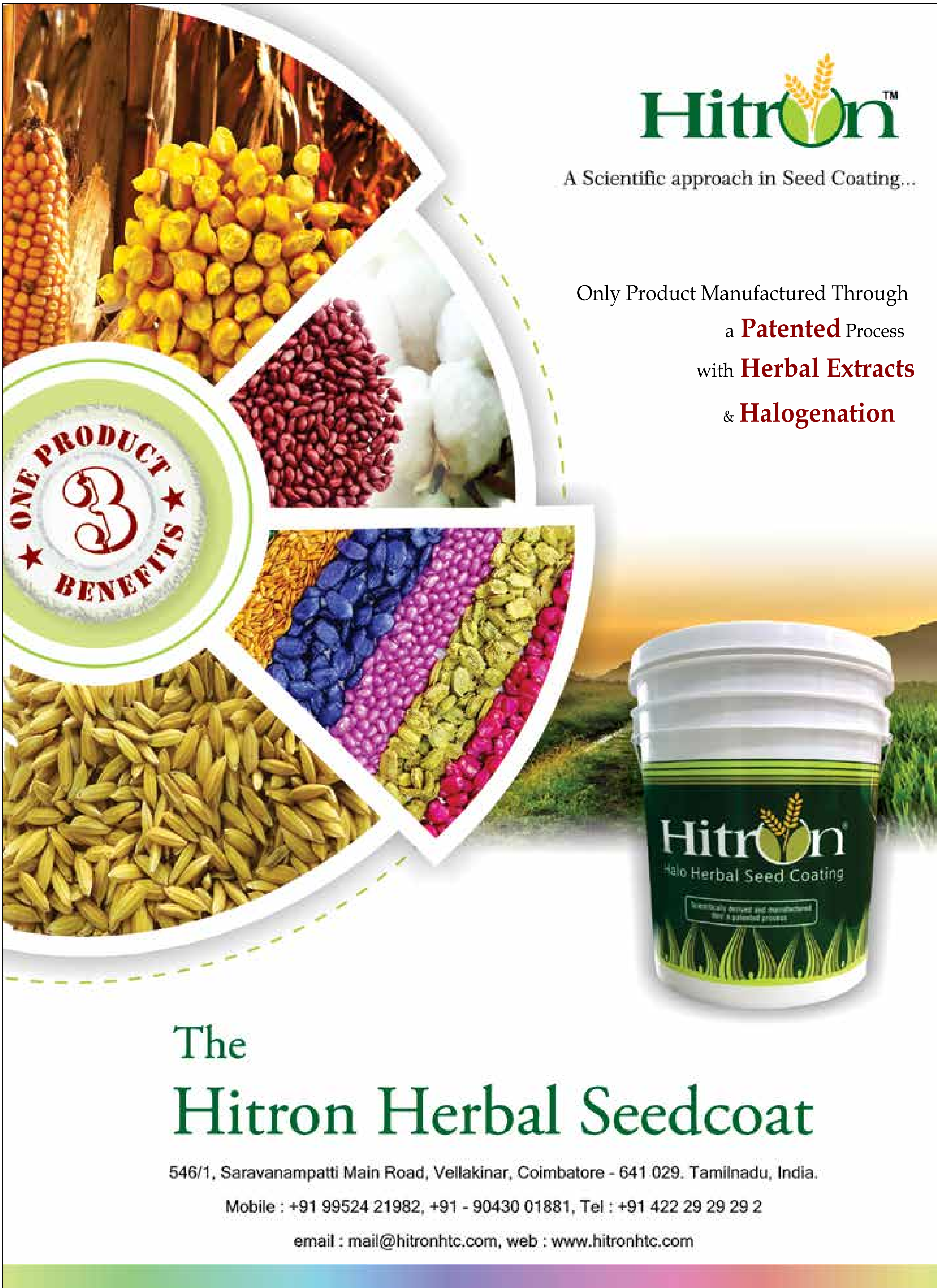
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Message
from Desk of
President

Agriculture sustains India. Not only does it provide livelihood for majority of Indians, it is the source of our culture and traditions. Harvests are celebrated as festivals and droughts as most evil of calamities. We as Indians have respected nature for thousands of years and Prithvi has reciprocated by giving us abundance. We are the centre of diversity of so many vegetables, fruits and other food crops. We are blessed with multiple agro-climate zones where all crops can grow.

Harnessing this biodiversity and abundance, India has a potential to become the seed provider to the world. The Government of India in its annual budget of 2016-17 announced the policy of doubling farmers' income by 2022. A 'Make in India' seed program will bring employment in rural areas and bring prosperity to Indian farmers, while at the same time share our rich genetic resources with farmers of other nations.

Seed industry in India today is way passed its foundation stages and taking long strides towards robust growth. While we have had many challenges along the way, today we are a vibrant seed industry with a strong foundation entrenched in indigenous innovation and technology.

But to achieve our national goal of doubling farmers' income sooner, we might need a new outlook. We need strong economic policy, which puts India first and hence, provide a chance for the Indian seed sector to forge deeper relationships with the world and bring more wealth for our hard working farmers.

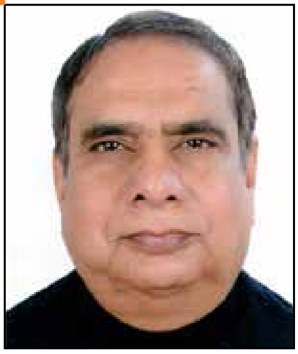
There is a need for bridging the gap from lab to the farmers' field, augmenting R & D capabilities and institutional collaboration and improvement in policy that engages the public and private sectors. We want to work with farmers for development and delivery of improved crops. Hence, aim of 'Doubling the farmers' income' initiative of Government of India has to be met coherently through productivity enhancement coupled with R&D work and policy support.

The current issue of Seed Times is on "Doubling the Farmers' Income". This edition will provide useful information for our reader to know more about the current status of farmers' income, availability of improved varieties and role of allied sectors. The analysis and insights in the issue will provide us an opportunity to re-think our strategies for establishing innovation based seed industry.

I thank the contributors and the team for this issue. Once again, on behalf of NSAI, I dedicate this issue to Indian farmers and hope to work towards making agriculture more profitable for farmers and India.

M Prabhakar Rao

Message
from Desk of
Executive Director



Indian Agriculture has grown impressively and Seed Sector has played key role in this growth. Quality Seed is the pivotal input for sustained growth of agricultural sector and other inputs are contingent upon quality of seed being optimally effective. With strong research back up, the Indian Seed Industry is ready to drive with full force for adopting best innovative practices.

In this edition, we have covered the Prime Minister's vision of doubling farmers income by 2022 which is worth serious attention. This laudable objective could not only improve the well-being of our farmers but will also trigger to boost agri-based industrial growth in rural India. Doubling farmers' income implies increasing income from crop cultivation and allied sources keeping in mind the market trend. Indian seed industry has also been highly agile in adopting new varieties and hybrids which have delivered value. Both public and private sector can play a vital role in improving the livelihoods of the farmers in rural India and the overall upliftment of agrarian economy.

I hope the readers would greatly benefit from the magazine.

Happy Reading!

R K Trivedi

Vertical Farming:
An initiative for Doubling farmers' income

Dr. Meenakshi Joshi
Chief Horticulture Officer, District: Pithoragarh, Uttarakhand.
mjoshi0089@gmail.com

Doubling farmers' income by 2022 is the mandate of ministry of agriculture India. As per FAO (2016), fifty-nine percent of the employment is generated in India by agriculture and contributed 23% to the country's GDP. Seventy percent of the rural households depend primarily on agriculture for their livelihood, with 82 percent of farmers being small and marginal. But there is a vast disparity between farmers' income and non-agricultural workers as a result an agrarian distress is seen in the country. The goal is set to double farmers income by 2022 is to promote farmers welfare, to reduce agricultural distress and to bring prosperity to the agricultural professionals and farmers of the country.

Seventy percent of the rural households depend primarily on agriculture for their livelihood, with 82 percent of farmers being small and marginal. But there is a vast disparity between farmers' income and non-agricultural workers as a result an agrarian distress is seen in the country. The goal is set to double farmers income by 2022 is to promote farmers welfare, to reduce agricultural distress and to bring prosperity to the agricultural professionals and farmers of the country.

In Uttarakhand cultivated land is 0.8 million ha. Out of the total, about 89% are under small and marginal. A large number and area are under small and marginal holdings, the scale of economies cannot be availed of, and so the input cost per unit of output is higher.

Uttarakhand is the state with hilly as well as plain terrain. If we consider horticulture, it can positively contribute to the economy of the state. . In mountain agriculture, most of the farmers are small to marginal, and have landholdings less than 2 ha. In district of Pithoragarh, total of 79,846 persons are practicing farming. The average size of operational landholdings is 1.08

ha as per the census 2015-16. The smaller land holdings contribute less economic returns as the farmers' livelihood depends completely on his small landholdings. The farmer focuses on cultivation of rice and wheat for daily need of food. Even the slightest of climatic effects, calamities or crop loss can make their economic return negative.

Vertical farming:

The new concept of Vertical Farming can help farmers in doubling their incomes in one year. Vertical farming is the production of fruits, vegetables, flowers, and medicinal plants in vertical surfaces or integration with other structures. Vertical farming is based on the idea of indoor farming techniques in controlled environmental conditions with artificial control of light, environmental control (humidity, temperature, gases, etc.) and fertigation. Some vertical farms use techniques similar to greenhouses, where natural sunlight can be augmented with artificial lighting and metal reflectors.

Technologies and devices: Vertical farming uses various physical methods or technologies in an integrated manner to make Vertical Farming a reality. The most common technologies are Greenhouse, Aeroponics, Aquaponics, Hydroponics and skyscrapers.

Hydroponics: Water-based farming system

In hills problems like migration, water scarcity, inadequate irrigation, biotic and abiotic stress, and animal menace prevail and are leading to low productivity. Scarcity of the necessary resources is a disturbing factor for the farmers and farmers are likely to divert from the agriculture activities to other non-agricultural activities for their livelihood . Hydroponics technique as a mean of vertical farming can be an alternative for increasing farmers' income.

"Hydroponics is defined as "the cultivation of plants in water." Hydroponics is, however, a technique for growing plants without using soil. By utilizing this technology, the roots absorb a balanced nutrient solution dissolved in water that meets all the plant's developmental requirements.

"Hydroponics is defined as "the cultivation of plants in water." Hydroponics is, however, a technique for growing plants without using soil. By utilizing this technology, the roots absorb a balanced nutrient solution dissolved in water that meets all the plant's developmental requirements. In Hydroponics system of cultivation almost all kinds of vegetables, fruits and herbs can be grown in the small area producing nutritious, pesticide-free, food per day to the small farmers. Hydroponic farming needs minimal water to produce the vegetables, fruits, and herbs, including reuse of the nutrient water continuously. It is the most efficient and cheapest manner for growing crops in a small area and can be an alternative to the traditional farming systems practiced in the country so far, as the vegetables produced are pesticide free, it can reduce the burdens on the health care systems and can improve the life expectancy.

This farming can stop migration from the rural areas as the farmer can utilize a small space vertically and optimally getting production for daily consumptions as well as for the economic gains. The hydroponic technique is to adopt a simple, inexpensive green, pesticide-free technology for cultivation to use every piece of land available to produce vegetables, fruits and herbs using very little expense. Farmers can also become entrepreneurs by selling their excess produce to the markets directly, thus bringing them out of the poverty line and improving their lifestyles. It produces the healthiest crops with high yields requiring minimal efforts. Nutrients are supplied to roots directly resulting in rapid growth of plants with smaller roots. Soil-less culture uses 80% less space and 95% less water to grow plants in comparison to soil-based culture. Soil-less culture also provides efficient nutrient regulation, higher density planting, and leading to increased yield per ha along with better quality of produce. The closed, controlled environment can eliminate use of many pesticides that are often necessary to keep pests from destroying traditional crops. It is also useful for the hills as these regions are having a scarcity of arable or fertile land for agriculture. All of these factors and the delicious taste of the hydroponically grown vegetables become more obvious over time.

Fig: Low Cost Hydroponic system prepare

Hydroponics can be classified as Open and Closed systems. The open system of hydroponics includes growing beds, tubular plastics or vertical and horizontal pipes and individual containers while closed systems include floating roots, Nutrient Film technique, PVC or Bamboo Channels and plastic or polystyrene pots set up in columns.

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Substrates are used in the container; the substrate can be an inert material, e.g., Sand, rice husk, coconut fiber, clay-bricks, saw-dust, volcanic stones, vermicompost, and water can be used.

Germinated plants in a tray at the two-leaf stage are shifted to the automated hydroponic system where water and nutrients are provided to the roots of plants. These plants are supplied with substrates for the support. Nutrients present in liquid form are mixed with the water in the tank established in the hydroponic farm. The nutrients and solution are changed every 7 to 10 days depending on the solution composition.

The water can be reused, and the losses of water can be minimized, this system can be used to optimize resource use and can be an important technique for the increasing prosperity of the farmers.

Economic overview:

Potential profitability of vertical farming is always questioned for economic and environmental benefits. Major concerns are transportation and initial costs of establishing a hydroponic system. Initial costs of establishing a hydroponics unit are vary , and marginal farmers cannot afford the bigger and automated units. But by providing low-cost hydroponics units with Bamboo poly-houses or by installing hydroponics unit under the poly-houses at subsidized rates farmers can be helped for initial development period. Government policies for establishing hydroponics units at subsidized rates can help farmers initially for the transfer of technology and dissemination. New schemes for vertical farming must be formulated for technology transfer and to motivate farmers about hydroponics technology.

Government policies for establishing hydroponics units at subsidized rates can help farmers initially for the transfer of technology and dissemination. New schemes for vertical farming must be formulated for technology transfer and to motivate farmers about hydroponics technology.

The hydroponic technique can be an alternative to increasing farmers' income, to meet the daily need of the population in the country and can reduce health expenses of the family with better economic gains. In hilly regions, better marketing of these vegetables can help farmers to get good returns as the price of hydroponic vegetables in Delhi is Rs 2400/Kg for green capsicum while farmers get 60 Rs/Kg price for capsicum in the local market, if traditionally grown. Hydroponics farming can provide better returns per unit area with optimum utilization of resources in the areas, where, resources are scarce, and demands are high. This vertical farming can be practiced at the rooftop or balcony also by people in non-agricultural activities. This farming can be a revolutionary step for meeting the population's demand by the available resources.


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Advantages:

Many of Vertical Farming's potential benefits are obtained from scaling up hydroponic growing methods. There are several advantages of the hydroponic system described below:

Preparation for the future: Population is continuously increasing, and the land is decreasing day by day. It is estimated that by the year 2050, the world's population will increase by 3 billion people and close to 80% will live in urban areas. Vertical farms have the potential to feed the world's population by creating additional farmland.

Reduction in health expenses: The crops produced are likely to be pesticide-free, so it can reduce burdens on the medical facilities, thus increasing the net income of the farmers and consumers.

Increased crop production: Crop production can be increased by increasing the number of crop seasons per year with a controlled environment and the losses due to biotic and abiotic stresses can also be reduced. It ultimately multiplies the productivity of the farm surface by a factor of 4 to 6 depending on the crop. In rooftop farming, the overall farm area will get increased, leading to the higher production per unit area. In situ consumption of city population will check the wastage due to transportation, spoilage, and infestation, ultimately leading to better economic gains.

Reduction of losses due to biotic stresses: Crops grown in traditional outdoor farming depends on supportive climatic conditions, and suffer from undesirable temperatures rain, monsoon, flooding, wildfires, and drought which ultimately leads to loss of crops or decreased yields. In Vertical Farming, productivity is mostly independent of weather, as the crops are grown under controlled conditions.

Conservation of natural resources: Vertical farming saves many natural resources as the human interference in the natural environment and biomes is reduced by practicing the farming vertically at a limited place with manipulated environmental conditions by reduced farmland, agricultural encroachment and deforestation can be avoided by vertical farming.

A threat to industrial agriculture caused by phosphorous-based fertilizers and runoff and leaching losses can be avoided by vertical farming.

Reduction of Mass extinction: Traditional agriculture interferes with wild populations, while vertical farming would cause nominal harm to wildlife. Vertical farming works on the principle of optimization of the available resources; therefore, scarce resources are conserved, leading to the conservation of natural resources.

Food Security: Food security is one of the primary factors leading to economic upliftment. Production of food in wastelands or places like balcony, the rooftop can help the population to be secure for their consumption.

Contribution to national growth: Vertical farming can be a better tool for the growth of the nation as it combines technologies and socioeconomic practices. It allows cities to expand while remaining substantially self-sufficient in food. This would allow large urban/rural centers to grow without food constraints.

Conventional crop growing in soil involves large space, lot of labour, and the large volume of water. In some places like metropolitan areas, the soil is not available for crop growing and in some regions scarcity of fertile cultivable arable lands due to their unfavorable geographical, or topographical conditions prevails. In conventional farming, there is a difficulty in hiring labor for agriculture practices. Hydroponics farming can help combat the challenges of climate change and also helps for efficient utilization of natural resources and mitigating malnutrition. Vertical farming can be the revolutionary farming in future for optimum use of resources, to ensure food security and nutritional security which, can ultimately lead to double farmers' income and can help in the economic upliftment of the society.

Amur Carp:
A New Entrepreneurship for Doubling Farmers' Income in Bihar, India

Dr. Adita Sharma and Dr. Tanushri Ghorai

Assistant Professor, College of Fisheries, Dholi, Dr. Rajendra Prasad Central Agricultural University, PUSA, Muzaffarpur, Bihar-843121

Email id: adita.cof@rpcau.ac.in

Bihar is endowed with vast and varied inland aquatic resources viz. rivers, canals, reservoirs, ox-bow-lakes, flood plains (chaur), ponds and tanks. The paradox of fisheries development in Bihar is that while it has large, untapped and under-utilized water resources for aquaculture, there is a large gap between the demand and domestic fish production. The annual domestic demand of fish within the state is nearly 6.42 lakh tons, against the present annual production of around 5.87 lakh tons only. The balance requirement is largely met through supply of fishes from other states especially 38,000 metric tons from Andhra Pradesh. The traditional fish culture, the preponderance of carps, lack of skilled and professional manpower, lack of production, weak extension, flood and drought, multi-ownership of water bodies, siltation of water bodies are the major constraints of fisheries in the state. There is a vastly under-utilized water resource in the state, which presents a large scope for expansion of fish culture. Bihar is endowed with large water bodies, viz. ponds (80,000 Ha.), where catch fisheries is popular. Fish production can be substantially increased by popularizing fish culture.

The paradox of fisheries development in Bihar is that while it has large, untapped and under-utilized water resources for aquaculture, there is a large gap between the demand and domestic fish production. The annual domestic demand of fish within the state is nearly 6.42 lakh tons, against the present annual production of around 5.87 lakh tons only.

In the ponds of North Bihar, farmers cultured mostly the common carp (Cyprinus carpio) for better production. Common carp, an exotic fish species brought from Bangkok (Thailand), has become integral part of fish culture system in India since 1956. Carp generally spawn in the spring and early summer (February- March) but in north Bihar it may spawn throughout the year, with first peak in January-March and second in July-August. However, the existing common carp stock is having disadvantages of early sexual maturation (<Six months) and spawning in grow-out ponds before attaining marketable size (at a weight of ~100 g). This has resulted in poor growth due to competition for food, space etc. with new recruits and as a consequence give poorer yield. The Gonado Somatic Index (GSI) can also exceed 20% of the harvested weight. For quite long, need was being felt to remove this constraint but unfortunately the selective breeding program on this fish also failed to yield desirable results.

To address this problem, a comprehensive study was undertaken to assess the present genetic status of existing common carp stocks and develop appropriate strategies for stock improvement of this species under Department of International Development (DFID)- Aquaculture and Fish Genetic Research Program. In this program, common carp stocks from different geographical origin viz. Hungary (Amur and P3), Vietnam (SV), Indonesia (RJ) and India (FRS and LBRP) were evaluated in different culture systems and environments to initiate a breeding program for identifying an improved stock with faster growth rate and delayed maturity. The study over a period of six years revealed that the Amur strain performed consistently superior to all other stocks and crosses including local stocks in all the trails across all the culture systems and environments. The increase in weight of Amur over local stocks ranged from 13.2% to 50.1% with a mean increase of 27.3%. After rigorous evaluation and protocols, Amur carp (Cyprinus carpiohaematopterus) has been released by KVAFSU for commercial production and supply of its seed to hatcheries for multiplication purpose and to farmers for growout purpose.

Fresh approach on assessment of growth potential of its 'Amur' strain in Indian conditions and positive outcomes have provided golden opportunity for improving its contribution in different fish culture systems being practiced in the country. An improved strain of wild common carp of Hungarian origin is known as Amur carp (Basavarajuet al., 2015).

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Salient features

Amur carp are late maturating (first spawning at the end of first year), fast growing (~27% faster than other carps) has similar food habit to that of existing stock and accept artificial feed, body is slender and belly is smaller, not susceptible for diseases, better reproductive potential, better motility, fertility and hatching percentage (Sharma, 2017), relatively low fat content and its viability is also good, spawns throughout the year (Basavaraju et al., 2013).Amur carp has been characterized by remarkable food conversion rate and exquisite ability to utilize natural food (FAO, 2018).

Habitat and biology

Amur carp live in the middle and lower streams of rivers, in inundated areas and in shallow confined waters, such as ponds, lakes, oxbow lakes and water reservoirs. They are mainly bottom dwellers but search for food in the middle and upper layers of the water body. The ecological spectrum of carp is broad. Best growth is obtained when water temperature ranges between 230 C and 300 C. The fish can survive cold winter periods. The optimal pH range is 6.5-8.5. The species can survive low oxygen concentration (0.3-0.5mg/lire) as well as super saturation. Carp are omnivorous, with a high tendency towards consumption of animal food, such as water insects, larvae of insects, worms, mollusks and zooplankton. Zooplankton consumption is dominant in fish ponds wherever the stocking density is high.The farming of carp is based on the ability of the species to simply accept and utilize cereals provided by the farmers. The daily growth of this species can be 2 to 4 percent of body weight. Carps can reach 0.6 to 1.0 kg body weight within one season in the polyculture fish ponds of subtropical/tropical areas. Growth is much slower in the temperate zone and the fish reach 1 to 2 kg body weight after 2 to 4 rearing season.

During induced breeding, after hormonal treatment carp release their ripe eggs within a much shorter period, which makes stripping possible. The quality of released eggs is 100 to 230 g/kg body weight.

During induced breeding, after hormonal treatment carp release their ripe eggs within a much shorter period, which makes stripping possible. The quality of released eggs is 100 to 230 g/kg body weight. The eggs shell becomes sticky after contacting water. Spawning becomes easier on nests, breeding Hapa containing aquatic weeds and inundated grass in tanks and ponds etc. The embryonic development of carp takes about three days at 20-230C. Under natural conditions, hatched fry stick to the substrata. About three days after hatching the posterior parts of the swim bladder develops, the larvae swim horizontally and start to consume external food with a maximum size of 150-180 μm.

Rearing of Amur carp fish seed for raising brood stock

A 0.08 ha pond is prepared for rearing of 5000 Nos. fry. Guidelines for Water Quality Parameters for carp growth are as follows:

pH: 7.3	**Dissolved Oxygen:** 5.0 mg/litre
Carbon dioxide: 12 mg/lit	**Total alkalinity:** 140 mg/lit
Phosphate: 0.008 mg/lit	**Conductivity:** 0.405 mho/cm

The following inputs are applied for optimum aquaculture production before the release of Amur carp fry to the pond:

Urea: 2 kg

Single Super Phosphate: 3 kg

Raw Cow Dung: 2 basket/7 days

Fish fed with Groundnut Oil Cake power 100 gm+ Rice Polish 100 gm twice a day. Gradually, based on increase in weight of the fish stock, quantity of the fed is applied @ 2-3% per kg body weight.

Breeding and Seed production of Amur carp

After rearing for a period of one year, the healthy brood fishes are selected, male and female fishes are segregated and kept in 2 different hapa. The induced breeding is done by applying hormone in 2 separate doses to male & female. For female 0.2 ml/kg body weight and for male 0.1 ml/kg body weight is applied respectively. 4-6 hours after injection, the female and male started releasing ova and milt respectively. Water hyacinth is placed inside the rectangular size breeding hapa fixed with bamboo poles for breeding and shelter of the brood fishes. Fertilization is completed within 12-18 hours and hatchlings start producing within 36-48 hours from the spawn. After 96-120 hours, hatchlings become active and are transferred to the nursery ponds. When the spawn is 4 to 5 days old, they are stocked in nursery ponds. Shallow, aquatic weed free drainable ponds of 0.5 to 1.0 ha are the most suitable for carp nursing. Nursery ponds should be prepared before stocking to encourage

the development of a rotifer population, since this constitutes the primary food of feeding fry. GNOC should be soaked under water in an aluminum hundi for 1-2 nights and may be mixed with raw cow dung on 1 day ahead of stocking of fry. The stocking density is 100-400 fry/m2. The length of the nursery period is 3 to 4 weeks and the survival rate from spawn to fry is 40-70%.

The production of carp fingerlings usually takes place in semi-intensive ponds, supported with manure generated natural food and supplementary feeding. Stocking nursed fry is the most successful way for producing medium and large size fingerlings. Depending on the required final size of fingerlings, 50,000-2,00,000 nursed fry/ha can be stocked in temperate zones, preferably in polyculture system where the proportion of Amur carp is 20-50 percent.

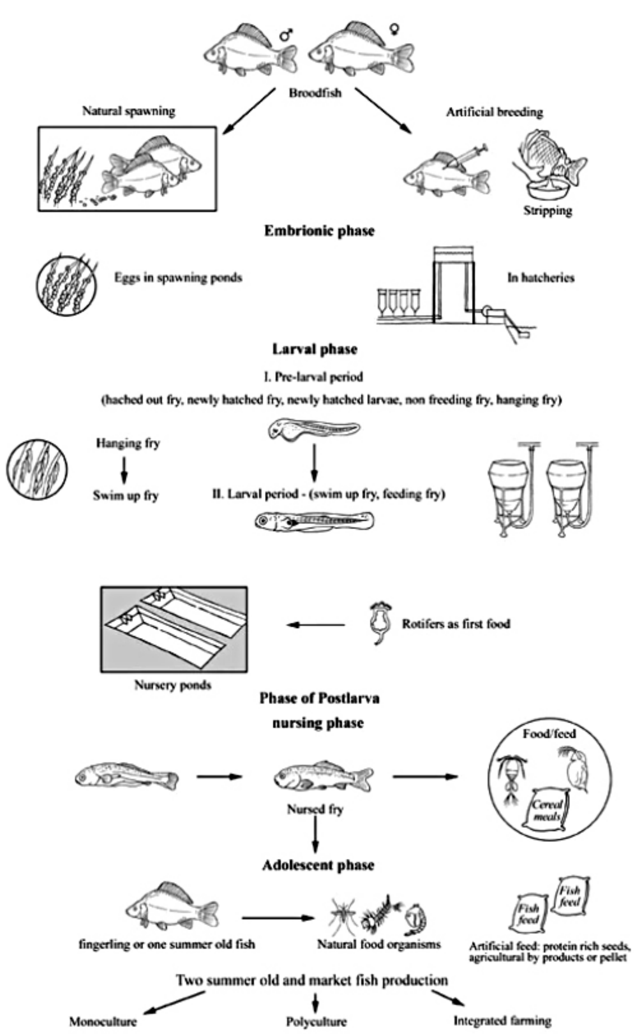

Figure 1: Breeding technology of Amur carp

> The Amur carp has greater practical significance in low-input aquaculture systems due to its better growth performance than the other strain.So, if Amur carp is cultured in large scale, a high profit will be obtained which will augment fish production and nutritional security. This will help to create gainful employment for fish farmers and improve availability of cheap protein source for rural population. This will ensure livelihood promotion and income stability in rural areas in addition to the nutritional security and diversity of the rural population.

Conclusion

In temperate zones, one summer old fish (20-100g) must be reared up to 250-400 g in the second year. The stocking rate is 4000-6000/ha, plus about 3,000 chinese carp/ha, if only cereals are fed. The stocking rate can be much higher (up to 20,000/ha) if cereals and pelleted feed also used. The daily rate of feeding is approximately 3-5% of body weight. Carp culture may be integrated with animal farming and plant production. Integration may be direct (animals above fish ponds), indirect (wastes of animals are utilized in the ponds as manure), parallel (rice-cum-fish), or sequential (fish production between crops). The successive cycling of fish/animal/legumes/rice (in 7 to 9 year cycles) is appropriate for considerably decreasing the environmental loading of intensive aquaculture. Since Amur carp burrow in the pond bottom, have a broad environmental tolerance and an omnivorous feeding habit they are a key species in integrated systems.The Amur carp has greater practical significance in low-input aquaculture systems due to its better growth performance than the other strain.So, if Amur carp is cultured in large scale, a high profit will be obtained which will augment fish production and nutritional security. This will help to create gainful employment for fish farmers and improve availability of cheap protein source for rural population. This will ensure livelihood promotion and income stability in rural areas in addition to the nutritional security and diversity of the rural population. A vibrant fisheries sector will add to the state economy and help to strengthen rural economy. Amur carp has been included as major candidate species for raising brood stock as well as production and dissemination of quality fish seed to various stated of the country. It may constitute the incorporation of improved fish strains for enhancing the production and profitability of farmers and helpful for doubling farmers income.

Doubling Farmers' Income through Seed Production

Mrinali Mandape

PhD Scholar, Division of Seed Science and Technology, ICAR-Indian Agricultural Research Institute, New Delhi-110012

*mrinalimandape@gmail.com

The current population (2018) of the country is 1.36 billion which is expected to be 1.51 billon by 2030. Keeping inview the amount of food required to feed world's largest population, the Prime Minister's Office declared an ambitious target of "Doubling Farmers' Income by 2022" as soon as the new government regime came to power. Undoubtedly now, doubling farmers' income is going to be a herculean task as the fact states that Indian farmers' income has increased only 3 folds in the past 30 years (1983-2013) on constant price.

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National Sample Survey Organization (NSSO) conducted 70th round of national survey entitled Situation Assessment Survey of Agricultural Households in 2013 and provided estimates of farmers income from various sources including that of agriculture. According to the report, average annual income from farm and non-farm sources has been Rs. 77,112 out of which 60 percent was from farm activities like crop cultivation, dairy and livestock rearing and rest 40 percent from non- farm activities like daily wages, small businesses and salary. Approximately 80% of the low-income marginal farmers are concentrated in eastern (58%) and western (21%) parts of India that have been laggards in agricultural development on account of several factors, such as under-investment in agricultural research, poor infrastructure (electricity, markets, roads), under-development of institutions (credit, extension, insurance) and a lack of complementarity among these (Pushpa et al., 2018). Thus, the ambitious goal of doubling farmers income would require targeted interventions and identification of strategies for farmers especially medium scale and marginal specifically in the eastern and western states (Birthal et al., 2015). India's net cropped area has stagnated for quite some time, which clearly implies limited scope for income growth through area expansion. The recourse, thus, needs to be with prospects for income growth by raising cropping intensity, reducing inefficiency in production, and diversifying production portfolio towards high-value crops and animal production (Pushpa et al., 2018).

High quality improved seed is a pre-requisite to achieve maximum outputs and good returns to farmers. Moreover, it acts as an improved technology in agriculture. Sowing good quality seed leads to lower seed rate, better plant emergence, more uniformity, vigorous early growth, enhanced resistance to pest and disease attack, less weeds, more yield by 5-20% and less replanting. High seed quality is a complex trait and pertains to high germination percentage, high genetic purity, high physical purity, high planting value, freedom from pest and diseases, freedom from weed seeds and other crop seeds. The National Agricultural Research System along with Indian Seed Industry has played a significant role in seed production of many crops and ensuring the timely availability of seeds to the farmers in order to generate their interest to go for seed production over commercial crop production. Nevertheless, adequate quantity of quality seed at appropriate time and affordable cost needs to be made available to every farmer for bringing about radical change in agricultural scenario in the country and doubling farmers' income. Although, significant advancements have been made in India with respect to production technologies and quality evaluation of seed but it may not be at place at the same pace in many developing countries.

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Guaranteeing Genetic Purity

Genetic purity is one of the most important quality attributes which refers to the true-to-type or genuineness of variety. When seed possesses the genetic composition that a breeder has claimed for or the genotype indicated, it is said to be genetically pure. Deterioration in the seed genetic purity may take place during seed multiplication and distribution cycle leading to proportionate decrease in its performance. Therefore, it is a necessity to ensure the genetic purity for enhancing seed production with methods like use of 'taxonomic keys'; laboratory experiments viz; phenol test for wheat, seed coat peroxidase test for soybean, KOH bleach test for sorghum, Ferrous sulphate colour test for paddy, Alkaloid test for Lupinus, Electrophoresis, PAGE, SDS-PAGE, chromatography of fatty acids, use of molecular markers; field experiments like Grow-Out-Test and Field-Plot-Test.

Guaranteeing Physical Purity

Physical purity refers to physical composition of the seed lot and freedom from dockage. Seed lot is composed of pure seed i.e seeds of same kind, inert matter, broken grains, soil and dust particles, chaff, weed seed and other crop seeds. Higher the content of pure seed, better would be the seed quality. Physical purity components are interpreted as pure seed which include intact seed units and pieces of seed units larger than one-half of the original size. Broken and cracked seeds, immature and shriveled seeds, empty seeds of Compositae family, insect damaged seeds, sclerotia and nematode galls all account for seed impurity which need proper cleaning and purity separations. Cleaning of seed lots can be done in three essential steps viz; preparing seeds for basic seed cleaning i.e. pre-conditioning, basic cleaning through Air Screen Machine, upgrading quality of cleaned seed. Cleaned seed lot is a must in ensuring greater seed production.

Contribution of agriculture in the GDP of SAARC countries is 16-30% with a Seed Replacement Rate at 10-30%, more specifically 30% in India. In order to overcome this situation, a rolling plan of the government needs to be floated where targets should be fixed to cover the area under quality seed.

Improving the Seed/Varietal Replacement Rate

Due to huge demand-supply gap, India suffers from a dismal Seed Replacement Rate (SRR). In few states it is as low as 5% across the crops which are a very big challenge to the seed industry and Indian agriculture. Contribution of agriculture in the GDP of SAARC countries is 16-30% with a Seed Replacement Rate at 10-30%, more specifically 30% in India. In order to overcome this situation, a rolling plan of the government needs to be floated where targets should be fixed to cover the area under quality seed. Another hurdle is dominance of very old varieties in the seed chain which needs policy intervention. The public sector has been limited to produce quality seeds of only low value food grain crops; while private sector since it was allowed to enter into market has focused on high value crops. Undoubtedly, private sector can reach more rapidly to the unreached areas but the cost of their seed is much higher in comparison to that of public sector seed. There should be some mechanism to have control over the cost of seed of private sector seed companies too so that small and marginal farmers can also procure the seed and it will definitely help in enhancing the SRR.

Promoting Export Import

With India's LPG regime of 1991, seeds started moving out of the country's boundary as trade was opened however, the trade surged up only after Export Import Policy, 2002-2007. With the seed and agricultural research held in fewer hands, the global food supply is vulnerable to the whims of market maneuvers, thus there is felt need for higher participation by private seed companies, NGOs/Civil Society Organizations and Seed Cooperatives. USDA concluded in its recent study that reduced competition in the market is associated with reduced research and development, paying stone for more GDP contribution to the R&D in India. Today, top 10 seed companies control more than half of the world's commercial seed sales. Amongst top 10 players in the global seed industry, only top 6 players have a turnover of around 3.6 times of remaining 7 players. With a global market of approximately US$ 50 billion per annum, the commercial seed industry is relatively small when compared to pesticide market. It is conservatively estimated that top 10 companies control 62% of global seed trade. In decreasing order Monsanto-Bayer › Corteva › Syngenta+ChemChina › Group Limagrain › Land O'Lakes › KWS › DLF › Sakata Seeds › Takii Seeds › RijkZwaan hold the global shares. African and Asian countries are new areas for many seed companies for expanding their seed business (Food and Agribusiness Research Management, Yes Bank Report 2015). Amongst Asian countries Malaysia, Myanmar, Pakistan, Sri Lanka and African countries like Ethiopia, Ghana, Kenya, Nigeria, Togo, Sudan, Angola and Tanzania are good seed destinations which would help Indian farmers in doubling their incomes. For trade acceleration and food security, seed trade in SAARC and beyond SAARC countries have a very high potential.

Enhancing Pollinator Activity

Bees are the most effective pollinators of crops and natural flora and are reported to pollinate over 70 percent of the world's cultivated crops. Research has shown that pollination by honey bees increase fruit set, enhance fruit quality and reduce fruit drop in apple (Dulta and Verma, 1987).In a research finding it has been found out that pollination by insects is inevitable for Brassica, since they are generally incompatible (Sihag, 2001) and the pollen is heavier and sticky, which is unable to be easily wind borne. Even though, the bees are reported as marvelously coevolved pollen transferring devices for Brassicas, the pollination potential and economic importance of the effect of honeybees on these vegetables still needs to be established. There are reports that placing of 3-5 bee colonies of Apisceranaindica/ acre of crop have increased the seed yield in sunflower by 79%, mustard by 55%, niger by 33%, sesame by 15%, safflower by 64%, cotton by 18%, litchi by 20%, coconut by 40%, and gourd crops by 20%. In an experiment conducted by KVK, Vaishali, (DRPCAU, Pusa), two honeybee colonies of Apis mellifera containing approximately 10,000 bees in a bee box were kept inside the net house to aid the pollination. The honeybees (A. mellifera F.) were reared in Langstroth boxes of size 50x40x30 cm at the KVK demonstration unit. Results showed that bee colony was placed inside the net house, their numbers inside the net house was found to be higher resulting in higher number of pods per panicle and higher seeds per pod and overall seed yield in the net house when compared to open field conditions. The thousand seed weight was also reported to be 3.64g and 3.21g in honeybee pollinated and natural crop, respectively (Devkota et al.,2003). Thus, for doubling farmers' income, we need to ensure better pollinator activity and conservation of pollinators in phase of climate change.

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Well tested GM Technology

Transparent procedures for testing, clearance and monitoring of GM crops will help in faster approval of potential materials.

Despite controversy Genetically Modified (GM) seeds are gaining considerable market share. This is evident from the fact that the market for biotech seed traits has shot up from $280 million in 1996 to $4700 million in 2004 further three-fold in 2017-18. Except Bt-Cotton no other crop has been allowed for commercial adoption amongst field and vegetable crops. Keeping the global trend of release of more and more GM products and challenge of meeting projected targets of agricultural production in the country, it is crucial to think over issues of bio-safety, hazards/benefits of GM technology on human health. Also, the field and seed standards need to be defined for facilitating the seed production of GM crops. As suggested by several biotechnology experts, Biotechnology Regulatory Authority of India (BRAI) needs to be made operational urgently. A regulatory system needs to be made highly efficient and full proof so that release process is not slowed down. Proper yield trials as suggested by formerEnvironment Minister, Dr. Jairam Ramesh need to be done before actual release of GM crops. Transparent procedures for testing, clearance and monitoring of GM crops will help in faster approval of potential materials. In 2004, Pioneer/DuPont earned 50% of its seed revenues from varieties that include a genetically modified trait. The market for biotech seed trait has shot up from $280 million in 1996 to $4,700 million in 2004, a 17-fold increase over past nine years.

Organic Seed Production

Increasing demand of organic products has led to the demand for seed production of such crops. Though in a few states like Rajasthan, the State Seed Certification Agency has been re-designated to empower it for certification of organic seed production, yet no consensus seed and field standard for organic seed production have been laid out. Exploring North East region of India for organic seed production in vegetables, and cereals would be a fruitful strategy.

Government of India has implemented National Programme for Organic Production (NPOP) for which APEDA is the nodal agency. It involves accreditation programme for certification, standards for organic production, promotion and organic farming etc. Increasing demand of organic products has led to the demand for seed production of such crops. Though in a few states like Rajasthan, the State Seed Certification Agency has been re-designated to empower it for certification of organic seed production, yet no consensus seed and field standard for organic seed production have been laid out. Exploring North East region of India for organic seed production in vegetables, and cereals would be a fruitful strategy. Use of organically produced seeds for organic production needs to be scientifically validated with respect to the residual effect of various chemicals used on commercial production chain. With the increasing awareness in the importance of nutrition and sustainable ecosystems, organic produce has started to fetch more money in the markets across globe thus, it is a sure shot deal for doubling the farmers' income.

Market-led Seed Production

According to the CEO, NITI Aayog, Amitabh Kant, the next revolution in agriculture would come by marketing and processing. Opening of the national e-platform named e-NAM (National Agriculture Market) on 14th April,2016 for marketing of farm produce in countrywide market has made it easier and more remunerative for farmers to earn better returns. It is not only a platform for online trading in commodities, but helps market in better price discovery. The e-NAM market transaction stood at Rs. 36,200 Cr by January 2018, mostly intra-market. Over 90 commodities including staple food grains, vegetable and fruits are currently listed in its list of commodities available for trade. Lack of market information/market intelligence in this area is a bottleneck in accuracy of business planning of seed as an industry. There is a scope of inclusion of quality seeds into the list of commodities available for trade which may ensure higher returns and better price to the seed produce to growers.

Climate Smart Seed Production

> The impact of climate change is unprecedented and has caused massive crop losses to farmers and seed growers in the recent past. Sudden rise and fall in temperature in conventional seed production areas is a serious issue which alarms for searching an alternative site for climate smart quality seed production.

Erratic rainfalls and frequent fluctuations in temperature have made the conventional seed production sites unfit or less remunerative in terms of production and quality of seed. The impact of climate change is unprecedented and has caused massive crop losses to farmers and seed growers in the recent past. Sudden rise and fall in temperature in conventional seed production areas is a serious issue which alarms for searching an alternative site for climate smart quality seed production. Likewise, the storage facilities now need climate resilience viz; cold storages, seed vaults etc. for keeping seed quality intact.

Empowerment through Group: FIGs and FPOs

Government of India has provisioned to formulate Farmer Interest Groups (FIGs) and Farmer Produce Organizations (FPOs). There are about 847 registered FPOs in India. Seed production through participatory/community partnership mode has a much higher potential than performing the business individually for a simple principle based on Compact Area Approach.This approach makes seed handling and delivery easier, drastically reduces varietal admixtures and impurities, ease in seed certification, better mechanization, higher genetic and physical purity and ultimately greater return on investment and cost of cultivation which would ensure doubled farmers' income in the years to come.

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Strategies for Doubling the Farmers' Income in India

Tabassum

PhD Scholar, Department of Genetics and Plant Breeding, College of Agriculture, GBPUAT, Pantnagar, US Nagar-263145, Uttarakhand

tabassum12081992@gmail.com

> There is need of convergenceof agricultural science with new technologies and focus should be on the involvement of unemployed adults/youth in rural areas in skilled low budget, non-crop activities which will helps to generates additional income. This measure will prevent the migration of poor villagers toward towns in search of work. They will become self sufficient to earn their livelihood.

Farmer, the unsung heroes never get proper attention. We never pay due respect to the "Jai Kisan". We never recognize their worth in our life. We never notice that they are real "Annadatas". Now India has set a very ambitious target of doubling the farmers' income by 2022. The Indian economy is largely based on agriculture, with around 55% of the population dependent directly or indirectly for their livelihoods on agriculture and allied sectors that generate 15% Gross Value Added. India has to come up with new ideas to work with farmers and empower them with new scientific knowledge as well as new technology for strengthening them.

The first question strikes in our mind is "how we do?" For this we must set our targets on priority basis. There has been considerable expansion and changes in the research and extension system but the key questions remain: "Is this sufficient to Double Farmers'Incomes by 2022? Is there a need for a different mindset to ensure that agricultural science empowers the farmers to reach their full economic potential? Can such be achieved while delivering food to the nation?'

There is need of convergenceof agricultural science with new technologies and focus should be on the involvement of unemployed adults/youth in rural areas in skilled low budget, non-crop activities which will helps to generates additional income. This measure will prevent the migration of poor villagers toward towns in search of work. They will become self sufficient to earn their livelihood.

For doubling farmers' incomes, the focus must be on lowering input cost and ensuring high output in forms of production and productivity per unit of area with increase probability of more profit generation. An interesting experiment was done by a private foundation in Itarasi, U.P. also known as "Itarasi Model". They developed a small scale poultry farming around the village of Itarasi through which poor households are able to generate Rs. 50,000.00 additional income. Likewise, in Uttarakhand and Himanchal Pradesh, Mushroom cultivation is like a boom for local residence and checked migration significantly.

These are the few strategies for improving growth in farmers' income as well as Source of income:

A) **Technology based:** Farm mechanisation in India has been a story of tractorisation. Time has come to promote efficient equipments, tools and small engine driven tractors to address small farmers' requirement adequately. It should be economic and easy availability.

- **Use of Solar system**-based irrigation pump which help in self dependency as well as reduce electric bill. Encourage the use of quality irrigation pipes and sprinklers system so that we can reduce the water requirement as in case of flood irrigation system.
- There should be Good Weather forecasting Models and a strong communication system like online and telecom facility via Kisan Call Centre and Kisan Suvidha App.

B) **Research based Improve Agricultural and management practices:**

There is need to devise ways to lower the cost of production and reduce the risks involved in agriculture such as pests, pathogens and weeds; there is a need to improve productivity; Enhance the production of Vegetables and Fruits also

Encourage the farmers, to go with the Integrated Pest Management practices, organic farming, adaptation of proper agricultural package, cultural practices, crop intensity and integrated farming system Seed replacement rate, Post-harvest strategy, cold storage chamber and Value addition practices. Also encourage them for less use of Pesticide, Herbicide and Inorganic Fertilizers,

- **Agronomic Principles:**

  Besides genetic principles of seed production, there involves the application of the following agronomic principles for the production of good quality seeds.

Selection of Suitable Areas for Seed Production

The areas for seed production are based on climatic factors which ensure a relatively satisfactory environment for vegetable seed production. These factors include rainfall, light intensity, temperature and wind velocity.

Selection of Variety

The selection of a right variety is very important for a successful seed production.

Source of Seed

The seed used for raising a seed crop should be of known purity, appropriate class and invariably obtained from authorized official agency

Seed Treatment

Seed treatment refers to the application of fungicide, insecticide or a combination of both to seeds so as to disinfect and disinfest them from seed borne or soil-borne pathogens and storage insects.

Better Agronomic Management

Best possible agronomic practices should be adopted for raising the healthy seed crop. Timely seed sowing, optimum plant population and optimum irrigation are some of the agronomic practices are to be followed for obtaining higher yield and better quality of seeds.

Insect and Disease Management

Pest and disease infestation not only reduces the seed yield but also damages the quality. So appropriate disease and insect control is very important in raising healthy seed crops.

Harvesting, Drying and Storage of Seeds

Harvesting of seed crop must be done at the time that allows both the maximum yield and the best quality seeds considering various maturity indices. In general, the seeds are harvested when their moisture content is about15-20%. In order to preserve seed viability and vigour it is necessary to dry seeds to safe moisture content level. The drying of seeds may be done by sunlight, chemical desiccants and by mechanical driers. For short period storage clean and dried seeds should be filled in neat and clean sacks or bags and stored in a clean, cool go down.

- **Use of Quality Seed, Production and Maintenance:**
  - **Qualities of Good Seeds:** Seeds are the basics requirement for growing a crop and it is very necessary for the farmers that his seed should be:
    - Genetically pure:
    - Physically pure
    - Physiologically viable
    - Free from insect pests and diseases
    - Free from seeds of weeds and other crops

- **Quality Seed Production**: Production of genetically pure and quality seed requires high technical skill and specialization. Seed production must be carried out under standard and well-organized conditions. The producer should be familiar with genetic as well as agronomic principles of seed production.
- **Genetic Principles**: During the course of seed production, it is necessary to ensure that the product is true-to-type. Genetic purity of a variety can deteriorates due to several factors during production cycle. The important factors of apparent and real deterioration of varieties are follows as suggested by Kadam (1942):
  - Developmental variations
  - Mutations
  - Minor genetic variation
  - Technique of the plant breeder
  - Mechanical mixtures
  - Natural crossing
  - Selective influence of diseases
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  - Minor genetic variation
  - Technique of the plant breeder
  - Mechanical mixtures
  - Natural crossing
  - Selective influence of diseases

Of these, mechanical mixture, natural crossing and selective influence of diseases is perhaps the most important reasons of genetic deterioration of varieties during seed production followed by raising the seed crops in areas outside their adoption which may cause developmental variations and genetic shifts in varieties.

- **Maintenance of Genetic Purity:**

  For the maintenance of varietal purity various methods have been suggested by Hartman and Kester (1968). The important safeguards for maintaining genetic purity during seed production are:

- **Control of Seed Source:** The use of seed of an appropriate class and from an approved source is necessary for raising the seed crop.

- **Crop Rotation:** Satisfactory intervals between related or similar crops is required to minimize the risk of plant material or dormant seeds remaining from the previous crops, which are likely to cross-pollinate or make admixture with the planned seed crop.

- **Isolation:** One major factor during the course of seed production is to ensure that the possibility of cross-pollination between different cross-compatible plots or fields is minimized. In addition to the question cross-pollination, adequate isolation also assists in avoiding admixture during harvesting and the transmission of pests and pathogens from alternative host crops. Seed crops can be isolated by two methods i.e., Isolation by Time, Isolation by Distance

- **Rouging of Seed Crop:** Rouging refers to the removal of off-type plants. Off-types refer to those plants that are not true to the type, diseased and abnormal plants. The numbers of rouging's required for the seed crop will vary according to the kind of vegetables, purity of the seeds sown, nature of the previous crop, etc. In general, the cross-pollinated vegetable crop for seed production should be thoroughly rogued before flowering. Regular supervision by trained manpower is important.

- **Seed Certification:** Seed certification implies that the crop and seed lot have been duly inspected and that they meet requirement of good quality seeds. To achieve this purpose, qualified and well-trained personnel of seed certification agencies carry out field inspections at appropriate stages of crop growth. They also make seed inspections to verify that the seed lot is of the requisite genetic purity and quality. The field standards include land requirements, isolation requirements, maximum permissible off-types, etc.

- **Grow-out Tests:** Varieties being grown for seed production should periodically be tested for genetic purity by grow-out tests to make sure that they are being maintained in their true form.

C) Additional Income generation: Additional income can be generated by skilled development training through NGOs, and Extension workers. The DFI Committee goals the "growth targets" for doubling farmers' real income while improving the ratio between farm and non-farm income from 60:40 as of now, to 70:30 by 2022, by:

a) Adopting a "demand-driven approach" for efficient monetisation of farm produce and to synchronise the production activities in Agriculture & Allied Sectors.

b) Improving and optimising input delivery mechanism and overall input efficiency [technologies, irrigation methods, mechanisation, Integrated Pest Management (IPM), Integrated Nutrient Management (INM), farm extension services, adaptation to climate change, integrated agri-logistics systems, Integrated Farming Systems Approach, etc.].

c) Offering credit support at the individual farmer and cluster levels for Dairy, Poultry, Goat & Pig Farming, Mashroom Production and Bee keeping.

d) Strengthening linkages with MSMEs (micro, small and medium enterprises), so as to accelerate growth in both farm as well as non-farm incomes along with employment creation.

Farmers' income is directly related to cost of agricultural production (including input costs) and profitable monetisation of the agricultural produce, through effective market linkages. The DFI Committee report deliberates upon specific economic activities and topics that have a durable impact on farmers' income increase, some of which are categorised as follows:

i. **Demand Driven Agricultural Logistics System** for post-production operations such as produce aggregation, transportation, warehousing, etc.

ii. **Agricultural Value System (AVS) as an integration of the supply chain and to drive market led value system** – District level, State level and National Level Value-System Platforms to promote individual value chains to collaborate and integrate into a sector wide supply chain.

iii. **Farmer** - Centric National Agricultural Marketing System by restructuring of the marketing architecture and networking of Primary Rural Agriculture Markets (22,000) and wholesale markets to facilitate Pan-India market access; as also integrating the domestic market with export market.

iv. **Developing Hub and Spoke System at back-end as well as front**-end to facilitate and promote an AVCS (which includes input providers, farmers, transporters, warehousing, food and agro-processors, retailers).

v. **Marketing Intelligence System to provide demand led decision making support system** - Forecasting system for agricultural produce, supply and demand, and crop area estimation to aid price stabilisation and risk management.

vi. **Promoting Sustainable Agriculture** – Conservation Agriculture, Climate Resilient Agriculture, Rainfed Agriculture, Ecology Farming, Watershed Management System, Integrated Farming System, Agro-Climatic Regional Planning, Agricultural Resources Management and Micro-Level Planning, etc.

vii. **Effective Input Management achieving Resource-Use-Efficiency** (RUE) and Total Factor Productivity (TFP) – Water, Soil, Fertilisers, Seeds, Labour-Farm mechanisation, Credit and Precision farming, so as to reduce farm losses.

viii. **Enhancing Production through Productivity** – to achieve & sustain higher production out of less and release land and water resources to diversify into higher value farming for enhanced income.

ix. **Farm Linked Activities including secondary and tertiary sector activities** of MSME scale, for promoting near-farm and off-farm income generating opportunities as well as to facilitate that more of the produce captures more of the market value.

x. **Agricultural Risk Assessment and Management** including drought management, demand & price forecast, weather forecast, management of biotic stress including vertebrate pests' access to credit for farmers for farming operations; providing long term credit, post-production finance to preventing distress sale by farmers, and crop & animal risk management through insurance.

xi. **Empowering Farmers through Agricultural Extension**, Knowledge Diffusion and Skill Development.

xii. **Research & Development and ICT** for Doubling Farmers' Income.

xiii. **Structural and Governance Reforms in Agriculture**, including building a database of farmers, facilitating farmer & produce mobilisation, institutional mechanism at district, state & national levels for coordination & convergence, utilising Panchayat Raj Institutions as key delivery channels for transparent and inclusive development.

D) Government Policies:

- **Financial Aid:** Crop insurance schemes (Fasal Suraksha Yojana), MSP: Govt increase the MSP for Rabi 2018-19, Banks loan with low interest rate (Kisan Credit Card service).

- **Agriculture department activities:** R&D through KVKs and extension worker, Stregthen Irrigation Facility by Pradhanmantri Sinchayi Yojana with the aim More crop per Drop; Promotion of Neem Coated Urea; Strong policies on GM crops; Regular check on market prices.

Recently, Niti Aayog came out with its "three-point action agenda". It put forward four points action plan to double the farmers' income. These four points includes the following measures:

1) Remunerative prices for farmers by reforming the existing marketing structure;

2) Raising productivity;

3) Reforming agriculture land policy; and Relief measures.

Conclusion:

Government need to take long term steps to ensure the economic viability of farming. Raising productivity, reforming land policies and solving remunerative price mess will require massive amount of public investment and political will. The strong leadership and the good government need to set the vision and enabling policy framework; the private sector should help to deliver on that vision through scalable and inclusive market-based activity; and key stakeholders such as farmers' organizations, civil society and international organizations combining their resources and expertise.

Only through such strong leadership from diverse stakeholders we can create the conditions needed for unlocking the entrepreneurship of smallholder farmers and ultimately boosting their income.

References:

http://agricoop.gov.in/doubling-farmers

https://niti.gov.in/

Doubling the Farmers' Income: Core Challenge, Strategy & Way Forward

Dr Mohammed Talha[1] and Dr Harsha[2]

1. PhD-Research Scholar, Department of Genetics and Plant Breeding, GBPUAT, Pantnagar, U S Nagar, Uttarakhand- 263145, India

2. Agriculture Officer, Assistant Director office Beawar, Rajsthan

mohammedtalha23@gmail.com

The training and adoption of latest technology by Indian farmers lags far behind. Expenditure of less than 1% of the agricultural GDP in research shows abysmal investment in research and development. There is a staggering lack of infrastructure across the entire agricultural value chain.

Introduction

Agriculture is source of livelihood to more than 600 million people of the country. With so much of dependence of our country on agricultural income a serious attention is needed in this aspect. With food security firmly in hand, the government's target to double farmers' income by 2022 is very critical for well-being of this country.

Core Challenges

The majority of Indian farmers are small and marginal, inefficiently resourced, ill-informed on market behaviour, risk prone, loaded with credit and debts and is dependent on traders to reach buyers. To further worsen the problem 60% of population depends on agriculture which contributes only 14% of national GDP. The training and adoption of latest technology by Indian farmers lags far behind. Expenditure of less than 1% of the agricultural GDP in research shows abysmal investment in research and development. There is a staggering lack of infrastructure across the entire agricultural value chain.

Despite increase in productivity of major corps, it is much lower than that of many countries. The vast rainfed area in the country, particularly drylands, where mostly coarse cereals, pulses and oilseeds are grown are still low yielding. Despite superior nutritional qualities and climate resilience, the area under cultivation of these crops is declining owing to low productivity, high labour intensity, drudgery and lack of attractive farm gate prices. Any positive development in these tracts could lead to better livelihood of farmers.

Alkalinity and salinity problems are other challenges affecting about 8 million hectares of land. Another 7 million ha of land in the country is losing its fertility due to water- logging. Besides, the organic matter content of soil is also dwindling in many of the states. The future sustainability of food production is highly vulnerable to climate change, resource degradation as well as water and air pollution. India's leading states in food production i.e., Punjab and Haryana face multiple environmental problems. Over extraction of ground water, imbalanced use of fertilizers and burning crop residues has both national and global impact. These along with subsidies for energy and fertilizer use and low water efficiency farms, put northern states in the eye of a perfect storm. Therefore, urgent action is needed towards a paradigm shift in Indian agriculture to usher more resource efficient and resilient path.

Strategies for Doubling Farmers' Income

The scientific way of crop production based on systematic soil test crop response, integrated plant nutrient system, weather based crop advisory for input application decision is much needed under current scenario. Innovative technologies like protected cultivation practices like shade net cultivation, poly house/ greenhouse cultivation and precision farming should be encouraged to increase crop yields. The renewed scientific efforts System of Rice Intensification (SRI) and Sustainable Sugarcane Initiatives (SSI) are needed to break the yield barrier and increase productivity in agriculture.

Fruit cultivation can be revolutionized by the adoption of Ultra High Density Planting and is the fastest way of reducing the gestation period and increasing the productivity of the orchards. Due to mono cropping, the crop enterprises are subject to risk and uncertainty and reinventing of the traditional practice is required but in a scientific way. Thus Integrated Farming System is the only solution to generate sustainable income and employment opportunity at farm level besides augmenting per unit land productivity. The different enterprises that can be integrated with cropping under wetland ecosystem are dairy, fishery, poultry, pigeon, mushroom cultivation and vermicompost. Under irrigated dryland ecosystem along with cropping, dairy, goat rearing, poultry, horticulture, apiary, sericulture and vermicompost are found promising and can be integrated. In the dryland ecosystem, the enterprises viz., cropping, horticulture, agroforestry, rabbit and sheep rearing can be integrated.

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With enhanced water use efficiency area under irrigation can be doubled in the country without requiring extra water. Adoption of irrigation technologies such as micro irrigation and management of water resources and new agronomic practices is required for realising the goal of “per drop more crop”.

Agri Markets are fragmented because of area restrictions imposed by APMC and this has had a negative impact on competitiveness. To promote market integration and the creation of a single market resulted in the concept of e-NAM, a pan India electronic market for farm produce. It will result in competition amongst buyers and enhance farmer realization, ensure transparent price discovery and reduce transaction cost. Farmers are adopting contract farming as it lowered the market risk, with the advance commitment to buy farmers’ produce at a pre-determined price and within a reasonable range of quality parameters.

Following area wise management strategies can be implemented for efficient input utilization and maximizing farm outputs:

Soil health management

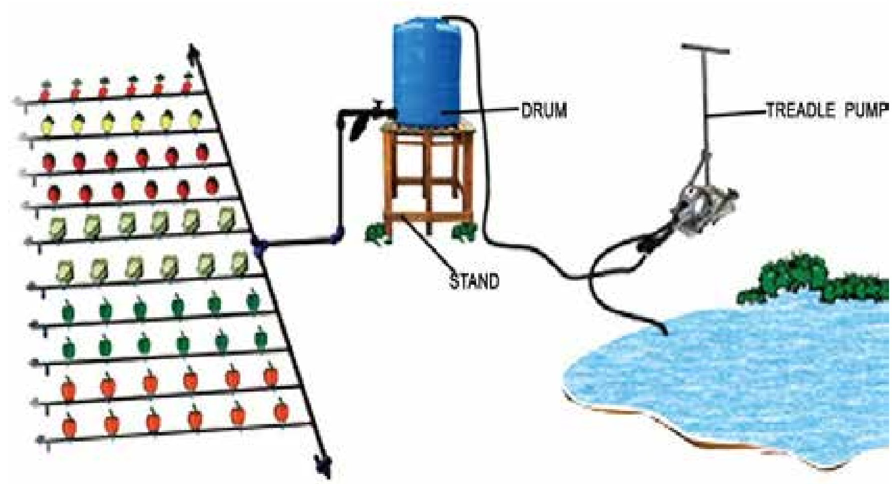
- Recycling of farm waste
- Organic waste in villages should be converted into organic manure using various compost techniques
- Strengthening soil health card programmes
- Promotion of bio fertilizers and micronutrient fertilizers
- Targeted application of soluble fertilizers
- Promotion of Low cost Zero/minimum tillage

Quality seed and planting material

- Development of Modern seed processing and storage facility
- Extensive promotion of new climate resilient area specific hybrids/HYVs in major crops
- Self-reliance through Participatory seed production programmes
- Subsidies based on quality seed replacement

Water management

- Application of mulching and micro irrigation systems
- Drip irrigation in high water demanding crops
- Cultivation of rice through SRI system
- Creation of village/farm ponds
- Adoption of In-situ rain harvesting systems

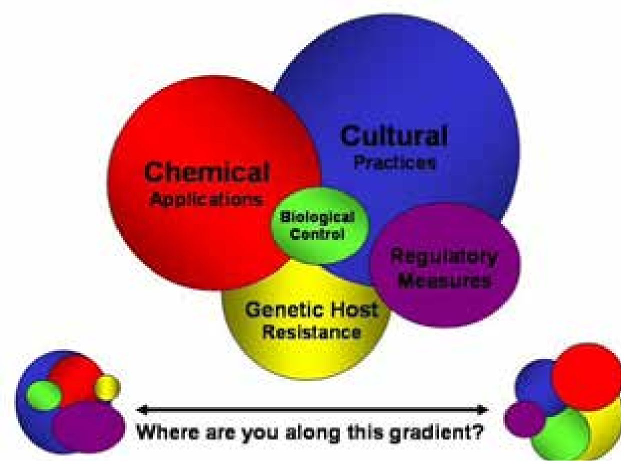


Weed management

- Integrated weed management (IWM)

Plant health management

- Mass multiplication of biopesticides at farmers level



Horticulture

- Providing quality material of fruit plant
- Promotion of intercropping, multi-storey plantation
- Contractual farming of local medicinal and aromatic plantation
- Promoting green house/polyhouse for off season cultivation

Farm mechanization

- Promotion of local manufacturers
- Adoption of zero/minimum tillage, deep ploughing and raised bed planting techniques
- Adoption of new weeding equipment's and minitractors

Post-harvest management and value addition

- Village level processing centres and rural godowns
- Establishment of primary processing centres at taluka level
- Awareness programmes on price forecasting, high price period and best priced market
- Popularization of available schemes of the Government
- Creation of multipurpose market yard with multiple facilities

Find out what quality grain is needed to sell into a more rewarding market | Dry the grain on a mat so its not in contact with the ground, and keep livestock away from it | Don't let drying grain get wet | Dry grain further if it is above the required moisture content | Inspect stored grain sacks for insect and rodent attack weekly

THE WAY AHEAD

For states such as Punjab and Haryana, the priority in these states should be to shift to high-value agriculture and value addition. Realignment in geographical orientation of the public procurement policy is suggested so as to shift water intensive cropping system to more ecologically suited areas for the cultivation of these staple crops. Adoption of climate resilient agriculture and embracing eco-friendly technologies needed to be done at ground level to see real impact. The current policies which support water, energy and input subsidies and price support for high water demanding crops should be revisited to eliminate vicious circle of resource degradation and move to virtuous circle of rapid and sustainable income growth.

Today, Indian agriculture stands at a crossroads and the challenges are multifaceted, but at the same time, smart solutions are available that have the potential to increase productivity, enhance climate resilience, and make agriculture climate-smart through proper soil health management, water management, farm mechanization, post-harvest management and value addition. These solutions can be deployed at scale if current farmer support programs are fully aligned with the government's target to double farmers' incomes. To conclude, let us provide the right conditions for farmers to produce more form less, reach markets and become entrepreneurs. That would imply a revolution in the agro & food sector in India and will lead to double the farmers' income.

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Realising the Aim of **Doubling the Farmers Income**

Neetu Thapliyal[1] and **Deepanker Pandey**[2]

Research Associate, National Seed Association of India

Assistant Director, National Seed Association of India

* neetuthap1602@gmail.com

1. INTRODUCTION

Agriculture is the main source of livelihood for more than 58 per cent of India's population. Since Independence, development of agriculture sector in India has focused primarily on raising agricultural output and improving food security. Transformation of Indian agriculture post-Green Revolution with the adoption of new varieties, effective disease management strategies, new farmer-friendly policies have led the country to become not only food and nutrition secure but also as one of food exporting nations of the world. Despite that, regular distress and crises in the recent past pose a severe threat to income and livelihood security of farmers. According to the report of DFI Committee, 2017, the average income of an agricultural household from July 2012 to June 2013 was as low as Rs. 6,426, as against its average monthly consumption expenditure of Rs.6,223. Further, 22.50 per cent of the farmers still live below poverty line. The agricultural income when compared to income realized from non-agriculture has been too low, with a wide variation across regions.

Agriculture is the main source of livelihood for more than 58 per cent of India's population. Since Independence, development of agriculture sector in India has focused primarily on raising agricultural output and improving food security. Transformation of Indian agriculture post-Green Revolution with the adoption of new varieties, effective disease management strategies, new farmer-friendly policies have led the country to become not only food and nutrition secure but also as one of food exporting nations of the world.

Farmers are at the epicentre of the Indian economy and their livelihood upliftment is a step towards holistic development of the nation. The decrease in productivity and income subsequently led to some serious implications on rural household poverty, and other economic, social as well as sustainability indicators (Mellor, 1999).

The annual growth in GVA (Gross Value Added) from agriculture has reduced drastically from 6.9 per cent (2016-17) to a mere 6.7 per cent (2017-18) as indicated by the estimates from the Central Statistics Office's (CSO). The growth was lower during the April-June 2017 quarter in comparison to real prices indicating the approaching deflation in farm sector (DFI Committee, 2017). As per CSO, the growth in GDP during 2018-19 is estimated at 7.2% and the real GVA is anticipated to grow at 7% in the current fiscal as against 6.5% in 2017-18.

Farmers are at the epicentre of the Indian economy and their livelihood upliftment is a step towards holistic development of the nation. The decreasing productivity and income subsequently led to some serious implications on rural household poverty, and other economic, social as well as sustainability indicators (Mellor, 1999). Hence, increasing the prosperity of farmers using innovations factoring in the same holding size and region has now become a priority for policy makers.

Revenue earned by a farmer from agriculture is important to address agrarian distress and endorse farmers' welfare. To achieve the goal of doubling the farmers' income by 2022, it is essential to promote farmers' income and to establish equality between the income of farmers and non-farm workers. To improve the economic condition of Indian farmers, the Government has implemented a seven-step path to move forward, first primary focus on irrigation with large budgets, with the aim of 'per drop, more crop'; second is the provision of quality seeds and nutrients based on soil health of each field; third large investments in warehousing and cold chains to prevent post-harvest crop losses; fourth promotion of value addition through food processing; fifth creation of a national farm market and e-platform; sixth Pradhan Mantri Fasal Bima Yojana (PMFBY) to reduce the possible risks and seventh focus on agri-allied activities (Barua et al., 2019).

The realization of doubling the income of farmers by 2022 comprising both farm and non-farm income (income from non-agricultural economic activities) requires a compound growth rate of 12.25 per cent per annum seven years from the base year 2016 (DFI Committee 2017). The present report contains the status of farmers' income across various holding sizes and regions, the challenges ahead, scope and pathways to achieve the goal of doubling the farmers' income by 2022 through potential drivers.

2. Status of Doubling the Farmers Income

1. Average Monthly Income per Agriculture household

During the FY 2012-13 average monthly income per agricultural household was estimated as Rs.6426/- at all-India level. During that period, the net receipt from farm business (cultivation and farming of animals) accounted for 60 per cent of the average monthly income per agricultural household in the country while nearly 32 per cent of the average monthly income was contributed by income from wages/ salary (NSSO Situation Assessment Survey 2014).

The NABARD- All India Rural Financial Inclusion Survey (NAFIS) 2016-17 showed that average agriculture household income has increased by Rs. 2,505/month in year 2016-17. The income of a farm household was indicated to be Rs. 8,931/ month in 2016-17.

2. Principle source of Income

Cultivation was principal source of income for about 78 per cent for the agricultural households in Rajasthan and Madhya Pradesh. However, livestock was reported as the principal source of income in more than 9 per cent of agricultural households of Tamil Nadu, Gujarat, Punjab and Haryana.

As per the Statement 6 of NSSO Situation Assessment Survey 2014, more than 80 per cent of agricultural households among the major states (Assam, Chhattisgarh and Telangana) reported cultivation as their principal source of income except for Kerala where about 61 per cent of the agricultural households reported to have earned maximum income from sources other than agricultural activities. Cultivation was principal source of income for about 78 per cent for the agricultural households in Rajasthan and Madhya Pradesh. However, livestock was reported as the principal source of income in more than 9 per cent of agricultural households of Tamil Nadu, Gujarat, Punjab and Haryana.

According to the NAFIS 2016-17, in all the states cultivation remained a major source of income (34 per cent), followed by daily wage labour (16 per cent), while livestock rearing contributed only 8 per cent of the income of agriculture households. The non-farm enterprises accounted for 6 per cent of the income and the other sources accounted for the rest.

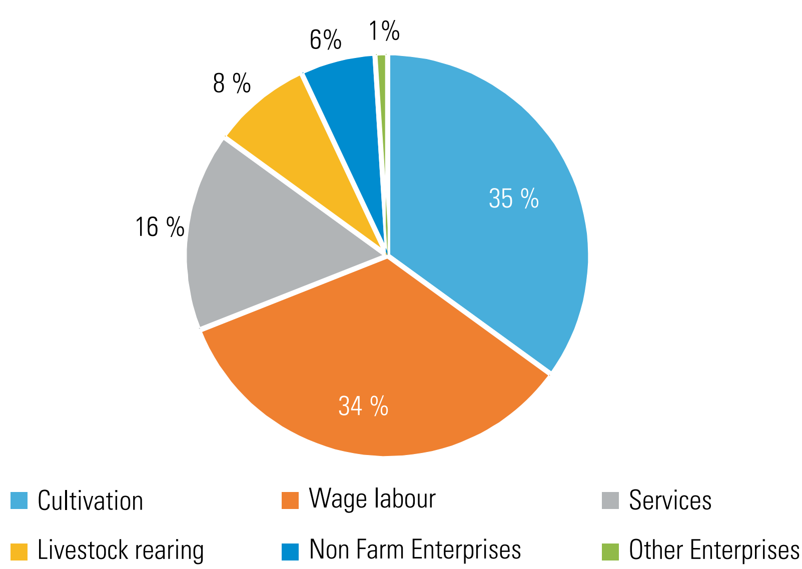

Fig 1.1 Source of income of agriculture households in India [NAFIS 2016-17]

3. Indebtedness of agricultural households

In 2014, NSSO Situation Assessment Survey revealed that about 52 per cent of the agricultural households in the country were estimated to be indebted and the average amount of outstanding debt per agricultural household was Rs.47,000/-. The situation was no different in 2016 according to the NAFIS 2016-17, 52.4 per cent of the agriculture households were indebted in 2016 and the average outstanding debt per agricultural households has increased to Rs. 1,04,602.

In 2014, among the major states, Andhra Pradesh indicated as one of the most indebted agricultural households in the country (92.9 per cent) followed by Telangana (89.1 per cent) and Tamil Nadu (82.5 per cent). While other states such as Assam (17.5 per cent), Jharkhand (28.9 per cent), and Chhattisgarh (37.2 per cent) indicated the lowest share of indebted agricultural households. The average amount of outstanding loan was the maximum for Kerala (Rs.2,13,600/-) followed by Andhra Pradesh (Rs.1,23,400/-) and Punjab (Rs.1,19,500/-). The states with lowest amount of average outstanding loan in 2014 were Assam (Rs.3,400/-), Jharkhand (Rs.5,700/-) and Chhattisgarh (Rs.10,200/-).

As per the NAFIS 2016-17 survey 41 per cent of rural households was indebted in 2016, of which majority (43 per cent) were agriculture households. Gujarat, Maharashtra, Telangana, Jammu and Kashmir and Himachal Pradesh were the most indebted households.

As per the NAFIS 2016-17 survey 41 per cent of rural households was indebted in 2016, of which majority (43 per cent) were agriculture households. Gujarat, Maharashtra, Telangana, Jammu and Kashmir and Himachal Pradesh were the most indebted households. Average amount of outstanding debt (AOD) for indebted agricultural households is reportedly ₹ 1,04,602 as on the 2016-17. Debt outstanding for indebted nonagricultural households is reportedly ₹ 76,731. Overall extent of indebtedness taking all households combined is reportedly ₹ 91,407.

4. Income of Agriculture Households

At all-India level, average monthly income per agricultural household during the agricultural year July 2012- June 2013 was estimated as Rs.77,112 /- (approx.) (NSSO Situation Assessment Survey 2014).

As per the estimates from NSSO data, the compound annual growth rate (CAGR) of farmers' nominal income was 11.8 per cent between 2002-03 and 2012-13. Haryana registered the highest income growth (17.5 per cent) while West Bengal was recorded with the lowest (6.7 per cent). However, the real growth was found to be lower relative to nominal income, wherein, Odisha had the highest CAGR of 8.3 per cent. Livestock contribution resulted in a significant change for the state (Chandrasekhar and Mehrotra, 2016). It was closely followed by Haryana (8.0 per cent), Rajasthan (7.9 per cent) and Madhya Pradesh (7.3 per cent), as against a national average of 3.5 per cent. Bihar and West Bengal experienced negative growth (real terms) in terms of farmers' income.

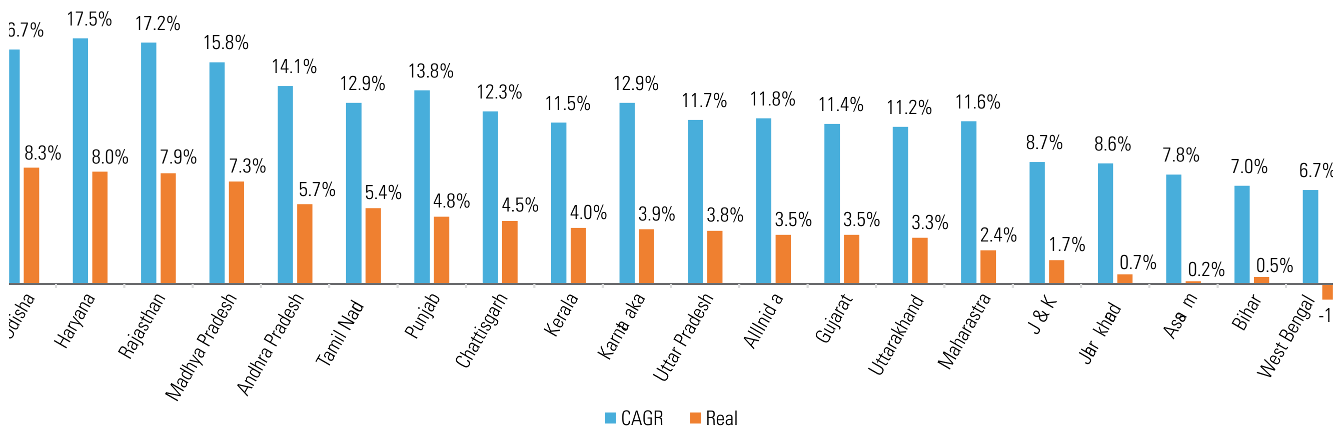

Fig 1.2 Income growth of farmers of major states of India [NSSO Situation Assessment Survey 2014]

In the reference year 2016-17, the average annual income of an agricultural household was estimated as Rs 1,07,172 from cultivation, livestock, non-farm sector activities and wages/ salaries (NAFIS, 2016). Thus, farmers' income grew at a compounded growth rate of 12 per cent per annum compared to Rs 77,112 per annum as per NSSO assessment in 2012-13. The income levels for 19 out of 29 states are above all India average and 15 states recorded annual compound growth of above 10.5 per cent between 2012-13 and 2015-16.

3. Challenges in Doubling the Farmers' Income & Way forward

Despite being one of the leading food-exporting countries at the global level, one-fifth of rural households in India whose main occupation is agriculture fall below poverty line (Barua et al., 2019). There are some major constraints in achieving the goal of doubling farmers' income viz. the decreasing crop productivity, the climate change, changing pest complex, the deteriorating seed quality and degradation of natural resources with time.

3.1 Crop Productivity

Crop production depends on the availability of arable land and is affected by various factors viz. climate change, agriculture facilities, macroeconomic uncertainty, as well as consumption patterns; it also has a great incidence on agricultural commodities' prices. Yield is the harvested production per unit of harvested area for crop products. The actual yield that is captured on farm depends on several factors such as the crop's genetic potential, the weather conditions like amount of sunlight, water and soil heath status, irrigation facility, the presence of weeds and pests.

The greatest challenge to the agriculture is to provide adequate food to increasing population. To increase crop production as well as crop productivity we need to combat challenges like scarce water and degrading land resources, recurring droughts, lack of facilities and difficult access to energy.

As per the 4th Advance Estimates, DAC&FW, Government of India, the total food grain production increased marginally to 284.83 million tonnes in the 2017-18 crop year. The total production of rice increased by 3.21 million tonnes from 109.70 million tonnes in the year 2015-16 to 112.91 million tonnes while production of Wheat estimated as 99.70 million tonnes is higher by 1.19 million tonnes than the production of wheat in 2015-16 (Table 1.1). The total output of nine oilseeds is estimated as 31.31 million tonnes in 2017-18 which is 0.04 million tonnes higher than production in the year 2015-16 (31.27 million tonnes). In commercial crops the production of cotton was estimated as 34.89 million bales (of 170 kg each) which is 1.91 million tonnes higher than previous year 2015-16. Production of sugarcane estimated at 376.90 million tonnes, higher by 70.84 million tonnes than its production during 2015-16 (Table 1.2). From the above data, it can be concluded that the production of food-grains, oil seeds and commercial crops has increased considerably over the years from year 2003 to 2018.

The country's requirement for food grains to provide for its population is projected to be 300 million tonnes by 2025 (Standing Committee on Agriculture, 2016). The estimated total food grains production in 2017-18 is 284.43 million tonnes (4th Advance estimates). If the current growth trend continues, the output goal can be achieved.

Although India is the second highest producer of paddy (rice) in the world (as of 2013), its yield is lower than China, Brazil and the USA. It is also the leading producer of pulses, but its yield is the lowest among the other countries (Agricultural Statistics at a Glance 2015)

Despite high levels of production, agricultural yield in India is lower than other large producing countries. Agricultural yield is the quantity of a crop produced on one unit of land. Although India is the second highest producer of paddy (rice) in the world (as of 2013), its yield is lower than China, Brazil and the USA. It is also the leading producer of pulses, but its yield is the lowest among the other countries (Agricultural Statistics at a Glance 2015). India's productivity has grown at a slower rate as compared to other countries. For instance, while rice yield in Brazil increased from 1.3 tonne/ha in 1981 to 4.9 tonne/ha in 2011, from 4.3 to 6.7 tonne/ha in China, in this period in India it increased from 2.0 to 3.6 tonne/ha (PRS India Report 2017).

3.2 Changing Pest Complex

Plant diseases have caused severe losses to humans in several ways. Plant diseases are a major yield and quality constraint for farmers in India and world. According to the Food and Agricultural Organisation (FAO) of the United Nations (UN), pests, including insects, lead to considerable losses to food crops globally. The total loss of food grains is around 1.3 billion tonnes per year. Plant pathogens (fungal, bacterial, viral or nematodes) damage plant parts above or below the ground.

The insect pest complex has been changed in the past years for many crops. Pest whose status has been changing from minor to major or secondary to primary pest is termed as an emerging pest (Rathi and Dalal 2018). Bemisia tabaci (Gennadius) on cotton, Helicoverpa armigera (Hubner) on vegetables and pulses, Spodoptera litura (F.) on vegetables, cotton and oilseeds, Pieris brassicae L. on crucifers, L. trifolii on vegetables and Atherigonia spp. on spring maize, have become increasingly severe during last decade. The invasive pest, coconut eriopyhid mite, Aceria gurrreronis Keiffer caused 64.16 – 89.42per cent nut infestation in at Thane, Maharashtra in 2014. During 2015–16 an epidemic of whitefly was noticed during August in the cotton growing areas of Haryana and Punjab (Kranthi, 2016).

3.3 Climate Change

Climate change is one of the most critical challenge at global level affecting the agriculture, natural resources, organisms and ultimately the economy of the country. The United Nations Framework Convention on Climate Change (UNFCCC) has recognized that the climate change will impact agriculture and all nations should prepare adaptations to the impacts on food security.

3.4 Seed Quality

Seed quality is the foundation for boosting the agriculture production and marketing. Good quality seeds are genetically and physically pure, vigorous and free from insect pests and pathogens.

Seed quality is the foundation for boosting the agriculture production and marketing. Good quality seeds are genetically and physically pure, vigorous and free from insect pests and pathogens. In the developing countries, informal seed systems are the primary source of seed for smallholder farmers. Improper storage environment, sensitivity of germinating seeds and young seedlings to dehydration stress lead to loss of desiccation tolerance with seed hydration and predicted climate change may further worsen the seed quality. The high quality seeds must possess the two characters viz. efficient seed germination and early seedling establishment that also represent the most susceptible stages of the life cycle of crop plants. Good-quality seed thus can be a significant factor for increasing agriculture production, productivity and enhancing food security.

High-quality seeds with enhanced vigour contribute nearly 30per cent of the total production (Afzal et al., 2016). Since, the first goal of a farm household in a changing agro-ecology is to obtain the improved seed with characteristics suitable to farmers' agro-ecological as well as his socio-economic condition. The availability of good quality seeds along with the support of other inputs is crucial to improve economy of farm household. Improve seed is pivotal in the improvement of food security and farm household livelihood (Abebe et al., 2017).

Integrated farming system approach has been widely accepted and has been commonly practiced in many countries as one of the tools for the sustainable production system.

3.5 Degradation of Natural Resources

With the continuous degradation of natural resources (air, water, land, soil etc.) the bright future of the world is uncertain. Due to the nonstop degradation of resources the agriculture production and productivity is also stagnating. To resolve this problem, integrated farming system approach has been widely accepted and has been commonly practiced in many countries as one of the tools for the sustainable production system.

It consists of a many eco-friendly practices that aim to achieve higher farm productivity and to attain sustainable agriculture, while decreasing the negative effects of intensive farming and preserving the environment. It is a combination of various agricultural enterprises, viz. cropping, animal husbandry, fishery, forestry and horticultural crops altogether to obtain the aim of high and sustainable crop production. To mitigate the impact of abiotic stresses Integrated Farming System is a suitable method that includes resource recycling and farm diversification.

Table 1.1 Production of Foodgrains from 2003-2018 (Million Tonnes)

Crop	Season	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17*	2017-18*
Rice	Kharif	78.62	72.23	78.27	80.17	82.66	84.91	75.92	80.65	92.78	92.37	91.50	91.39	91.41	96.30	97.50
	Rabi	9.91	10.90	13.52	13.18	14.03	14.27	13.18	15.33	12.52	12.87	15.15	14.09	13.00	13.40	15.41
	Total	88.53	83.13	91.79	93.36	96.69	99.18	89.09	95.98	105.30	105.24	106.65	105.48	104.41	109.70	112.91
Wheat	Rabi	72.16	68.64	69.35	75.81	78.57	80.68	80.80	86.87	94.88	93.51	95.85	86.53	92.29	98.51	99.70
Jowar	Kharif	4.84	4.04	4.07	3.71	4.11	3.05	2.76	3.44	3.29	2.84	2.39	2.30	1.82	1.96	2.10
	Rabi	1.84	3.20	3.56	3.44	3.81	4.19	3.93	3.56	2.69	2.44	3.15	3.15	2.42	2.60	2.85
	Total	6.68	7.24	7.63	7.15	7.93	7.25	6.70	7.00	5.98	5.28	5.54	5.45	4.24	4.57	4.95
Bajra	Kharif	12.11	7.93	7.68	8.42	9.97	8.89	6.51	10.37	10.28	8.74	9.25	9.18	8.07	9.73	9.13
Maize	Kharif	12.73	11.48	12.16	11.56	15.11	14.12	12.29	16.64	16.49	16.19	17.14	17.01	16.05	18.92	20.24
	Rabi	2.25	2.70	2.55	3.54	3.85	5.61	4.43	5.09	5.27	6.06	7.11	7.16	6.51	6.98	8.47
	Total	14.98	14.17	14.71	15.10	18.96	19.73	16.72	21.73	21.76	22.26	24.26	24.17	22.57	25.90	28.72
Ragi	Kharif	1.97	2.43	2.35	1.44	2.15	2.04	1.89	2.19	1.93	1.57	1.98	2.06	1.82	1.39	1.98
Small Millets	Kharif	0.56	0.48	0.47	0.48	0.55	0.44	0.38	0.44	0.45	0.44	0.43	0.39	0.39	0.44	0.44
Barley	Rabi	1.30	1.21	1.22	1.33	1.20	1.69	1.35	1.66	1.62	1.75	1.83	1.61	1.44	1.75	1.77
Nutri/ Coarse Cereals	Kharif	32.22	26.36	26.74	25.61	31.89	28.54	23.83	33.08	32.44	29.79	31.20	30.94	28.15	32.44	33.89
	Rabi	5.39	7.10	7.33	8.31	8.86	11.49	9.72	10.32	9.58	10.25	12.09	11.92	10.37	11.33	13.10
	Total	37.60	33.46	34.07	33.92	40.75	40.04	33.55	43.40	42.01	40.04	43.29	42.86	38.52	43.77	46.99
Cereals	Kharif	110.84	98.59	105.01	105.78	114.55	113.45	99.75	113.73	125.22	122.16	122.70	122.34	119.56	128.74	131.38
	Rabi	87.45	86.64	90.21	97.30	101.46	106.45	103.70	112.52	116.98	116.63	123.09	112.53	115.66	123.24	128.21
	Total	198.28	185.23	195.22	203.08	216.01	219.90	203.45	226.25	242.20	238.79	245.79	234.87	235.22	251.98	259.59
Tur	Kharif	2.36	2.35	2.74	2.31	3.08	2.27	2.46	2.86	2.65	3.02	3.17	2.81	2.56	4.87	4.25
Gram	Rabi	5.72	5.47	5.60	6.33	5.75	7.06	7.48	8.22	7.70	8.83	9.53	7.33	7.06	9.38	11.23
Urad	Kharif	1.20	0.95	0.90	0.94	1.12	0.84	0.81	1.40	1.23	1.48	1.15	1.28	1.25	2.18	2.84
	Rabi	0.27	0.38	0.35	0.50	0.34	0.33	0.42	0.36	0.53	0.47	0.55	0.68	0.70	0.66	0.73
	Total	1.47	1.33	1.25	1.44	1.46	1.17	1.24	1.76	1.77	1.95	1.70	1.96	1.95	2.83	3.56
Moong	Kharif	1.43	0.81	0.69	0.84	1.25	0.78	0.44	1.53	1.24	0.79	0.96	0.87	1.00	1.64	1.44
	Rabi	0.28	0.25	0.26	0.28	0.27	0.26	0.25	0.27	0.40	0.40	0.65	0.64	0.59	0.52	0.57
	Total	1.70	1.06	0.95	1.12	1.52	1.03	0.69	1.80	1.63	1.19	1.61	1.50	1.59	2.17	2.01
Lentil	Rabi	1.04	0.99	0.95	0.91	0.81	0.95	1.03	0.94	1.06	1.13	1.02	1.04	0.98	1.22	1.61
Other Kharif Pulses	Kharif	1.18	0.61	0.54	0.70	0.96	0.80	0.49	1.33	0.93	0.62	0.71	0.77	0.72	0.89	0.82

Crop	Season	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17*	2017-18*
Other Rabi Pulses	Rabi	1.44	1.32	1.36	1.37	1.19	1.28	1.28	1.33	1.34	1.60	1.51	1.74	1.50	1.77	1.76
Total Pulses	Kharif	6.16	4.72	4.86	4.80	6.40	4.69	4.20	7.12	6.06	5.91	5.99	5.73	5.53	9.58	9.34
	Rabi	8.74	8.41	8.52	9.40	8.36	9.88	10.46	11.12	11.03	12.43	13.25	11.42	10.82	13.55	15.89
	Total	14.91	13.13	13.38	14.20	14.76	14.57	14.66	18.24	17.09	18.34	19.25	17.15	16.35	23.13	25.23
Total Foodgrains	Kharif	117.00	103.31	109.87	110.58	120.96	118.14	103.95	120.85	131.27	128.07	128.69	128.06	125.09	138.33	140.73
	Rabi	96.19	95.05	98.73	106.71	109.82	116.33	114.15	123.64	128.01	129.06	136.35	123.96	126.47	136.78	144.10
	Total	213.19	198.36	208.60	217.28	230.78	234.47	218.11	244.49	259.29	257.13	265.04	252.02	251.57	275.11	284.83

Table 1.2 Production of the Commercial Crops for 2003-18 (Lakh Tonnes)

Crop	Season	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17*	2017-18 *
Groundnut	Kharif	68.60	52.62	62.98	32.94	73.62	56.17	38.52	66.43	51.27	31.87	80.58	59.30	53.68	60.48	75.40
	Rabi	12.67	15.12	16.95	15.69	18.20	15.51	15.76	16.22	18.37	15.08	16.56	14.71	13.66	14.14	16.39
	Total	81.27	67.74	79.93	48.64	91.83	71.68	54.28	82.65	69.64	46.95	97.14	74.02	67.33	74.62	91.79
Castor seed	Kharif	7.97	7.93	9.91	7.62	10.54	11.71	10.09	13.50	22.95	19.64	17.27	18.70	17.52	13.76	15.68
Sesamum	Kharif	7.82	6.74	6.41	6.18	7.57	6.40	5.88	8.93	8.10	6.85	7.15	8.28	8.50	7.47	7.51
Niger seed	Kharif	1.09	1.12	1.08	1.21	1.10	1.17	1.00	1.08	0.98	1.02	0.98	0.76	0.74	0.85	0.74
Soybean	Kharif	78.18	68.76	82.74	88.51	109.68	99.05	99.64	127.36	122.14	146.66	118.61	103.74	85.70	131.59	109.81
Sunflower	Kharif	3.06	4.31	4.56	3.66	4.63	3.57	2.14	1.92	1.47	1.87	1.54	1.11	0.66	0.98	0.83
	Rabi	6.24	7.56	9.83	8.62	10.00	8.01	6.36	4.59	3.69	3.57	3.50	3.23	2.30	1.53	1.28
	Total	9.30	11.87	14.39	12.28	14.63	11.58	8.51	6.51	5.17	5.44	5.04	4.34	2.96	2.51	2.11
Rapeseed & Mustard	Rabi	62.91	75.93	81.31	74.38	58.34	72.01	66.08	81.79	66.04	80.29	78.77	62.82	67.97	79.17	83.22
Linseed	Rabi	1.97	1.70	1.73	1.68	1.63	1.69	1.54	1.47	1.52	1.49	1.41	1.55	1.25	1.84	1.75
Safflower	Rabi	1.35	1.74	2.29	2.40	2.25	1.89	1.79	1.50	1.45	1.09	1.13	0.90	0.53	0.94	0.47
Total Nine Oilseeds	Kharif	166.72	141.49	167.67	140.12	207.13	178.08	157.28	219.22	206.91	207.91	226.12	191.89	166.80	215.13	209.96
	Rabi	85.14	102.04	112.11	102.77	90.42	99.11	91.53	105.57	91.08	101.52	101.37	83.21	85.71	97.62	103.12
	Total	251.86	243.54	279.78	242.89	297.55	277.19	248.82	324.79	297.99	309.43	327.49	275.11	252.51	312.76	313.08
Sugarcane	Total	2338.62	2370.88	2811.72	3555.20	3481.88	2850.29	2923.02	3423.82	3610.37	3412.00	3521.42	3623.33	3484.48	3060.69	3769.05
Cotton #	Total	137.29	164.29	184.99	226.32	258.84	222.76	240.22	330.00	352.00	342.20	359.02	348.05	300.05	325.77	348.88
Jute # #	Total	102.52	93.99	99.70	103.17	102.20	96.34	112.30	100.09	107.36	103.40	110.83	106.18	99.40	104.32	96.28
Mesta # #	Total	9.21	8.73	8.70	9.56	9.90	7.31	5.87	6.11	6.63	5.90	6.07	5.08	5.83	5.30	5.08
Jute & Mesta # #	Total	111.73	102.72	108.40	112.73	112.11	103.65	118.17	106.20	113.99	109.30	116.90	111.26	105.24	109.62	101.37

* As per the 4th Advance Estimates, DAC&FW, GoI

Lakh bales of 170 kgs. each

Lakh bales of 180 kgs. Each

The farmers' income can be increased by adopting the suitable scientific technologies viz. use of bio-fertilizers, micro irrigation and seed quality enhancement along with use of improved varieties.

4. WAY FORWARD

4.1 Adoption of region-specific improved varieties

The varieties used in most long-term experiments have been bred many times since the beginning of those experiments; improved varieties have emerged from breeding programs. Use of improved and hybrid seeds can help in bridging productivity gaps. The yield that the new hybrids and improved variety seeds provide are relatively higher, and thus could be thought as a potential way of enhancing the productivity.

The new varieties developed in the breeding programs have the higher yield potential and are also more resistant to pests and diseases than the older varieties (Table 1.3). The change in varieties is necessary because of changes in the pest complex and the breakdown of resistance over time.

4.2. Technology Adoption

Adoption of technologies also helps in increasing the production and productivity of agricultural output. The farmers' income can be increased by adopting the suitable scientific technologies viz. use of bio-fertilizers, micro irrigation and seed quality enhancement along with use of improved varieties.

4.2.1. Bio fertilizers

It can be inferred from the long-term experiments that use of bio-fertilizers is eco-friendly, more efficient, productive and economical to the marginal and small holding Indian farmers as compared to the conventional chemical fertilizers. The more is the use of bio-fertilizers more is the crop productivity, and hence the less is the damage to the soil texture due to the excessive use of chemical fertilizers.

4.2.2. Micro Irrigation

Under traditional irrigation methods like flood irrigation in Paddy practiced in major parts of the country, crop utilizes only less than one half of the water while the other remaining half gets lost in conveyance, application, runoff and evaporation. Micro irrigation (MI) methods such as drip and sprinkler system need to be employed for efficient water distribution and application for crop production. Drip and sprinkler irrigation methods are solution to reduce conveyance and distribution loss and allow higher water use efficiency. Drip irrigation has the greatest potential for the efficient use of water and fertilizers through fertigation (Ashoka and Malamasuri, 2015).

4.2.3. Seed Enhancement

Seed enhancement refers to the technologies that help to increase the consistency of seed performance, thereby improving a crop yield and quality. Seed enhancements techniques include physical, physiological and biological treatments to overcome germination constraints and providing uniform stands, crop development and better yields. Seed enhancement technologies are gaining increasing attention for their potential to confer greater disease resistance in seeds, improve seed vigour and modify seed emergence capabilities. Many shotgun approaches are being used for seed enhancement for the past years, which includes seed priming, magnetic stimulation, seed pelleting and coating.

4.2.4. Genetic Modification/ Genetic Engineering

In the recent years, the transgenic varieties and genetically modified/ genetically engineered crops have overtaken the old commercial varieties all over the world. In 1996, genetic modified crops were first grown commercially, since then the global cultivation of GM crops have seen an enormous rise making it the most accepted crop technology of today. In the last two decades, almost 28 countries have adopted this technology since these varieties have the great potential to improve the production and productivity under different agro climatic conditions.

The decision of the Genetic Engineering Approval committee (GEAC), Government of India clearing the release of Bt cotton for commercial cultivation during 2002-2003 crop season, is considered as one of the major milestones in the history of cotton improvement in India.

In India, Bt cotton is the only GM crop under cultivation and it covers around 95 per cent of the total cotton growing area. The decision of the Genetic Engineering Approval committee (GEAC), Government of India clearing the release of Bt cotton for commercial cultivation during 2002-2003 crop season, is considered as one of the major milestones in the history of cotton improvement in India. In a short period of 12 years, around 7.7 million farmers have adopted Bt cotton in India. Presently, India is not only the largest producer of cotton but also the 2nd largest exporter of cotton in the world. Major states under the cotton cultivation are Gujarat, Maharashtra, Telangana, Madhya Pradesh, Karnataka, Andhra Pradesh, Haryana, Rajasthan, Punjab and Tamil Nadu. As a further advancement, a total of 1128 varieties of Bt cotton hybrids have been allowed to be commercially released by GEAC from 2002-2012 for various zones of India.

During the 2007–08 and 2008–09 seasons, pink bollworm populations in India were surveyed to evaluate their responses to Cry1Ac and seed powder containing the Cry1Ac and Cry2Ab2. It was indicated in the results that resistance to Cry1Ac had evolved by 2008 in a population sampled from non-Bt cotton in the Amreli district of Gujarat in western India. The data constituted was the first evidence of field-evolved resistance of pink bollworm to Cry1Ac. This initial evidence spurred more extensive evaluations during the 2009–2010 growing season, which confirmed field-evolved resistance to Cry1Ac in Amreli. The lack of cross-resistance to Cry2Ab2 suggests that plants producing this toxin are likely to be more effective against resistant populations than plants producing only Cry1Ac (Dhurua and Gujrar, 2011).

Resistance to Bt crops is evolving faster now than before. Consistent with theory, resistance evolved slower with recessive inheritance of resistance, low initial resistance frequency, and abundant refuges of non-Bt host plants.

In India, Pink bollworm have developed resistance to Cry1Ac & Cry2Ab in Bt cotton. Bt crops producing two or more toxins are useful, but are not a solution. Besides deploying a new set of Bt toxins into the seed, two or more at a time, with 20 per cent non-Bt seeds as refugia, and Integrated pest management (IPM) system (IPM) could be an effective solution for cotton in India (Tabashnik et al., 2013).

4.2.5 Climate-Smart Agriculture (CSA)

Climate-Smart Agriculture (CSA) can be explained as one of the many sustainable agricultural practices (SAPs) that can make households withstand the deleterious effects of climate change and variability in smallholder farming systems (Manda et al., 2016). Crop diversification through rotations and intercropping, agro forestry, conservation tillage, cultivation of drought-resistant crops, water harvesting, and integrated soil fertility management are the techniques and practices that falls under the CSA. The adoption of the above-mentioned techniques by the farmers can increase the crop productivity and ultimately livelihoods of farmers.

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4.3. Diversification / intensification / relay cropping for higher profitability

Crop diversification is an important instrument for economic growth. It is one of the most reliable interventions well suited for land holding of all sizes as a popular risk management strategy. In the case of marginal and small land holders, bed planting of wheat along with vegetables like cucurbits as relay cropping in alternate furrows will yield higher profits in comparison to sole wheat cultivation. Some significant progress has been made during the past few years in crop diversification. However, the level of success varies from country to country as is driven by the market demand.

4.4. Integrated Pest Management

Integrated Pest Management (IPM) is an effective, environmentally friendly and strategic approach to crop-pest control. IPM aims to minimize pest populations by combining environmentally friendly pest-control methods and economically viable farming practices (Kabir and Rainis, 2015). IPM strategies aim to protect air, water, and soil resources while meeting specific production objectives (Mangan and Mangan, 1998; National Pesticides Information Center in USA, 2015. The focus of IPM is to protect and encourage natural predators of pest insects rather than the judicious use of pesticides. Currently, most of the rice farmers rely on intense applications of insecticide instead of following the IPM strategies for pest insect control (Mohiuddin et al., 2009).

4.5. Availability of Quality Seeds

The impact of investments in agricultural research can be realized only if farmers have better access to high quality seed of the new crop varieties. Since seed quality is one of the main factors that affects crop production potential

Seed quality comprises many aspects where four key attributes are explicitly identified: genetic purity, physical purity, physiological and health quality. However, seed quality can be affected by environmental conditions under which the crop is grown, the cultural practices used for production and the storage condition.

it should reach farmers in a good quality state. Seed quality comprises many aspects where four key attributes are explicitly identified: genetic purity, physical purity, physiological and health quality. However, seed quality can be affected by environmental conditions under which the crop is grown, the cultural practices used for production and the storage condition.

Maintaining seed quality is essential to meet the expectation of farmers as well as consumers. Seed producers should be aware of the technical and regulatory requirements for growing a crop for seed, and ensure that all operations are carried out strictly under specific guidelines in a timely fashion. The quality of the seed can be ensured by following a combination of key technical procedures and regulatory measures. The quality control assurance system by establishing administrative guidelines and technical procedures plays a supervisory role for smooth operation and implementation of the program and for enforcing the regulatory measures to maintain the quality of seed produced. Limited choice in improved varieties seeds, lack of sufficient seed quantity, and high seed production costs are some of the major constraints hindering the development of an effective and efficient seed industry.

4.6. From Conventional to Modern Plant Breeding

Plant breeding aims to the improvement of developmental traits such as overall plant architecture, morphological features, leaf structure, vascular architecture and flowering time that has great potential to increase biomass and crop yield. Modern plant breeding is being used as a new and potentially powerful tool and has been added by all the major seed corporations to their crop breeding research programs. It can augment and/or accelerate conventional cultivar development programs, to get better products, and more genetic uniformity, or achieve results not obtained easily through conventional breeding.

Transcriptome profiling, along with the characterization of genetic variation at the level of the entire genome, and associated QTL mapping and Genome-wide Association Study (GWAS) are major strategies to identify the genes governing a desirable trait in crop plants.

Recent advances in sequencing-based technologies and functional genomics have provided the ability to decode the genetic basis of desirable plant developmental traits. Transcriptome profiling, along with the characterization of genetic variation at the level of the entire genome, and associated QTL mapping and Genome-wide Association Study (GWAS) are major strategies to identify the genes governing a desirable trait in crop plants. Genomics-assisted breeding approaches along with bioinformatics and metabolomics technology have become essential components of crop improvement programs.

More investment from the public and private sectors is necessary to build and maintain capacity for research and sustained crop improvement to ensure the development of crops with higher yield.

4.7. Policy & Regulatory Reforms

4.7.1 Rationalizing the subsidy schemes

There is a need to rationalise the subsidy schemes and strategically allocate more share to develop the weaker links in the supply chain, especially those that boost investment in infrastructure and assets at village level. The capital goods used for creation of, and to modernise the agricultural logistics, such as pre-coolers, integrated pack-houses, reefer vehicles, reefer containers, warehousing, silos, cold stores, etc., can be exempt from GST to reduce the cost burden, as these were previously exempt from excise duty (DFI Committee Report).

4.7.2 Direct cash transfer scheme

Income transfers are not one-stop-solution to address the farm distress and measures should be taken to improve the structural reforms in Indian agriculture. Also, it is important to implement income transfers schemes effectively by assuring Centre-state coordination and transparency in the process.

Direct cash transfer is a poverty reduction measure in which government subsidies and other benefits are given directly to the farmers in cash rather than in the form of subsidies. The measure seeks to provide a direct income support to the farmers. The Indian Government's dominant policy instrument for supporting Indian farmers has been subsidizing key farm inputs (such as fertilizers, power for irrigation, canal waters, agri-credit and crop insurance) and minimum support prices (MSP) for 23 major crops. At present, different schemes are available at all India or state level for direct income support to farmers viz. Pradhan Mantri Kisan Samman Nidhi (All India), Ryatu Bandhu Pathakam (Telangana) and Krushak Assistance for Livelihood and Income Augmentation (Kalia) Scheme (Odisha). Income transfers are not one-stop-solution to address the farm distress and measures should be taken to improve the structural reforms in Indian agriculture. Also, it is important to implement income transfers schemes effectively by assuring Centre-state coordination and transparency in the process.

4.7.3 Crop insurance scheme

In 2016, Government launched Pradhan Mantri Fasal Bima Yojana (PMFBY)-a new crop insurance scheme to mitigate the rural distress caused by crop failure or damage due to factors like unseasonal rains, monsoon failure, storms, floods, pests and diseases. There are around 118.6 million cultivators in the country. The present coverage of the scheme is below 25 per cent.

The government aims to enrol a greater number of marginal and small holders under crop insurance scheme. In the Modified National Agricultural Insurance Scheme, the premium was in the range of 2-15 per cent of the sum insured. The government provided a subsidy of 75 per cent if the premium was above 15 per cent. The insurance companies calculated the premium based on actuarial rate which for some crops were very high that went up to 40 per cent. If the actuarial rate was higher than the capped rate, then the sum insured would come down accordingly. For example, let us consider that the sum insured for a crop is Rs 30,000 with premium capped at 11 per cent. If the actuarial rate is 22 per cent for the crop, then the sum insured will be reduced to Rs 15,000 under MNAIS. In PMFBY scheme there is no cap on the total value government will be contributing towards the subsidy. Even if balance premium is 90 per cent it will be borne by the government. The removal of capping on premium is expected to encourage more farmers to join the scheme.

The success of this program lies in increasing awareness amongst the farmers about this scheme. There is also an urgent need to launch campaigns to educate farmers and create awareness about the scheme among them.

4.7.4 Additional investment on agricultural R&D to pave path for innovation.

The Indian agricultural R&D system has so far responded well to the national challenges, but complexity of research and regulatory issues needs to be addressed now. There may not be adequate capacity to handle multiplicity of issues. For this it is required to put national efforts and capacity building within the government departments and fostering close interaction among these research systems like CGIAR, NARS etc. Research-extension linkages and revival of public extension shall continue to be a major challenge for improving overall effectiveness of agricultural R&D system. Lack of funds, manpower and skills are major weaknesses of the public extension system (World Bank, 2012).

Apart from funding the ICAR- SAUs system, private funding of research system also needs to be increase. Molecular breeding, biotechnology, genomics, fertilisers, transgenic research and tissue culture had attracted significant investment from the private companies for R&D activity.

In 2014, total public funding for agricultural research and education stood at Rs. 108.5 billion (or approx. 1,800 million US dollars). Of this, the Union Government contributed 43.5 per cent through regular grants to ICAR and the rest 56.5 per cent was contributed by the State Governments for SAUs. A part of ICAR funds (37 per cent) are used for supporting various activities like frontline extension, development of education and coordinated research projects in SAUs. In addition, there are research projects in SAUs which are sponsored under the funding from the World Bank and other donors. Thus, a considerable part of the expenditure incurred by SAUs is funded by ICAR and other sources. The funding of ICAR to SAUs has grown over time, providing an opportunity for better coordination among research, education and extension activities of ICAR institutes and SAUs. This leadership role of ICAR provided a unique advantage for planning and implementation of nationally important research programs in a 'mission mode' approach in partnership with SAUs. Apart from funding the ICAR- SAUs system, private funding of research system also needs to be increase. Molecular breeding, biotechnology, genomics, fertilisers, transgenic research and tissue culture had attracted significant investment from the private companies for R&D activity.

The success of hybrids and Bt cotton, Single Cross maize hybrids, Floriculture and Agro-Chemicals, Livestock, Diary etc has notably contributed to boost the national R&D. The capacity building and priority of investment of private R&D to generate public good in partnership with public organizations is a more substantive issue that needs to be considered. The ability of private sector to refine and commercialize technology developed by public R&D and create competition among private companies can perhaps generate larger benefits for farmers.

Conclusion

Most of the Indian farmers are small/subsistence and poor farmers who shoulder the responsibility to feed the expanding population. They are also a key for biodiversity and for improving sustainability. To achieve the aim of doubling the real income of farmers by 2022, the effort and resources necessary to achieve it would have to be at least three times that of the current under a Business As Usual (BAU) scenario levels (Gulati and Saini, 2016).

The use of quality seed, improved varieties and the best suitable cultural practices, is recognized as the most economical way of increasing crop production, productivity and the livelihoods of the farmers. Greater percentage of improvement in agricultural production has come from the use of improved seed. In essence, no agricultural practices, i.e. fertilization, irrigation etc can improve crop production beyond the limit set by seed. In ensuring this, seeds of new varieties must be made available to the farmers in adequate quantity and quality and at affordable prices, and on time. There is a key role to be played by the private sector to bridge the gap between the supply and demand of seed, and make quality seed available to farmers in their villages in the right amount and at the right time. It is expected that the increased supply will also reduce prices, making the technology available to the poorer farmers, and thus increase productivity and economic activity, and reduce poverty and food insecurities. There is a need of investment in research breeding and cultivar development in traditionally open-pollinated cultivars and in the minor crops. More investments in this area will mean cheaper cultivars for growers to choose from and more preservation of crop biodiversity.

Simple institutional and functional linkages between research and seed producing institutions; clear seed policies formulation and implementation in the country and capacity building in the R&D with incorporation of experts and extension agents that can strengthen the entire integrated seed system would provide practical solution to the problem.

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Figure 6: Yield in different countries in 2014-15 (in tonne/ha). State of Agriculture in India, 2017, PRS India,https://www.prsindia.org/policy/discussion-papers/state-agriculture-india#_edn8.

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Table 1.3

Field crop varieties of different field crops released during last five years for indenting during Rabi 2018-19 Breeder Seed Production Programme

A. CEREALS									
1. WHEAT									
S. No	**Variety name and parentage**	**Areas**	**Developed by**	**Production Condition**	**Grain yield (q/ha)**		**Notification No.**	**Special features**	**Nucleus seed (q)**
					Av.	Pot.			
1	K 1317 (K0307/ K9162)	NEPZ	CSA UAT KANPUR	Rainfed, Timely Sown	30.10	38.60	399(E) 24.01.2018	Resistant to brown rust & leaf blight. Good Chapati quality (Score:8.05)	*
2	DBW 168 (SUNSU PZ CHIBIA)	PZ	ICAR IIW-BR, Karnal	Irrig., Timely sown	47.50	70.10	1379(E) 27.03.2018	Very good for chapati (8.15/10), biscuit quality, Soft grains (36),	2.30
3	DBW 173 (KAUZ-IAAI/K	NWPZ	ICAR IIW-BR, Karnal		47.20	57.00	1379(E) 27.03.2018	Tolerant to terminal Heat (HSI =0.98), Resistance to yellow & brown rust	2.50
4	UAS 375 (UAS 320/GW 322// Lok 62)	PZ	UAS	Rainfed, Timely sown	21.40	29.10	1379(E) 27.03.2018	Resistance to brown & black rust	0.50
5	Pusa Wheat 1612(HI1612) (KAUZI/ALTAR84/ AOS/3/MIL AN/ KAUZ/4/H UITES)	NEPZ	ICAR-IARI	Rest. Irrigation	37.60	50.50	1379(E) 27.03.2018	32.4% and 52.4% yield gain at one and two irrigations, Resistance to yellow & brown rust	0.00
6	MACS 4028(d) (MACS 2846/ BHALEGAON3*2)	PZ	ARI, Pune	Rainfed, Timely sown	19.30	28.70	1379(E) 27.03.2018	Resistance against stem and leaf rust, early maturing (102 days), protein content (14.7%)	*
7	Pusa Wheat 8777 (HI 8777) (B93/HD 4672// H18627) (d)	PZ	ICAR-IARI RS, Indore	Rainfed, Timely sown	18.50	28.80	1379(E) 27.03.2018	Resistance to leaf rust, protein (14.3%), zinc (43.6 ppm) and iron (48.7 ppm) content	*
8	BRW3723 Sabour Nirjal (ACHYUT/ BL1887)	Bihar	BAU, Sabour	Rainfed, Timely Sown	28.70	47.30	2805(E) 25.08.2017	Drought tolerance	0.00
9	HW 5207 (CoW 3) (HW3029//V76 3 2312 (Yr15))	Tamil nadu	IARI RS Wellington + TNAU Coimbatore	Rest. irrigation, Timely Sown	40.80	59.60	2805(E) 25.08.2017	Resistance to leaf and stem rust, carrying LR24+SR2 4, S-2, Yr15	*
10	Gujarat Junagadh Wheat 463 (GJW 463) (GW496/ KLP010)	Gujarat	JAU, Junagadh	Irrigated, early sown conditions of Saurashtra and timely sown conditions of rest of Gujarat	55.70 (ES), 50.90 (TS)	78.30 (ES), 67.50 (TS)	2805(E) 25.08.2017	Moderately resistance to brown and black rust	*

S. No	Variety name and parentage	Areas	Developed by	Production Condition	Grain yield (q/ha)		Notification No.	Special features	Nucleus seed (q)
					Av.	Pot.			
11	KRL283 (CPAN 3004 /KHARCHIA 65//PBW 343	Uttar Pradesh	ICAR CSS-RI, Karnal	Salt affected soils (Irrigated, Timely sown)	20.90	41.00	1379(E) 27.03.2018	Resistance to leaf blight, Karnal bunt and hill bunt	*
12	HUW669 (Malviya 669) (ALTAR84/ HUW 206/ MI-LAN)	Uttar Pradesh	BHU, Vara-nasi	Rainfed/ Rest. Irrig.	24.10	43.00	1379(E) 27.03.2018	Resistance to all the three rusts and leaf blight	*
13	Chhattisgarh Genhu-3 (CG 1013) (GW 322/KYZ 0285)	Chhat-tisgarh	IGKVV RS, Bilaspur	Irrigated, Timely sown	33.40	49.30	1379(E) 27.03.2018	Resistance to leaf rust, Zinc content (43.1 ppm)	*
14	UAS 334 (SITE/ MO/4N AC/TH. AC//3*PVN/3/ MIRLO/BUC)	Karna-taka	UAS, Dhar-wad	Irrigated, timely sown	49.10	59.50	1379(E) 27.03.2018	Resistance to black and brown rust	*
15	PBW 660 (WG6761/ WG6798)	NWPZ	PAU, Lud-hiana	Rainfed, Timely sown	35.30	49.30	3544(E), 22.11.16	Chapati quality	2.75
16	HD 3171 (PBW 343/HD2879)	NEPZ	IARI, Delhi	Rainfed, Timely sown	28.00	46.30	1007(E) 30.03.17	Resistance to yellow, brown and black rusts	3.00
17	WB 2 (T. DICOC-CON C19309/ AE.SQUARROS A (409)/3/ MILAN/S87230// BAV92/4/ 2*MI-LAN/ S87320// BAV92)	NWPZ	IIWBR, Karnal	Irrigated, Timely sown	51.60	58.90	1007(E) 30.03.17	Zinc(42.0 ppm) rich whaet variety, resistance to yellow and brown rusts	11.20
18	HI 1605 (Pusa Ujala) (BOW/VEE/5/ ND/VG91 44// KAL/BB/3/ YACO/4/C HIL/6/ CASKOR/3/CROC _1/AE.SQUARRO-SA (22 4)//OPA-TA/7/PASTOR/M ILAN/KAUZ/3/ BAV92)	PZ	ICAR-IARI RS, Indore	Rest. irrigation, Timely Sown	29.10	44.00	1007(E) 30.03.17	Resistance to brown and black rust, excellent chapati quality	4.50
19	PBW 723 (Unnat PBW343) (PB-W343+Lr57/Yr40 +Lr37/Yr17)	NWPZ	PAU, Lud-hiana	Irrigated, Timely sown	49.20	63.20	1007(E) 30.03.17	Resistance to yellow and brown rust	24.50
20	HPBW 01 (PBW1 Zn) (T. DICOC-CON C19309/ AE.SQUARROS A (409)/3/MI-LAN/ S87230// BAV92/4/2*MIL AN/S87320// BAV92)	NWPZ	PAU, Lud-hiana	Irrigated, Timely sown	51.7.	64.80	1007(E) 30.03.17	Zn rich variety, re-sistance to yellow and brown rusts	8.00

S. No	Variety name and parentage	Areas	Developed by	Production Condition	Grain yield (q/ha)		Notification No.	Special features	Nucleus seed (q)
					Av.	Pot.			
21	MACS 3949 (STOTI/ALTAR84/ ALDI 3/THB/ CEP7780//2*MU SK_4)	PZ	ARI, Pune	Irrigated, Timely sown	44.00	64.30	1007(E) 30.03.17	Resistance to stem and leaf rusts, Good pasta quality	1.30
22	HI 8759(Pusa Tejas) (H18663/H18498)	CZ	IARI RS, Indore	Irrigated, Timely sown	56.90	75.50	1007(E) 30.03.17	Good for pasta making	5.00
23	PBW 677 (PFAU/MILAN/5/ CHEN/A E.SQUAR-ROSA//BCN/3/ VEE#7/BOW/4/ PASTOR)	Punjab	PAU, Lud-hiana	Irrigated, Timely sown	59.90	78.20	3544(E) 22.11.16	Resistance to yellow and brown rust	15.50
24	PBW 725 (PBW621// GLUPRO/3*PB W 568/3/ PBW 621)	Punjab	PAU, Lud-hiana	Irrigated, Timely sown	61.70	81.50	3544(E) 22.11.16	Resistance to yellow and brown rust	28.50
25	AKAW 4210-6 (PDKV Sardar) (31d SSN-1999-Sel. 186)	Maha-rashtra	PDKV, Akola	Irrig., Late sown	39.20	62.50	3544(E) 22.11.16	Early maturity	2.72
26	VL 953 (VL Gehun 953) (VW 0185/DO-RADE 5)	U'Khand	VPKAS, Almora	Irrig., Timely sown	33.4 (Hills) 44.74 (Plain)	_	3544(E) 22.11.16	Resistance to yellow and brown rust	1.50
27	UP 2784 (CPAN 4078/ PBW 442)	U'Khand	GBPUA&T, Pantnagar	Irrig., TS (Plains)	44.30	55.20	3544(E) 22.11.16	Resistance to leaf and stripe rust	*
28	CG 1015 (Chattis-garh Genhu-4) (NI 908/BL 1986)	Chattis-garh	IGKV, Bilaspur	Irrig., Late sown	36.70	68.80	1007(E) 30.03.17	Resistance to brown and black rust	1.50
29	BRW 3708 (Sabour Samriddhi (PAS-TOR/MILAN// MILAN /SHA7)	Bihar	BAU, Sabour	Irrig., Timely sown	46.90	_	1007(E) 30.03.17	Tolerant to leaf blight and brown rust	5.00
30	BRW 934 (Sabour Shreshtha) (HUW234/ CBW12-SEL)	Bihar	BAU, Sabour	Irrig., Late sown	43.10	54.00	1007(E) 30.03.17	Resistance to brown rust and loose smut	*
31	UAS 347	PZ	UAS, Dhar-wad	Rainfed, Timely sown	18.40	24.60	2 680(E) 7.10.2015	Resistance to brown and black rust	*
32	HS 562	NHZ	IARI-RS Shimla	Rainfed/IR , Time-ly sown	36.0 (RF) 53.7 (IR)	58.8 (RF) 62.2 (IR)	2238 (E) 29.6. 2016	Resistance to yellow rust	3.30
33	HD 4728 (Pusa Malwi)	CZ	IARI, New Delhi	Irrig., Timely sown	54.20	75.10	2238 (E) 29.6.2016	Good grain quality	*
34	Raj 4238	CZ	SKNAUD urgapura	Irrig., Late sown	45.50	62.80	2238 (E) 29.6.2016	Good chapatti score (8/10)	7.05

S. No	Variety name and parentage	Areas	Developed by	Production Condition	Grain yield (q/ha)		Notification No.	Special features	Nucleus seed (q)
					Av.	Pot.			
35	PBW 658	Punjab	PAU, Ludhiana	Irrig., Late sown	46.70	60.70	112(E) 12.1.2016	Resistant to stripe & leaf rust and leaf blight	1.00
36	MPO 1255 (MPO (JW) 1255	MP	JNKVV Powarkhed	Rainfed/RI-Timely sown	21.3 (RF) 33.8 (RI)	34.50 (RF) 47.3 (RI)	2238 (E) 29.6.2016	Suitable for pasta	4.00
37	MP 3382	MP	JNKVV Jabalpur	Irrig., Timely sown	59.20	79.40	2238(E) 29.6.2016	Good chapatti score (8.03/10)	20.00
38	HD 3117	NCR	IARI, New Delhi	Conservation Ag. Under Late Sown	47.90	50.10	2238 (E) 29.6.2016	Conservation Ag. Under Late Sown	*
39	HDCSW 18	NCR	IARI, New Delhi	Conservation Ag. Under Early Sown	63.00	73.00	2238 (E) 29.6.2016	Conservation Ag. Under Early Sown	*
40	GW 451	Gujrat	SDAU, Vijapur	Irrig., Timely sown	53.90	66.00	2238 (E) 29.6.2016	Good grain Quality	9.20
41	NIAW 1994 (Phule Samadhan)	Maharashtra	MPKV, Nikhad	Irrig., Timely sown	46.1 (TS) 44.2 (LS)	62.0 (TS)	2238 (E) 29.6.2016	Suitable for TS and LS conditions	11.51
42	HS 542 (Pusa Kiran) (MILAN/ KAUZI/PRINIA/3 / BABAX)	NHZ	IARI-RS Shimla	Rainfed, Early sown	32.90	49.30	2015		2.90
43	WH 1124 (MUNIA/ CHTO/AMSEL)	NWPZ	HAU, Hisar	Irrigated, Late sown	42.70	56.10	2015		9.50
44	WH 1142 (CHEN AEGILOPS SQUARROSA(TAUS)// FCT/3/2*WEAVER)	MWPZ	HAU, Hisar	Restricted irrigation, Timely sown	48.10	62.50	2015		8.00
45	NW 5054 (THELIN//2*ATTILA*2/P ASTOR)	NEPZ	NDUA&T,-Faizabad	Irrigated, Timely sown	47.00	64.20	2015		0.00
46	K 1006 (PBW343/ HP1731)	NEPZ	CSA, Kanpur	Irrigated, Timely Sown	47.00	65.40	2015		4.95
47	HD 3118 (Pusa Vatsala) (ATTILA*2/PB W65// WBL Delhi Late sown L1*2/TUKURU)	NEPZ	IARI, New Delhi	Irrigated, Late sown	41.70	66.40	2015		5.50
48	DBW 107 (TUKURA/ INQLAB)	NEPZ	IIWBR, Karnal	Irrigated, Late sown	41.30	68.70	2015		21.25
49	DBW 110 (KIRITAT /4 /2 *SERI* 2/3KAUZ* 2/ BOW/ /KAUZ)	CZ	IIWBR, Karnal	Irrigated, Late sown	39.00	50.50	2015		14.30
50	MACS 6478 (CS/ TH.SC //3*PVN/ 3 MIRL O/BUC/ 4/ MILAN /5/ TILHI)	PZ	ARI, Pune	Irrigated, Timely sown	45.00	65.70	2015		1.50

S. No	Variety name and parentage	Areas	Developed by	Production Condition	Grain yield (q/ha)		Notification No.	Special features	Nucleus seed (q)
					Av.	Pot.			
51	DBW 93 (WHEAR/TUKU-RU/WHE AR)	PZ	IIWBR, Karnal	Restricted irrigation, Timely sown	45.00	65.70	2015		1.00
52	HI 8737 (Pusa Anmol) (HI8177/ H18158//H18498)	CZ	IARI-RS Indore	Irrigated, Timely sown	53.40	81.00	2015		35.00
53	UAS 446 (DWR 185/DWR 2006//UAS 419)	PZ	UAS Dharwad	Rainfed, Timely sown	18.30	24.40	2015		*
54	HW 1098 (Nilgiri Khapli) (NP 201 Mutant developed through 20 Kr irradiation)	Dicoc-cum growing areas	IARI RS, Wellington	Irrigated, Timely sown	45.50	59.00	2015		*
55	UAS 304	PZ	UAS Dharwad	Irrigated, Timely sown	46.80	59.90	2014		1.26
56	HD 2967	NEPZ & NWPZ	IARI, New Delhi	Irrigated, Timely sown	50.40	66.00	2014		106.00
57	MP 3336 (JW 3336)	CZ	JNKVV Jabalpur	Irrigated, Late sown	44.70	64.40	2014		30.00
58	DBW 71	NWPZ	IIWBR, Karnal	Irrigated, Late sown	42.70	68.90	2014		4.00
59	WHD 948	PZ	HAU, Hisar	Irrigated, Timely sown	46.50	69.50	2014		*
60	DBW 90	NWPZ	IIWBR Karnal	Irrigated, Late sown	42.80	66.60	2014		3.00
61	HD 3086 (Pusa Gautami)	NWPZ	IARI, New Delhi	Irrigated, Timely sown	54.60	71.10	2014		54.00
62	DBW 88	NHZ	IIWBR Karnal	Irrigated, Timely sown	54.20	69.90	2014		4.75
63	HD 3090 (Pusa Amulya)	PZ	IARI, New Delhi	Irrigated, Late sown	41.40	63.10	2014		1.50
64	HD 3059	NWPZ	IARI, New Delhi	Irrigated, Late sown	39.50	59.40	2014		14.00
65	HPW 349	NHZ	HPKV, Palampur	Rainfed/Irrigated, Timely sown	47.0 (IR) 25.9 (RF)	61.4 (IR) 42.1 (RF)	2014		3.50
66	HI 8713	CZ	IARI-RS, Indore	Irrigated, Timely sown	52.30	68.20	2013		15.00
67	WH 1105	NWPZ	HAU, Hisar	Irrigated, Timely sown	51.50	71.60	2013		38.00
68	WH 5216	SHZ	IARI, Wellington	Restricted irrigation, Timely sown	45.60	62.40	2013		*

* Nucleus seed Production not reported

2. BARLEY						
S.No.	**New Variety**	**Year**	**Agro-eco. Zone / State & Production Conditions**	**Grain yield (q/ha)**		**Nucleus seed (q)**
				Avg.	Pot.	
1	DWRB 137	2018	NEPZ IR-TS	42.49	53.62	5.15
			CZ IR-TS		67.44	
2	K 1055 (Prakhar)	2018	UP IR-TS	38.30		*
3	RD 2794	2016	NEPZ IR-TS Salt Tolerant	29.90	43.30	5.5
4	RD 2849	2016	NWPZ IR-TS		69.20	0.00
5	BH 959	2015	CZ IR-TS	49.90	67.50	1.00
6	BH 946	2014	NWPZ IR-TS	51.96	66.32	1.50
7	BHS 400 (Pusa Sheetal)	2014	NHZ RF-TS		58.70	0.62
8	Mahamana 113 (HUB 113)	2014	NEPZ IR-TS	43.20	63.77	3.00
9	DWRB 92	2013	NWPZ IR-TS	49.81	69.06	3.20
10	DWRB 91	2013	NWPZ IR-LS		58.90	1.35
11	RD 2786	2013	CZ IR-TS	49.76	61.40	7.00
12	DWRB 101	2015	NWPZ IR-TS	49.20	67.44	3.70
13	DWRB 123	2017	NWPZ IR-TS	49.30	67.26	2.75
14	BH 946	2014	NWPZ IR-TS	51.96		1.5
15	VLB 118	2014	NHZ RF-TS		50.00	
	IR-Irrigated' RI-Restricted irrigation; RF- Rainfed; TS-Timely sown; LS-Late sown					
	* Production not reported					

B. PULSES					
1. CHICKPEA					
S. No.	**Variety**	**Year of release**	**Developing Institute/SAU**	**Salient features**	**Area of adoption**
a. Central Release Varieties					
1	GNG 1958	2013	Sriganga nagar	Suitable for normal sown irrigated condition. It matures in 145 days. It has brown seed colour with 25.4 g average 100-seed weight.	NWPZ (Punjab, Haryana, Western U.P., Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
2	GNG 1969(K)	2013	Sriganga nagar	Suitable for normal sown irrigated condition. It possess creamy beige seed colour with 26.2 g/100 seeds.	NWPZ (Punjab, Haryana, Western U.P.,Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
3	GLK 28127 (K)	2013	Ludhiana	Large seeds (36.0 g/100 seeds), light yellow or creamy colour with irregular owl head.	NWPZ (Punjab, Haryana, Western U.P.,Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
4	Pusa 3022 (BG 3022) (K)	2015	IARI New Delhi	Large seeded (35.7 g/100 seeds) kabuli chickpea with attractive beige coloured seed.	NWPZ (Punjab, Haryana, Western U.P., Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
5	Vallabh Kabuli Channa-1 (K)	2015	Modipuram	Large seeds (27.5 g/100 seeds), white beige colour, moderately resistant to Fusarium wilt.	NWPZ (Punjab, Haryana, Western U.P., Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
6	GNG 2144	2016	Sriganga nagar	Desi type chickpea with medium bold seeds (15.9g/100 seeds).It has tolerance to fusarium wilt disease.	NWPZ (Punjab, Haryana, Western U.P., Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
7	NBeG 119(K)	2016	Nandyal	Large seeded (38.8 g/100 seeds) kabuli variety.	SZ (Andhra Pradesh, Telangana, Karnataka and Tamil Nadu).
8	CSJ 515	2016	Durgapura	Small brown colour seeds (17.0 g/100 seeds), mod. resistant to dry root rot, wilt & collor rot and tolerant to Ascochyta blight and BGM.	NWPZ (Punjab, Haryana, Western U.P., Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
9	GJG 0809	2017	Junagadh	Medium brown colour attractive seed (21.5 g/100 Seeds), mod. resistant to wilt & stunt, root rot & tolerant to Ascochyta blight.	NHZ (Jammu & Kashmir, Himachal Pradesh, Uttarakhand, North Eastern Hills).
10	GNG 2171	2017	Sriganga nagar	Yellow coloured seed of size 15.9 gm/100 seed; tolerant to fusarium wilt disease	NWPZ (Punjab, Haryana, Western U.P., Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand).
11	Pant Gram 5	2017	Pantnagar	Brown coloured seed of size 16.2 gm/100 seed; tolerant to fusarium wilt disease	NWPZ (Punjab, Haryana, Western U.P., Jammu & Kashmir, Delhi, Northern Rajasthan, Himachal Pradesh and Uttarakhand)
12	BG 3043	2018	IARI New Delhi	Desi variety with medium large (21.4 g/100 seeds) seed.	NEPZ (Eastern U.P., Bihar, West Bengal, Jharkhand, and Assam).

b. State released varieties					
S. No.	**Variety**	**Year of release**	**Developing Institute/SAU**	**Salient features**	**Area of adoption**
1	NBeG 3	2013	Nandyal	Large seeded desi variety (24.0g/100 seeds), tolerant to drought with good rooting quality, tolerant to wilt.	Andhra Pradesh
2	JG 12	2014	Jabalpur	Desi variety with medium (15g/100 seeds) seed size. Semi-spreading habit with profuse pods.	M.P.
3	PBG 7 (GL26054)	2015	Ludhiana	Desi variety with medium (16.1g/ 100 seeds) seed size. Tall variety with profuse podding	Punjab
4	Birsa Chana 3	2015	BAO, Jharkhand	Desi type, resistant to lodging, shattering, wilt disease and tolerant to gram pod borer	Jharkhand
5	Bidisha (BG 1084)	2015	Berhampur, WB	Medium maturing desi variety with small seeds (12-14 g/ 100 seeds)	WB
6	JGK 5 (K)	2016	Jabalpur	Extra-large seeded (55-60 g/100 seeds) kabuli variety having resistance to Fusarium wilt and moderate resistance to root rot.	M.P.
7	BDNGK 798 (K)	2016	ARS, Jalna	Kabuli type with white medium (29g/100 seeds) grains. Moderately resistant to wilt and stunt	Maharashtra
8	Gujarat Junagadh Gram 6 (GJG6)	2016	Junagadh	Tolerant to wilt and stunt, suitable for normal sowing.	Gujarat
9	JG 36 (Jawahar Gram 36)	2016	JNKVV, Jabalpur	Semi spreading plant with dark brown seed. Tolerant to wilt.	Madhya Pradesh
10	GBM 2	2016	UAS, Raichur	Tall and erect plant type, suitable for mechanical harvesting	Karnataka
11	Indira Chana - 1	2017	IGKVV, Raipur	Erect plant type with more primary branches, resistant to wilt	Chhattisgarh
12	Nandyal Gram 49 (NBeG 49)	2017	ARS, Nandyal	Semi spreading plant type with medium height, Tolerant to wilt.	Andhra Pradesh
13	Pant Gram-4 (PG 065)	2017	GBPUAT, Pantnagar	Semi erect plant type, tolerant to wilt, BGM and dry root rot	Uttarakhand
14	Pant Gram-3 (PG 043)	2017	GBPUAT, Pantnagar	Semi erect plant type, medium seeds (24.4g/ 100 seeds), tolerant to wilt, BGM	Uttarakhand
15	Pant Kabuli Gram-2 (PG071) (K)	2017	GBPUAT, Pantnagar	Semi-erect plant type, kabuli variety (31.4g/ 100 seeds), tolerant to wilt, BGM	Uttarakhand
16	Dheera (NBG 47)	2017	ARS, Nandyal	Semi-erect plan type, suitable for mechanical harvesting.	Andhra Pradesh
17	Phule Vikram	2017	MPKV, Rahuri	Semi-erect plan type, early maturing, suitable for mechanical harvesting.	Maharashtra

2. LENTIL									
S. No.	**Name of Variety**	**Centre responsible for developing**	**Pedigree**	**Year of release**	**Average yield q/ha**	**Days to maturity**	**Reaction to major diseases**	**Area of adaptation**	**Any other relevant information**
1	IPL 316	IIPR, Kanpur	Sehore 74-3 x DPL -58	2013	14-15	110-115	Tolerance to wilt and rust	Central Zone	Large seed
2	RVL 11-6	RAK College, Sehore	JL 3 x DPL 62	2017	11 -12	107-113	Tolerant to Wilt.	Central Zone	Large seed
3	L 4717 (Pusa Ageti Masoor)	IARI, New Delhi	ILL 7617 x 91516	2016	12-13	96-106	Resistant to wilt and Ascochyta blight. HIGH IRON CONTENT	Central Zone	Extra early type
4	RKL 14-20 (Kota Masoor	AU, Kota	LL 1049 x RKL 11	2018	12-15	97-104	Tolerant to drought and high temperature	Central Zone	
5	L 4727	IARI, New Delhi	Sehore 74-3 x Precoz	2018	11-15	92-128	Moderately resistant to wilt	Central Zone	Suitable for timely planting under rainfed conditions
6	IPL 220	IIPR, Kanpur	(DPL 44 x DPL 62) x DPL 58	2018	14-18	119-122	Resistant to rust and Fusarium wilt	NEPZ	Suitable for normal sown conditions
7	RKL 607-1	AU, Kota	KLB 339 x SL 94-	2018	10-14	98-107	Tolerant to drought and high temperature	Central Zone	Suitable for normal sown conditions
8	Shalimar Masoor-2	Srinagar Centre, SKUAST-K	EC-3109 (Selection from ICARDA material)	2013	12.85	200-205	Moderately resistant to wilt and rust, resistant to white grub	Suitable for Kashmir Valley up to an altitude of 1850 m amsl	Large Seeds, Protein content of 23.03%
9	RVL 31	RAK, Sehore	Selection from local collection from Shajahpur	2014	18-19	110-115	Resistant to wilt	M.P.	Large seeds, high biomass
10	KLB 345 (Shekhar 4)	CSAUA&T, Kanpur	Precoz x KLB 231	2014	18-20	110-115	Resistant to wilt and rust	Whole U.P.	Large seed
11	KLB 2008-4 (Krati)	CSAUA&T, Kanpur	LG 362 xDPL 62	2015	18-20	115-120	Resistant to wilt	Whole U.P.	Large seed
12	KLS 09-3 (Krish)	CSAUA&T, Kanpur					Resistant to wilt and rust	Whole U.P.	
13	IPL 526	IIPR, Kanpur	DPL 62 x DPL	2016	10-12	101-110	Tolerance to Whole U.P. rust & wilt	Whole U.P.	Medium large seed

S. No.	Name of Variety	Centre responsible for developing	Pedigree	Year of release	Average yield q/ha	Days to maturity	Reaction to major diseases	Area of adaptation	Any other relevant information
14	Pant Lentil -9 (PL 098)	GBPUA&T, Pantnagar	Pant L 5 x IPL 105	2016	13-14	113-135	Resistant to rust, wilt and ascochyta blight diseases	Uttarakhand	Small seed
15	RLG 5 (Keshwanand Masoor 1)	RARI, Durgapura	Sel. from local germplasm	2016	15-16	130	Mod. resistant to root knot nematode	Rajasthan	Double podded and suitable for rainfed condition
16	Shalimar Masoor -3 (SKUA-L2-96)	SKUAST-K, Srinagar	KLS 221 (Sel. from IIPR germplasm)	2018	11.5-12.5	204	Tolerant to frost and winter chilling	Suitable for Kashmir valley	
17	KLB 345 (Shekhar 4)	CSAUA&T, Kanupr	Precoz x KLB 231	2018	18-20	111	Resistant to rust and wilt	U.P.	Bold seeded
18	KLS 122 (Shekhar 5)	CSAUA&T, Kanupr	KLS 564 x KL 320	2018	16-18	105-115	Resistant to rust and wilt	U.P.	Small seeded
19	IPL 526	IIPR, Kanpur	DPL 62 x DPL 58	2018	7-9	97-128	Tolerance to rust and wilt	U.P.	Large seeded

3. FIELD PEA										
S. No.	**Name of Variety**	**Centre responsible for developing**	**Pedigree**	**Year of release**	**Average yield q/ha**	**Days to maturity**	**Reaction to major diseases**	**Area of adaptation**	**Any other relevant information**	**Status of nucleus seed**
1	HFP 529	CCS HAU, Hisar	HUDP 9 x Arkel 2012 X(HUDP 12 x Arkel)	2012	22-25	120-125	Resistant to powdery mildew & tolerance to rust	NWPZ	Dwarf type	Sufficient quantity of nucleus seed is available
2	IPFD 10-12	IIPR, Kanpur	IPF 99-25 x EC	2014	22-25	110-115	Resistant to powdery mildew	CZ	Dwarf type, green dry seeds	
3	HFP 715	CCS HAU, Hisar	DMR 50 x HFP 9948	2014	15-16	115-120	Resistant to powdery mildew	NHZ	Dwarf type	
4	IPFD 12-2	IIPR, Kanpur	HUDP 15 x EC 342002	2016	22-25	110	Resistant to Powdery mildew, pod borer and moderately resistant to aphids and leaf miner	CZ	Dwarf type	
5	IPFD 11-5	IIPR, Kanpur	(DDR 16 X HUDP 7) X DDR 16	2016	19-20	105-110	_	CZ	Dwarf type	
6	IPFD 2014-2	IIPR, Kanpur	IPFD 99-13 x P 1297-97	2018	22-23	105-110	Moderately resistant to pod borer, aphid, leaf miner and nematode	CZ	Dwarf type and early vigour	
7	Shalimar Pea-1	Srinagar Centre, SKUAST-K	Selection of KFPD-8	2013	13-14	210-215	Resistant to Powdery Mildew and moderately resistant to rust, moderately resistant to pod borer and white grub	Suitable for Kashmir Valley up to an altitude of 1850 meters amsl	Higher protein content 20.65%	
8	Pant Pea - 155	GBPUA&T, Pantnagar	Pant P 13 x DDR 27	2016	18-20	120-135	Resistant to rust and powdery mildew diseases and tolerant to pod borer pest	Uttarakhand	Dwarf type	
9	RFP 2009-1 (Indira Matar 1)	IGKV, Raipur	Rachna x EC 334160-1	2016	17-18	100-105	Tolerant to powdery mildew and rust	Madhya Pradesh and Chhattisgarh	Suitable for rice fallow cultivation	
10	IPFD 6-3	IIPR, Kanpur	KPMRD 389 x HUDP 7	2016	19-20	110-115	Resistant to Powdery mildew and moderately resistant to rust	U.P.	Tendril typed	
11	RFP 4 (Keswanand Matar 1)	RARS, Durgapura	Bonneville x NPL	2016	17-18	110-120	Moderately resistant to Powdery mildew, rust, root rot & root knot nematode	Rajasthan	Seed medium bold	

C. OILSEEDS							
1. INDIAN MUSTARD							
S. No.	**Name of Variety**	**Year of release**	**Developing Insitute/ SAU**	**Area of adaptation**	**Days to maturity**	**Average yield q/ha**	**Special Character**
1	RH 725	2018	CCSHAU, Hisar	Zone II , Jammu, Punjab, Haryana, Delhi and Northern Raiasthan	142	26.0 -27.0	Suitable for timely sown and rainfed conditions
2	DRMR 1165-40	2018	ICAR-DRMR, Bharatpur	Zone-II, Jammu, Punjab, Haryana, Delhi & Northern Rajasthan			Timely sown and rainfed conditions
3	CS-58 (CS 1100 - 1-2-2-3)	2017	CSSRI, Karnal	HR, PB and UP	138	20.90	For salinity
4	Pant Rai 21 (PRB 2008-5)	2017	GBPUAT, Pantnagar	UK	122-127	12.0 -18.0	_
5	Pusa Double Zero Mustard- 31	2016	ICAR-IARI, New Delhi	Zone-II Northern Rajasthan, Punjab, Haryana, Delhi, Jammu & Kashmir	142	23.30	First variety of Indian mustard with double low quality traits (low erucic acid content in oil and low glucosinolate content in seed meal) Timely sown irrigated
6	GM-3 (Gujarat Mustard-3)	2016	SD Agril. Univ., Sardar Krushinagar, Gujarat	Gujrat	145-155	29.9	Early and bold seed size
7	Pusa Double Zero Mustard31 (PDZ-1)		ICAR-IARI, New Delhi	NCR	144	23.7	Low erucic and low glucosinolate (double zero)
8	RLC 2 (IC 511615)	2016	PAU, Ludhiana, Punjab	PB	150	20.40	For quality oil
9	PBR 378	2016	PAU, Ludhiana, Punjab	PB	146.5	24.5	Rainfed situation
10	Gujarat Dantiwada Mustard 5 (GDM 5) (SKM 518)	2016	Sardarkrushinagar Dantiwada Agricultural Univ. Sardarkrushinagar, Gujarat	PB, HR, J&K, RJ and DL	144	22.1	Rainfed situation
11	Raj Vijay Mustard 1	2016	Rajmata Vijaya Raje Scindhia Krishi Vishwa Vidyalaya, ICAR, Morena, MP	MP	108	17.0-18.0	Suitable for early sowing
12	JK Samriddhi Gold (JKMS 2)	2016	JK Agri Genetics Ltd., Hyderabad, Telangana	UP	125-130	20.0-30.0	_
13	Bayer Mustard 5450	2016	Bayer Bio Science Pvt., Hyderabad, Telangana	UP	130-135	28.0-30.0	For quality oil
14	RLC 3	2016	PAU, Ludhiana, Punjab	PB	149	18.20	_
15	Gujarat Dhantiwada Mustard 4	2015	SDAU, Sardar Krushinagar, Gujarat	GJ	112	24.17	High yield
16	Albeli 1	2015	Shakti Vardhak Hybrid Seeds Pvt. Ltd, Hisar	RJ, UP, MP and UK	140-145	21.3	Suitable for irrigated condition

17	Pant Rai-20	2015	GBPU&T, Pantnagar, Uttarakhand	UK	124	19.7	_
18	PBR-357	2015	PAU, Ludhiana, Punjab	PB, HR, DL, J&K and RJ	147	25.2	High yield
19	RGN-298	2015	ARS, S. K. Rajasthan Agricultural University, Sriganganagar, Rajasthan	RJ, PB, HR, DL, J&K and UP	143	21.7	Rainfed Timely sown Condition
2. YELLOW SARSON							
1	JK Pukhraj (JKYS 2)	2016	JK Agri Genetics Ltd., Hyderabad, Telangana	UP	115-120	15.0-20.0	_
2	Pant Sweta (PYS - 2007-10)	2017	GBPUA&T, Pantnagar	UK	110-120	10-15	_
3. GOBHI SARSON							
1	RSPN 25	2014	SKUAST, Jammu	J&K	145-155	15.0-18.0	_
2	GSC 7 (GSC 101)	2015	PAU, Ludhiana	PB, HR, HP, J&K and RJ	139-232	19.2	Low erucic and low glucosinolate (double zero)
4. TORIA							
1	Pant Hill Toria-1 (PT-2006-4)	2016	GBPUAT, Pantnagar	UK	122-134	5.0- 7.5	Spring type Toria
2	Pant Toria 508 (PTE-2008-2)	2016	GBPUAT, Pantnagar	UK	_	_	_
3	TL-17	2016	PAU, Ludhiana, Punjab	PB	90	13	_
4	Sushree	2012	OUAT, Bhubneshwar	OD	75	13.8	_
5	Raj Vijay Toria 1	2017	Rajmata Vijaya Raje Scindhia Krishi Vishwa Vidyalay, ICAR, MP	MP	98-105	11.0-16.0	Suitable for rainfed and irrigated condition, tolerant to shattering, suitable for sowing in first to second week of sepember, tolerant to drought condition
5. KARAN RAI (B. carinata)							
1	BJC 1 (PC ^) (African sarson)	2016	PAU, Ludhiana	PB	157	19.25	Suitable for mechanical harvesting
6. TARAMIRA							
1	Jwala Tara (RTM 1355)	2017	SKNAU, Jobner, Jaipur, Rajasthan,	Rajasthan, Haryana, Punjab, Uttar Pradesh, Madhya Pradesh, Gujarat and Delhi	137-142	12-13	Suitable for rainfed situation, Maturity days, Av. Yield
2	Jobner Tara (RTM-1351)	2016	SKNAU, Jobner, Raj	Rajasthan, Haryana, Punjab, Uttar Pradesh, Gujarat, Delhi, Uttarakhand and Maharashtra	130-145	12-15	Suitable for rainfed situation, Maturity days, Av. q/ha

7. SAFFLOWER					
S. No	**Name of Variety/ hybrid/inbred line developed by ICAR Institue/ Dte./ NRCs**	**Year of Notification**	**Special features**	**Areas of Adaptability**	**Nucleus Seed availability**
1	SSF-708	2012	Moderately tolerant to aphid Yield (kg/ha) - 1300-2200 Days to maturity - 115-120 Oil content (%) - 29	Western Maharashtra	Available
2	PKV-Pink (AKS 311)	2013	Moderately tolerant to wilt Yield (kg/ha) - 1500 Days to maturity - 135-140 Oil content (%) -30	Vidharbha region of Maharashtra	
3	NARI -H-23	2014	Tolerant to wilt and aphids Yield (kg/ha)- 1710 Days to maturity - 114-156 Oil content (%) -31	MS, KK,MP. Chattisgarh, Rajasthan, WB	
4	NARI-57	2015	Resistant to wilt Yield (kg/ha)-1500 Days to maturity - 118-151 Oil content (%)-29	Ms, KK,MP, WB, Rajasthan, UP, Punjab, Jharkhand	
5	NARI-96	2018	Higher tolerance to wilt than national checks A-1 and PBNS 12 and on par with the national checks for Alternaria Yield (kg/ha)-2023 Oil content (%) -33.21	MS, Telangana, AP, MP, Chattisgarh, Rajasthan	
6	DSH-185	2018	Resistant to wilt Yield (kg/ha)-1740 Days to maturity - 121-143 Oil content (%) - 28	All India	

8. LINSEED					
S. No	**Name of Variety**	**Year of release**	**Areas of Adaptability**	**Remarks**	**Nucleus Seed availability**
1	KL 263	2018	HP, Punjab and J &K		Available
2	JLS 95	2018	MP, UP		
3	Sabour Tisi-1	2018	Bihar, JH, Assam	Replacement of Himani, Shubhra, Garima and Surbhi in Bihar and Jharkhand	
4	RLC 143	2018	CG, Odisha, MP		
5	Arpita	2016	Odisha	Replacement of earlier linseed varieties in Odisha	

D. FORAGES				
Rabi varietal details				
1. OAT				
S. No.	**Variety**	**Year**	**Area of adoption**	**Special feature**
1	OL 1760	2017	Telengana, Andhra Pradesh, Karnataka and Tamil Nadu	Resistant to leaf blight and was superior in terms of dry matter yield, green fodder yield, crude protein yield
2	OL-1769-1	2017	Rajasthan, Haryana, Punjab, Uttarakhand and Western UP	
3	SKO-225	2017	J&K, HP and Uttarakhand	Superior for green fodder yield, dry matter yield, per day productivity for green fodder, leafiness and crude protein content in Hill Zone
4	OS-424	2017	J&K, HP and Uttarakhand	
5	JHO 2012-2	2017	Telangana, Andhra Pradesh, Karnataka and Tamil Nadu	Superior for green fodder yield, dry matter yield, crude protein yield, per day productivity for green fodder and dry fodder
6	RO-11-1	2016	North East (West Bengal, Odisha, Jharkhand, Bihar, eastern UP, Manipur, Assam), North West (Rajasthan, Punjab, Haryana, Uttarakhand), Central zone (Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh, central UP), South zone (Telengana, Andhra Pradesh, Karnataka, Tamil Nadu)	
7	OL-1804	2016	North East Zone (West Bengal, Odisha, Jharkhand, Bihar, eastern UP, Manipur, Assam)	
8	OS-405	2016	Central zone (Maharashtra, Gujarat, Madhya Pradesh, Chhattisgarh, central UP)	
9	OS-403	2016	North West (Rajasthan, Punjab, Haryana, Uttarakhand)	
10	OL-1802	2016	Chhattisgarh, Central UP	
11	OS-403	2015	North East (Assam, Manipur, Odisha, West Bengal, Eastern UP, Bihar, Jharkhand) and South Zones (Telangana, Andhra Pradesh, Karnataka, Tamil Nadu)	
12	JHO 2009-1	2015	Central Zone (UP, MP, Maharashtra, Gujarat)	
2. BERSEEM				
1	JSBC-1	2017	Maharashtra, Rajasthan, Punjab, Haryana, UP and MP	Single cut short duration condition
3. LUCERNE				
1	TNLC-14	2017	Telangana, Andhra Pradesh, Karnataka and Tamil Nadu	Resistant to rust and aphids and superior for forage and seed yield
2	RRB-07-1	2014	Punjab and Rajasthan	

Doubling Farmers' Income through Livestock

Dr Geeta

Veterinary officer, Uttarkashi, Uttarakhand, India

pipaliyageeta@gmail.com

Introduction

India has vast livestock resources. Around 20.5 million people in India depend upon livestock for their livelihood. The livestock contributes food and non-food items to the society. They impart food items such as Milk, Meat and Eggs for human consumption. India is number one in production of milk in the world. It is producing about 165.4 million tonnes of milk in a year (2016-17). Similarly, it is producing about 88.14 billion of eggs, 8.89 million tonnes of meat in a year. The value of output of livestock sector at current prices was Rs 8,11,847 crores in 2015-16.

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Apart from the food items, the livestock also contributes to the production of wool, hair, hides and pelts. India is generating around 43.5 million Kg of wool per annum. Leather is the most important product which has a very high export potential (Annual Report 2017-18). Despite lot of advancements in the use of mechanical power in Indian agricultural operations, nonetheless, bullocks are still the back bone of Indian agriculture. The bullocks are saving a lot on fuel which is a necessary input for using mechanical power like tractors, combine harvesters etc. Other potential role of livestock is use of pack animals like camels, horses, donkeys, ponies, mules etc to transport goods in different parts of the country. Also, in situations like hilly terrains mules and ponies serve as the only alternative to transport goods. Likewise, the army has to count on these animals to carry various items in high areas of high altitude. Dung and other animal wastes serve as very good farm yard manure and the value of it is worth several crores of rupees. In addition, it is also used as fuel (bio gas, dung cakes) and for construction as poor man's cement (dung).

Livestock are also considered as a biological control of bush, plants and weeds. Livestock offer security to the owners, are good companions and also the animals like cocks, rams, bulls etc are used for competition and sports.

Livestock are considered as "moving banks" because of their potentiality to dispose of during emergencies. They serve as capital and in cases of landless agricultural labourers and many times it is the only capital resource they possess. Livestock support as a treasure and in case of crisis, they aid as guarantee for getting loans from the local sources such as money lenders in the villages. Livestock are also considered as a biological control of bush, plants and weeds. Livestock offer security to the owners, are good companions and also the animals like cocks, rams, bulls etc are used for competition and sports.

Livestock sector contributes 4.11% GDP and 25.6% of total agriculture GDP. Livestock plays an important role in the economy of farm and non-farm households. It contributes 16% to the income of small farm households as against an average of 14% for all rural households. Hence, livestock is a principle source of income of two-third of rural community. It also provides employment to about 8.8 % of the total population in India.

Role of livestock in farmers' economy

The livestock exhibit a significant role in the economy of farmers. The livestock serve the farmers in different ways. Farmers earn income from various sources, viz. crop cultivation, horticulture, dairy, poultry, fisheries, other allied activities, non-farm activities and wage employment.

Status of Livestock resources in India

As per 19th Livestock census, 2012 (GOI, 2014) India's livestock sector is one of the largest in the world with a holding of 10.86% of world livestock population about 512.05 million nos. In world's total livestock population India ranks first in the population of buffaloes (57.83%) followed by cattle (15.06%), sheep (7.14%), goats (17.93%), camel (2.18%), equine (1.3%),pigs (1.2%), chickens (4.72%) and ducks (1.94%). However, as compared to the previous census the total livestock population in India has decreased by 3.33%. In total livestock population, highest contribution is of cattle (37.28 %) followed by buffalo (21.23 %), sheep (12.71%), goat (26.4%), pig (2.01 %) and others 0.5%.Total population of poultry in India is about 729.21 million, which includes 692.65, 23.54 and 13.02 million chickens, duckand turkeys & other poultry species respectively. India is the second largest poultry market in the world generating about 63 billion eggs and 649 million poultry meat. It is ascertained that growth pattern in total poultry population is quite more in

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comparison to total livestock population. India ranks third in the population of sheep (72 millions), fifth in the population of ducks and chicken and tenth in camel population in the world (Table 1.1).

Dairying has become an important source of income for millions of rural families. It is one of the most important assets for providing employment and income generating opportunities particularly for women and marginal farmers. The per capita availability of milk has reached to a level of 355 grams/day during the year 2016-17 which is more than the world's average availability 302 grams per day in 2016 (Annual Report 2017-18). Most of the milk in the country is produced by small and marginal farmers. Strengthening the small and marginal farmers for the milk production would help India become a milk exporter in the world.

With globalization of the dairy industry, private contribution has augmented quite significantly. However, the share of organized sectors in milk acquisition is very low as a large fraction of the milk and milk products are sold through the informal approach (Table 3). The informal demand consumes approximately 41 % of the milk and milk products produced in the country, contributing for about 75 % of the marketable excess of milk. The formal pathway, with its packaged milk and dairy products, contributes for only about 25%% of the marketable surplus, which is about 15% % of the production. To strengthen milk production and dairying activities via scientific and holistic approach for obtaining higher levels of milk production and productivity and to meet out the augmenting requirement for milk in the country, NPBBDD programme was launched in 2014. It was developedby combining four current schemes of the Department of Animal Husbandry, Dairying and Fisheries in the dairy sector namely, National Project for Cattle and Buffalo Breeding (NPCBB), Intensive Dairy Development Programme (IDDP), Strengthening Infrastructure for Quality and Clean Milk Production (SIQ and CMP) and assistance to cooperatives. NPBBDD has two components National Programme for Bovine Breeding (NPBB) and National Programme for Dairy Development (NPDD). With this NPDD scheme the per day new processing capability has been increased to 15.17 lakh litres and 4.04 lakh litres per day new milk chilling capacity has been installed till 2017-18 (Annual Report 2017-18).

Poultry production plays a crucial role in acquiring nutritional guarantee of the country in rural areas. The egg production in the country has risen from around 83 billion nos. in 2015-16 to around 88 billion in 2016-17 recording a rise of about 6% (Table 1.2). The targeted egg production by 2022 is 106 billion at a CAGR of 5%. The per capita availability of egg has increased from 61 in 2013-14 to 66 in 2015-16 andit has increased to 69 in 2016-17. Egg production is presently having a 5-6% CAGR. However, with novel scientific approaches like 500 eggs in 100 weeks compared to present 320+ eggs in 72 weeks, an obtainable significant increase in egg production can be expected by 2022-23 and it is possible if sufficient policy support is implemented to poultry industry. The poultry meat production in the country has enhanced to nearly 3.46 million tonnes during the year 2016-17 from 3.26 million tonnes during the year 2015-16 at around 6% growth rate. The production of meat and meat products has exhibited a remarkable growth. The targeted Poultry Meat production by 2022 is 4.20 million tonnes at a CAGR of 5% (National Action Plan for Egg and Poultry-2022). In addition to the dairy and poultry sector, overall fish production has also recorded a rise of about 18.86% as compared to the last three years, whereas inland fish production has recorded a growth of more than 26%. The combined production of all types of fisheries (capture and culture), the total fish production in the country has reached at about 11.41 million tonnes in 2016-17.

The commercial poultry sector is well matured in India. However, it needs policy support. The presently convenient veterinary support in terms of infrastructure (for hospitals and diagnostic labs) and technical manpower are unsatisfactory. Maize and Soya forms the major part of poultry feed but the cost of both the feed ingredient is very high in India due to lower productivity per hectare of land in comparison to other countries like China, USA and Brazil.

Barriers in increasing the livestock production

One of the major problems in doubling farmers' income is improving productivity of low-producing animals. The average annual milk yield of Indian cattle is only 50 % (1172 kg) of the global average. Similarly, the meat yield of most species is 20-60% lesser than the world average. Inadequate prophylactic vaccination and deworming are also the important issues to be taken care of. Persistent outbreaks of diseases like FMD, BQ, PPR, Brucellosis, Swinefever and Avian Influenza etc. extend decreased livestock productivity and production.

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Livestock sector secures only about 12% of the total public investment on agriculture and allied sectors and about 4-5% of the total institutional credit issuing to agriculture and allied sectors (Dinani et al. 2018). There is scarce funding, subsidy and bank loan in livestock in comparison toother agriculture sectors. Presently, only 6% of the animal heads (excluding poultry) are supported with insurance cover. Only about 5%of the farm households in India keep access to information on livestock in contrast to 40.4% for crop farming. It was noted that at present, the livestock extension efforts were sporadic and highly unorganized for want of an institutional set up at central level as well as at the level of the states. There are several states not having adequate egg production to meet their demand and depend on the imported eggs and chicken meat from other states. Organized slaughtering facilities are also too incompetent. Lack of connection to organized markets and insufficient profits sidetrack farmers from investing into improved technologies and quality inputs (11TH FIVE YEAR PLAN 2012-17).

Conclusion

A large number of rural populations in India rely upon agriculture for their living. Livestock plays a critical role in imparting nutritive food to both in rural and urban households. Since agriculture could only arrange employment for a maximum of 180 days in a year, the farmers rely upon livestock for applying their labour during off season. As the livestock distribution is much more equitable than land distribution. Thus, changes in the strategies for livestock and dairying have crucialimpacton the economy of the small holder farmers and for reduction of poverty.

Genetic elevation of poor performing livestock through crossbreeding, upgrading and selective breeding to magnifying their production along with local adaptability, economic feeding practices, proper health care and management practices will result in augmentation of production. The development of the market for the products, product processing, packaging, value addition, cold storage facilities should be taken care of by the Government. The easy availability of high yielding germplasm is of paramount importance to produce the animals with higher productivity. The livestock insurance should be expanded to cover the entire country. It should also cover small ruminants like sheep, goats and poultry with the pattern of assistance that is available for cows and buffalos. Adopting diversified and integrated farming, contract livestock farming and adopting PPP model will reinforce the livestock production.

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In a market driven economy, the future of the small holder rural milk producer will be protected only when consumer needs and wants are effectively connected with the functions of milk processing and milk production units. For that repetition of AMUL co-operative model for milk production is required to be followed. The deployment of appropriate technology for improving productivity and reducing the cost of milk production, also improving the quality of milk at the farm level–such as cooling, avoiding contamination, machine milking of high yielder is required at an appreciable required scale. Similarly Namakkal model for poultry production and increasing backyard poultry farming would drive the poultry production. Also promoting organic farming to specific areas along with increased funding, subsidy and easy availability of bank loan for livestock farming is mandatory. Thus, all these discussed points are the key areas to increase the livestock production and productivity and hence doubling the farmers' income.

Table 1.1 Livestock population

*** indicates including Mithun and Yak**

S. No	Species	Number (in millions)	Ranking in the world population
1	Cattle	190.9	Second
2	Buffaloes	108.7	First
	Total*	**300**	**First**
3	Sheep	65.0	Third
4	Goats	135.2	Second
5	Pigs	10.3	-
6	Others	1.7	-
	Total livestock	**512.3**	
	Total poultry	**729.2**	**Seventh**
7	Duck	-	Fifth
8	Chicken	-	
9	Camel	-	Tenth

Table 1.2 Egg and Poultry meat production in India

Year	Egg Production (million tonnes)	Poultry Meat Production (million tonnes)
2011-12	66.45	2.48
2012-13	69.73	2.68
2013-14	74.75	1.92
2014-15	78.48	3.05
2015-16	82.93	3.26
2016-17	88.03	3.46
Targeted by 2022	**106**	**4.20**

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909, Surya Kiran Building,
19, Kasturba Gandhi Marg, New Delhi - 110001 (INDIA)

Ph.: 011-43553241-45; Fax: 011-43533248
E-maill: info@nsai.co.in
Web: www.nsai.co.in