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Prospects of skill development in

livestock and allied sector in India for retaining youth in agriculture

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India's XII Five-Year Plan is focused towards creating more of employment opportunities through skill development of the youth. At present the country faces a severe shortage of well-trained, skilled workers. It is estimated that only 2.3% of the workforce in India has undergone formal skill training as compared to 68% in the United Kingdom, 75% in Germany, 52% in United States of America, 80% in Japan and 96% in South Korea. Large sections of the educated workforce have little or no job skills, making them largely unemployable. Therefore, India must focus on scaling up skill training efforts to meet the demands of employers and drive economic growth. This article focuses on skills development in livestock and allied sector particular in India, while also drawing on global findings on more comprehensive approaches to assist marginalized youth.

Key words: Agriculture, Livestock, Skill development, Youth

The country's population more than (54%) is below the age of 25 allowing it with an opportunity to provide a skilled-workforce to fill the expected shortfall in the ageing developed world (Document on the framework of implementation of the National Mission for Skill Development, www.firstpost.com). The rural population is about 70%, and the indications are that the migration of rural youth to cities is around 45% in the country, which is quite alarming.

Engagement of youth in agriculture

The current trend of leaving agriculture as a profession by youth even with the increased government support is due to various reasons. Young people perceive agriculture as a profession of intense labour, not profitable and unable to support their livelihood compared to what white collar jobs offer (www.youthinfarming.org). Inadequate credit facility, lack of agricultural insurance, poor returns to agricultural investment, lack of basic farming knowledge and lack of access to tractors and other farm inputs are the major constraints hindering youth participation in agriculture. Apparently, the agriculture sector is not looked at as a viable sector of employment and remains highly unattractive to the youth due to the risks, intensive nature and low profitability. For a country to attain economic stability, the agricultural sector must be vibrant and the youth should be encouraged imbibing farming as a noble profession. Youth have the potential to overcome some of the major constraints to expanding animal production in developing countries such as scientific feeding, animal health care, genetic improvement and protection against predators because they are often more open to new ideas and practices than adult farmers. Generally, youth are willing to adopt new ideas and technologies and therefore agricultural. extension services should target youth to transform agriculture.The youth could be the ideal catalyst to change the poor image of persons involved in agriculture, especially in the rural communities given their greater possibility to adapt new ideas, concept and technology which are all important to changing the way agriculture is practised and perceived. Large-scale migration of rural youth from farming to urban areas has caused concern among the agricultural policy makers; since, such a trend, if not checked, is likely to affect agricultural activities in the future.Thus, checking migration and retaining youth in agricultural sector is currently a big challenge.

Trends in agriculture work force in India

The overall number of farmers has dropped by 15 million since 1991. This has several implications for the future of Indian agriculture and India's food security. Young farmers can play an important role in ensuring food security, if they are encouraged to involve in farming and

the challenges they face are addressed. Over the past few years, rural youth have been shying away from agriculture and globally there is an increasing interest in finding ways of engaging youth in agriculture. As per the 2011 Census, 263 million people (54.6%) are engaged in the agriculture sector and over half of them are now agricultural labourers. The total agricultural workers is expected to decline to 190 million by 2022 (expected decline of 33%). In agriculture sector, about 18.5% of the workers were skilled in 2009-10 of which less than 0.5% have formal technical education.

Role of livestock in Indian agriculture

The share of agricultural sector in GDP declined from 26.3% in 1995 to 17.4% in 2014. The share of livestock sector in GDP has also declined but not as steep as the share of agricultural sector. It remained between 5 and 6% until 2000-01 and then gradually declined to 4.1% in 2012-13. Nonetheless, the share of livestock in the agricultural GDP improved consistently from 15% in 1981-82 to 25.6% in 2013-14. Livestock sector grew at an annual rate of 5.3% during 1980s, and declearation to 3.6% during 2000A.D. Despite this decleration, growth in livestock sector remained about 1.5 times higher than the growth in crop sector, and this provided a cushion to overall agricultural growth. According to estimates of the Central Statistics Office (CSO), the gross value added from livestock sector was about ₹ 7,33,054 crore during 2014-15 which is about 28.7% of the output from agriculture and allied sectors at current prices and 27.8% at constant prices. The growth of value of output from livestock sector during XIth Plan was 4.8% per annum and of fisheries was 3.6% per annum. Milk production during 2015-16 was 160.35 million tonnes (18.5% of the world milk production) with an annual growth rate of 4.6% during last 10 years and current estimated annual growth rate of 9.6%. The per caput availability of milk is around 322/day in 2014-15.

According to *Livestock Census 2012*, total livestock population in India is 512.06 million in which rural and urban population were 491.69 and 20.37 million respectively. Similarly, total poultry population is 729.21 million in which rural and urban population were 697.90 million and 31.31 million respectively. The number of milch animals (in-milk and dry) in cows and buffaloes has increased from 111.09 million to 118.59 million, an increase of 6.75%. The number of animals in milk in cows and buffaloes has increased from 77.04 million to 80.52 million showing a growth of 4.51%. The female cattle population has increased by 6.52% over the previous census (2007) and the total number of female cattle in 2012 was 122.9 million though the total bovine population was 299.9 million in 2012 which shows a decline of 1.57% over previous census. The she buffalo population has increased by 7.99% over the previous census and the total number of she buffalo was 92.5 million in 2012. The buffalo population has increased from 105.3 million to 108.7 million showing a growth of 3.19%. The exotic/ crossbred milch cattle increased from 14.4 million to 19.42 million, giving rise to an increase of 34.78%. The milch buffaloes increased from 48.64 million to 51.05 million with an increase of 4.95% over previous census. According to APEDA, India's exports of animal products was ₹ 33 128.30 crore in 2014-15, which include the major products like buffalo meat (₹ 29,282.60 crore), sheep/ goat meat (₹ 828.11 crore), poultry products (Rs. 651.21 crore), dairy products (₹ 1,205.38 crore), animal casing (₹ 19.32 crore), processed meat (₹ 14.21 crore), other meat (₹ 2.67 crore) and natural honey (₹ 535.07 crore).

Prospect of skill development in livestock sector

Dairying is providing livelihood to millions of the poorest and for many it is the sole source of livelihood bringing cash to their hands twice daily in some places and weekly once in other places. Small holder dairying is major source of household income, especially among the landless farmers. The impact study on 'Operational Flood in India' showed smallholder dairying accounting for more that 50% of the household income of landless farmer and that the importance of dairying as a source of household income decreased as the size of farm increased. As land is not equitably distributed, this indicates that development of small holder dairying would be a path out of poverty for the resource-poor in the society.

Dairy animals (8) generate employment of 840 human-days as against 45, 80 and 38.6 human-days, from paddy-I (2 acres), paddy-II (5 acres) and groundnut crops (6 acres), respectively. The maximum contribution (64.4%) to the aggregate net returns and maximum employment contribution (83.7%) to the aggregate employment from dairy animals revealed that dairying practised by the small-farmers category would be a strong potential source of income and employment generation. The earnings from dairy (5 nos.) and sheep farming (17 nos.) were quite high i.e., ₹ 16,000 (42%) and ₹ 7,650 (20.9%) respectively, so that could be more attractive in terms of income and employment generation in marginal farmers. Proper training and skill development in commercial milk production can motivate rural youth in this sector to earn their livelihood from it.

Commercial goat farming

Goats are important in small sectors farming system and are thought to sustain vulnerable and harsh climatic conditions. Goat's efficient reproduction, foliage utilization and unique feeding habits have made it a species dared under droughts and other natural distresses. Extensive and semi-intensive kid rearing was reported to be profitable, on an average fetching ₹ 1,200 per kid reared as per the prices prevailing in 2012.

India has the world's largest goat population after China. The rate of increase in goats in the past five decades has been the highest among all ruminants; beating sheep and cattle. Today, about 5 million households in the country rear goats. Many households are absolutely

surviving on income from goat rearing. Most of them are poor and marginal farmers. India is the largest goat meat producer after China. The rate of goat meat production (18.6%) in 1997-2007 was double the production rate (9.3%) in the previous decade. Despite a steady increase in supply, goat meat prices are continuously rising. The Wholesale Price Index shows the prices of mutton and chevon has increased by 75% in the past five years. This is the highest among all the primary food items except pulses and potato. The main reason for price increase is the rising export of goat meat to West Asia. Sixty countries import goat meat from India. The demand for goat meat is increasing faster than the growth in goat population. The goat meat market is set to rise as the middle class is expanding and meat consumption is increasing. Experts in the field are of the opinion that if this trend continues, India will have to import goat meat from Australia or other countries to meet the demand. Demand for goat meat and mutton will rise to 12.72 million tonne in 2020 against 3.8 million tonnes this year according to the National Institute of Economics and Policy Research, Delhi. India will need 248 million goats to meet this demand, which is almost double the number of goats in 2007. The demand projections of goat meat pose excellent business opportunities in this area. Skill development for the rural youth in commercial goat farming by themselves or through contact farming can be boost to this sector which can earn income and generate employment for the rural youth. Average employment generation by contract goat farming in western Odisha was about 229 man days which provides a relative gainful employment of 33 to 418 man days for the resource poor goat farmers from a flock size from 3 to 4 goats to more than 10 goats. An economic analysis of goat farming during February to April 2013 revealed an annual income of ₹ 10,366/year was earned from flock size of only 7 goats among landless and marginal farmers in West Bengal.

Commercial piggery

For the resource-poor farmer in the rural households, the advantage of pig production outweighs the other forms of livestock species. These animals convert a variety of crop waste, kitchen waste and livestock offal into high quality meat. They are also very efficient converters of concentrate feeds to meat when compared to ruminants. They give relatively rapid return on investment as, even on low planes of nutrition; a piglet is ready for slaughter at 12 months of age. Pigs are often considered in small-scale farming communities as 'living banks' which can be slaughtered at times of particular financial need. Commercial piggery is a profitable enterprise. India's consumption levels of Pork meat are significantly low when compared to other meats. The total world consumption of meat is estimated to be of the order of 240 million tonne per annum and India's share of consumption is only 2.2%. South India states like Goa, Karnataka, Andhra Pradesh, Telengana, Tamil Nadu, Kerala, Bengaluru are meat eaters and small Christian sectors also consume pork. Launching of piggery alone or in combination with other crop/ livestock enterprise has earned many farmers huge profits.

Sheep

Sheep with its multifacet utility for wool, meat, milk, skins and manure, form an important component of rural economy in arid, semi-arid and mountainous areas of the country. It provides a dependable source of income to the shepherds through sale of wool and animals. Sheep make a valuable contribution to the livelihood of the economically weaker sections of the society. Amongst the livestock owners, the shepherds are the poorest of the lot. The contribution of sheep to total meat production in the country is around 14%. The contribution of sheep through export of meat is 8% of the total export value of agricultural and processed food products. Live sheep are also exported for meat purpose. Sheep skin is also exported in the form of leather and leather products.

Commercial poultry farming

India is the second largest egg producer and third largest broiler chicken producer in the world with production estimates of 65,000 million (2.8 million tonnes) eggs and 3 million tonnes of broiler meat per year. The market is estimated to be worth about ₹ 90,000 crore (EUR 12.65 Bn). While agricultural production has been rising @ 2% per annum over the past two to three decades, poultry production has been rising @ of 8 to 10%, posting an annual turnover of US$ 7,500 million. In addition, exports are also seeing considerable growth. India's poultry exports grew from ₹ 314.25 crore (EUR 44.1 Mn) in 2010 to ₹ 494 crore (EUR 69.4 Mn) in 2012 (www.abroader.com).

Eggs and chicken meat are the cheapest source of animal protein affordable by the masses. Poultry products account for more than 75% of the non-vegetarian items consumed in India and poultry meat is presently accounting for 27% of the total meat consumed and is the most popular meat from any single livestock species. The poultry industry growth rate is higher than National GDP growth rate of 9%. India is the biggest consumer market in the world, with a population of 1.2 billion consumers growing at a GDP of 9% per annum. For bridging consumption gaps between NIN recommended (180 eggs and 11 kg meat), compared with current consumption patterns (55 eggs and 2.5 kg of poultry meat) it presents huge opportunity for youth to tap the market. To meet the above requirements (5-fold increase in egg consumption and 10-fold increase in meat consumption), there is a requirement to create 10 million jobs in the poultry sector in the country. The poultry sector holds more promises for the upcoming youth due to the various reasons. First poultry meat is the most economical source of animal protein without any religious fact. Secondly, the changing consumption patterns especially amongst the youths who are taking up egg and poultry meat on account of high nutritional value. Thirdly the fast paced growth of organized retail

in India which is currently 6%. Further, the relative cost of 1 kg broiler is equivalent to 7.2 kg feed in USA whereas it is just 4.9 kg in India. Factors like low-cost man power, availability of the all the inputs and high production efficiency are instrumental in making India an efficient poultry producer in the world. Further, the development of new high yielding strains suitable for rural farming such as Vanaraja, Giriraja, Gramapriya, Giririani, Krishna J, Gramalakshmi, CARI Gold and Rajasri strains pose excellent opportunities and immense potentiality for the development of poultry sector in the country thereby presenting higher opportunities of skill and entrepreneurship development in rural areas.

Value added milk product

India is the largest producer of milk in the world and accounts for nearly 18.5% of the global milk production. Milk production in India has been growing at around 4.6% annually. The level of milk processing is around 35% in India of which only 13% is processed by the organized sector (shodhganga.inflibnet.ac.in). The major milk products which are being produced are malted food, infant milk food, cheese and condensed milk.

The market value of dairy products is anticipated to grow at the compounded annual growth rate of around 11.4% during 2008-2022. This will push the market value of dairy products processing market to reach at around ₹ 2,597 billion by the end of 2022A.D.

Increasing demand for probiotic and branded milk has led to the growth in investment in dairy processing. The growth in the dairy processing is likely to increase the demand for value added products such as cheese, butter, yoghurt, ice-cream, etc. in days to come. Proper training and skill development in value addition to milk production can motivate rural youth in this sector to earn their livelihood from it.

Meat processing

The XI Five-Year Plan targeted a GDP growth of 10% per annum for the meat and meat products sector. There are about 60 meat processing units registered under the Factories Act. The revenue generated by the processed meat and poultry meat is expected to grow at a Compound Annual Growth Rate (CAGR) of 16.3% during the period 2008-2022, which will make the market value to take a leap from ₹ 369 billion in 2008 to reach at ₹ 3,065 billion by 2022. Meat and poultry market is the fastest growing market among all segments of processed food market in India. The share of the processed meat and poultry products in the processed food market of India is expected to almost double from 11% in 2011 to around 20% by 2022. The improvement in the income levels of the individual will spur the domestic demand for meat and poultry products. Even the high demand for frozen products will help this market to witness the impressive growth in day-to-days to come.

Animal feed industry

Animal feed is an important input for enhancing animal quality. According to some estimates, there is a supply demand gap in fodder production to the extent of over 60% in the case of green fodder and about 25% in the case of dry fodder. The fodder demand is projected to grow to 1,764 million MT in 2020. A doubling of supply is required to meet the demand-supply gap by 2020. Only 50% of the marketed feed is produced in the organized sector. This huge demand made this sector very much income and employment generating to the rural youth. Proper skill development through training and awareness can motivate the rural youth for animal feed and fodder production and earn their livelihood. Further, skill development in various new emerging animal feed supplements such as Urea Molasses Mineral Block, Urea Molasses Liquid Diet, Probiotics, Compressed Completed Feed Block can make rural youth generate and earn attractive income.

Animal breeding services

Livestock owners with a small training of 3-4 months through the milk cooperatives/NGO's can become skilled paravets/pashumitra/ pashusakhi and can generate gainful employment and also serve the livestock owners. In fact, health care delivery services are very poor in Indian villages. At present, there is one veterinary center for every 14,299 animals which is too low in comparison to the recommendation of National Commission on Agriculture (NCA) to have one Veterinary Center for every 5,000 animals, 1 Veterinary institution for 4 villages, and therefore, most of the states are lagging far behind the NCA recommendation. Accordingly, it is necessary to increase and strengthen the existing veterinary health care facilities to take care of precious livestock. As on 31 March 2015 there are only 11, 367 veterinary hospitals/polyclinics and 26,034 veterinary dispensaries, 23,722 vet aid centers (stockmen clinics and mobile dispensaries) across the country providing service for the huge livestock population. There is one veterinarian for every 7,000 animals covering 11 villages and 62 km. area. Limited availability of man power and weak extension system has increased the work burden on the veterinary officers. Therefore the state governments in various states are training rural youth and women as paravets for providing community service and income generation. A study at IVRI on the income generated by the paravets through providing AI services revealed that the average annual income generated was ₹ 81,163.63 ± 4469.14 and the average contribution of the AI service of the paravets to the total income was 40%.

Integrated farming system

Among the various risk mitigating techniques, IFS is the simple, stable, most efficient, equitable, economically viable and environment friendly practice. Several specific possibilities for integration of various livestock enterprises with crop production for small and marginal land holders under irrigated and dry land situations of semi-arid tropical regions of India were introduced and field tested over extended periods

starting in the mid-1980s. IFS helps the farmer to optimally utilize the limited resources available with them like money, land, time, labour etc. to increase their average monthly income with the substantial enhancement of social standing, round the year employment opportunities for the family members. Further, adaptation of IFS increases the socio-economic status of the marginal and small farmers. Among the various components of farming systems in the country, milch animals (cows and buffaloes) irrespective of breed and productivity, is the first choice of the farmers as an integral part of their farming system. A number of success stories on IFS models in different parts of the country suggest that farmers' income can be increased manifold by way of integration of enterprises in a farming system mode.

Skill development initiatives

Krishi Vigyan Kendra: Krishi Vigyan Kendras (KVKs) numbering 645, exist practically in every district of India. The main mandate of the KVKs is to impart need based vocational training to farmers, farm women & rural youth to change their knowledge, skill & attitude and as a result uplift the standard of living. As many as 54,415 training programmes were organized by the KVKs during 2015-16 wherein 15.27 lakh farmers/ farm women, rural youths and extension personnel participated. Trainings (43,381) were organized on various technologies to update the knowledge and skills of 12.52 lakh farmers and farm women. Skill-oriented training courses (7,000) were organized for 1.68 lakh rural youth, including 61,742 young women (36%) during the year. These courses were on integrated farming, mushroom production, value addition, dairy farming, seed production, vermi-culture, nursery management of horticulture crops, bee-keeping, protected cultivation of vegetables, repair and maintenance of farm machinery implements, sheep and goat rearing, poultry production, production of organic inputs and small-scale processing (Annual Report, ICAR, 2015-16). The ICAR has also recently launched a KVK portal to facilitate farmers and other stakeholders in accessing the information and also for online monitoring system at the national level to review and monitor the functioning of KVKs against the mandates and objectives (www.icar.org.in).

Nehru Yuva Kendra Sangathan

The *Nehru Yuva Kendra Sangathan* (NYKS) is an autonomous organization under the Ministry of Youth Affairs and Sports. The main objective of NYKS is to channelize the power of youth (13-35 yrs) on the principles of voluntarism, self-help and community participation. Over the years, NYKS has established a network of youth clubs in villages, where Nehru Yuva Kendras (501) have been set up, harnessing youth power for development by forming Youth Clubs, which are village level voluntary action groups of youth at the grassroots level to involve them in nation building activities, working for community development and youth empowerment. Though, only a few NYKS are involved in agricultural development but more could be achieved, if NYKS could focus on skilling rural youth in agricultural activities.

NABARD farmers' clubs

The broad objective of setting up Farmers' Clubs is to achieve prosperity for the farmers with overall agricultural development in its area of operation by facilitating credit counseling, technology counseling and market counseling. NABARD's policy support for Farmers' Club Programme emphasizes on linking technologies with farmers' club members, while facilitating market access through capacity building of members of Farmers' Clubs including leadership training; linkage with technology/markets; Self-Help Groups (SHGs)/Joint Liability Groups (JLGs) formation and forming Federations of Farmers' Clubs/Producers' Groups/Companies. Under this programme, the NABARD has so far assisted formation of more than 1.27 lakh farmers' clubs across the country. The NABARD provide a financial assistance of ₹ 10,000 to each club per annum for 3 years to meet routine expenses for formation, maintenance, and organizing awareness meets.

National Agricultural Research and Education system

The NARES comprises of Universities including three universities of Agriculture, four universities of Horticulture, three veterinary universities and three Fishery university which are involved in education and training to graduates and postgraduates. The country has a total of more than 57 veterinary colleges imparting veterinary education which are functioning under the 14 Veterinary universities, three Central Agriculture University and three Central University. A total of three ICAR institutes including animal science institutes are also involved in imparting skill education in the livestock and allied sector. Recently the Government of India has also launched a National Agriculture Education Project with an outlay of Rs. 1,000 crore with the assistance of World Bank to improve the agriculture education in the country.

National rural livelihood mission

The National Rural Livelihood Mission aims at creation of opportunities for both wage employment and skill development for the rural youth, who lack skills in many areas of agricultural production and processing. The National Skill Development Mission and the National Skill Qualification Framework are aggressively pushing the agenda of skill development to build the capacity of rural youth so that they are meaningfully employed in rural areas itself. Thus, need-based experiential skill learning supported by public sector banks/organizations in rural areas is the key to strengthen the Rural Self-Employment Training Institutes being set up in all districts under NRLM to assist.

National livestock mission

The mission is designed to cover all the activities required to ensure

quantitative and qualitative improvement in livestock production systems and capacity building of all stakeholder. The mission will cover everything useful to improvement of livestock productivity and support projects and initiatives required for that purpose subject to condition that such initiatives which cannot be funded under other Centrally Sponsored Schemes under the Department. It has four submissions out of which one is focused on Skill Development, Technology Transfer and Extension. This sub-mission will provide a platform to develop, adopt or adapt the technologies including frontline field demonstrations in collaboration with farmers, researchers and extension workers, etc. wherever it is not possible to achieve this through existing arrangements.

Agricultural Skill Council of India

Considering the need for skilling the work force in agricultural sector, the Agricultural Skill Council of India (ASCI) has been recently proposed by National Skill Development Corporation (NSDC), which could be one ideal institution to train rural youth. The ASCI proposes to train, certify and accredit 56.5 million work forces comprising of farmers, wage workers, entrepreneurs and extension workers, over 10 years through its training partners. Some of the supporting bodies of ASCI for promotion of skills in livestock and allied sectors include Indian Dairy Association, CLFMA Livestock association of India, GCMMF, ICAR, NABARD, SFAC, APEDA etc.

ASEAN-India Farmers Exchange

The Ministers of the ASEAN concerned over the small number of young farmers' involvement in the agriculture sector, agreed on the importance of promoting innovation and entrepreneurship among young farmers to achieve more sustainable agriculture development in the region. This initiative is expected to create greater awareness among the young and innovative farmers on the promising career in agriculture sector.

New Schemes for Agriculture and Livestock Development

Recently, the Ministry of Agriculture and Farmers Welfare, Government of India, have also launched various schemes viz., Farmers FIRST, ARYA, Student READY and *Mera Gaon Mera Gaurav* for agriculture and livestock development. Farmers FIRST programme will benefit 1.0 lakh farmer. In ARYA programme, 10,000 rural youth (under the age of 35 years), 400 from each selected districts in the plains and 200 from hilly and less populated areas would be trained and associated with agricultural enterprise with the outlay of 100 crore. Similarly, 25,000 students (Agriculture and allied sector graduates) will get experience based and skill oriented hands on training in Student READY programme. Under the *Mera Gaon Mera Gaurav,* 20,000 agricultural scientists will work for the agricultural development through creating awareness and capacity building programme in lakh villages.

SUMMARY

At present, 263 million people (54.6%) are engaged in the agriculture sector and over half of them are now agriculture labourers (*Census, 2011*). The total agricultural workers are expected to decline to 190 million by 2022 (expected decline 33%). In agriculture sector, about 18.5% of the workers were skilled in 2009-2010 of which less than 0.5% have formal technical education. These facts reveal an urgent need to educate the Indian population of the importance of skill development and formal technical education in various areas of agriculture and the employability of the sector especially the animal husbandry subsector. This will not only attract back the farmers towards agriculture but also the next generation youth.

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- A total of ₹ 788.33 crores have been sanctioned for opening six new agricultural colleges for eastern India under Central Agricultural University, Imphal, and a new Central Agricultural University in Meghalaya.
- For the establishment of two new agricultural research institutes in Asom and Jharkhand, a sum ₹ 100 crores is allocated.
- First academic session of the Rani Lakshmibai Central Agricultural University has been allocated for four new agricultural colleges in Datiya and Jhansi.
- An Memorandum of Understanding was signed for transforming the Rajendra Central Agricultural University, Pusa, Samstipur, Bihar. A proposal of ₹ 400 crores is submitted in EFC.
- Post-Graduate Institute of Horticulture is being established in Amritsar, Punjab.
- Foundation stone of the Indian Institute of Agricultural Biotechnology is laid at Ranchi for promoting agricultural biotechnology.