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Doubling farmer's income with production enhancement through productivity gains

Dr. Sujit Kumar**Abstract**

Agriculture is a primitive science as well as art being practiced over the globe since unmemorable time. Agriculture sector is facing intolerable population pressure due to its exponential growth and additive growth in agriculture production. It resulted continuous increase in inputs to achieve more and more yield due to which great ecological imbalance and diminishing return have been realised after green revolution. In spite of various positive all efforts production was enhanced significantly but long term effect was deterioration of soil health, nutritional security problems and problem of marketability. Slowly and slowly share of agriculture in gross domestic produce (GDP) was also reduced. In the history of India, there was an year of dissatisfaction for agricultural development in 2002-03 where contribution of agriculture in GDP became negative. Whereas, during 2008-09 it was maximum i.e. near to 4% against 10% from non-agricultural sector. In Indian scenario as per census of 1980-81 only 66.4% share of marginal farmers were prevailing whereas, as per senses of 201-11 this figure enhanced up to 67%. It means land holding size is decreasing very fast in one hand whereas, number of holding increasing in another hand confirming that there is no scope for horizontal expansion in agriculture and the vertical enhancement is the only way out.

It is clear that agriculture is becoming non-profitable venture which insisted youth from villages to move towards cities in search of employment. Agriculture is presently not a means of sustainability of life but it has to produce more from less and high value commodities therefore, mandate of agriculture needs to be redefined in modern era resulting food and nutritional security along with sustainability, expanding upon the production exponentially. Various strategies has been proposed as per the vision of govt. of India including per drop more crop, improving seed replacement rate, distribution of soil health card, large investment in ware housing and cold chain, facilitation of processing and value addition industry, creation of national agriculture market, removing distortions and e-platforms, various crop insurance schemes like 'Pradhanmatri Fasal Bima Yojna' with minimum premium and maximum security, promotion of ancillary activities like poultry, sericulture, bee-keeping and fisheries.

Policy supports in recent cost revealed that growth rate in annual income of agriculture is only 3.9 % whereas, the maximum growth rate was achieved in livestock sector i.e. 14.9% as compared to cultivation including horticulture i.e. only 4.3%. Therefore, a balanced harmony among all sectors are necessary in the form of farming system module to double the farmers' income in our country.

Keywords: agriculture, doubling farmers' income, diversification, farming system approach, policy reforms

Introduction

Horticulture sector is producing maximum value share (25%) against lowest net area share (7%). On contrary rice, wheat and maize are contributing 20% value share from 42% net area share, hence it is necessary to diversify rice, wheat, maize with high value enterprise i.e. horticulture and animal sector (milk 24%, meat 8%, fisheries 5% value share from negligible net area share). In the state nutriceals may be intensified in areas affected by various types of stresses (ecological and edaphic). Similarly medicinal and aromatic crops may also be intensified in the problem areas with establishment of processing units to ensure market of the produce. As per matrix of current production and demand fruits, milk, fish and edible oil are the most potential areas where intervention needed to boost production significantly as their required demand growth will be 196.1%, 135.3 %, 98.2% and 83.1%, respectively in coming decades.

Fifty per cent yield gap exists in yield potential of Bihar and Uttar Pradesh for lentil. Similarly 46.5% yield gap exists between Punjab and Uttar Pradesh for wheat and 44.7% for rice. Hence efforts should be made to bridge the gaps through adoption of potential model of leading state. Since rice and wheat are the major crop of Uttar Pradesh, it is necessary to mention that rice production and productivity was increased 73.1 million tonnes and 1.4 tonnes per hectare, respectively from 1960-61 to 2015-16 whereas, in case of wheat these values are 81.6 million tonnes and 2.2 tonnes per hectare, respectively.

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There should be strategic plan to convert culturable waste, barren and unculturable land and fallow land into cultivable lands to enhance the productivity horizontally. As it is evident that a significant area is prevailing under problematic conditions. These areas can be judiciously brought under cultivation following intense land management practices.

As reported 30% produce of horticultural crops are being spoiled due to their perishability. So their perishable nature should be judiciously targeted based on assessment of production and availability of market to escape unexpected low prices of produce due to high level of production. Based on a survey, it is found that the major problems faced by horticulture farmers are finance, marketing, labour, storage, maintenance, education etc. Major thrust areas for horticulture development are cluster approach linked with post-harvest management and marketing, market intelligence to promote market led production, quality seeds and planting material, adoption of improved varieties and rejuvenation with improved cultivars, hi-tech horticulture and precision farming, high density plantations, etc. High production, earliness, superior quality, uniform produce and resistance to biotic and abiotic stresses are the main advantages of F1 hybrids. Adoption of hybrid varieties can increase 1.5-3 times more yields which mean more income from increased output from same area.

Sericulture is a labour intensive sector and much suited to the countries like India wherein more than 85 per cent of the farmers are small and marginal. Sericulture farming supports village level cottage based industry. The sector involves four independent activities namely plant food cultivation, silk worm rearing, silk reeling and weaving, printing and dyeing. India has a unique distinction of being the only country producing all the four types of commercial exploited silks (mulberry, eri, muga and oak tasar) and is the second largest silk producer in the world after China. mulberry silk is the dominant one and contributes to about 70 per cent of the country's raw silk production. China has advantage mainly because of large area under mulberry cultivation, use of bivoltine races, large scale operations in egg production, uniformity in quality, reeling and weaving operations having large economy of scale and reduced cost of production. When sericulture economics is compared with other agro-enterprises, farmers gets highest income and this income is spread over to 8 to 10 times in a year unlike other crops wherein farmers get annually ones or two times income. With respect to forest plentiful areas and landless labours of state, rearing of silkworm should be popularized specially the vanya silks where silkworms are reared on forest trees other than mulberry. In spite of huge work force, India's share in raw silk production is only 14.1%. Hence, this is a potential sector for increasing farmers' income with integration of sericulture in various farming systems.

Redesigning crop geometry and commodity matrix

Horticulture sector is producing maximum value share (25%) against lowest net area share (7%). On contrary rice, wheat and maize are contributing 20% value share from 42% net area share, hence it is necessary to diversify rice, wheat, maize with high value enterprise i.e. horticulture and animal sector (milk 24%, meat 8%, fisheries 5% value share from negligible net area share). In the state nutriceals may be intensified in areas affected by various types of stresses (ecological and edaphic). Similarly medicinal and aromatic crops may also be intensified in the problem areas with establishment of processing units to ensure market of the

produce. As per matrix of current production and demand fruits, milk, fish and edible oil are the most potential areas where intervention needed to boost production significantly as their required demand growth will be 196.1%, 135.3 %, 98.2% and 83.1%, respectively in coming decades.

Irrigation management particularly micro-irrigation or irrigation techniques based on water conservation technology can be a game changer in productivity enhancement as it is evident with an example that fruits and vegetable productivity increased by 42.3% and 52.8%, respectively only because of judicious use of water. India is largest producer of pulses in the world whereas the second largest producer of paddy, wheat and sugarcane. India is also an important producer of commercial crops like cotton and tobacco. But in most of the cases the productivity of various crops in India are lower than those in the US, Europe and China, because in most of these countries crops are largely grown in high input management conditions with considerably long growing periods. There always exists a gap between what is projected as the potential yield of any crop variety at a research station, and what is produced by the farmers themselves. Several factors are responsible for these yield gaps such as physical, biological, socio-economic and institutional constraints which can be effectively improved through participatory research and government attention. Bridging these yield gaps will not only increase crop production but also help to improve the efficiency of land and labour use, reduce production cost and add to food security. The current yield gaps show a lack of transfer of technology, adoption and knowhow to farmers. Productivity enhancement also requires yield gap minimization between district to state, state to state and state to nation. Hence, it is necessary to strengthen research and development with participatory approach. Adaptive research/refinement/validation programmes will play a major role in fulfilling the potential gaps of a variety for which the responsibility should be given to SAUs and KVKs.

Fifty per cent yield gap exists in yield potential of Bihar and Uttar Pradesh for lentil. Similarly 46.5% yield gap exists between Punjab and Uttar Pradesh for wheat and 44.7% for rice. Hence efforts should be made to bridge the gaps through adoption of potential model of leading state. Since rice and wheat are the major crop of Uttar Pradesh, it is necessary to mention that rice production and productivity was increased 73.1 million tonnes and 1.4 tonnes per hectare, respectively from 1960-61 to 2015-16 whereas, in case of wheat these values are 81.6 million tonnes and 2.2 tonnes per hectare, respectively. This clearly revealed that a balanced focus towards yield improvement is needed for rice as compared to wheat. As per suggestions of FAO and USDA, India has to achieve more than 2 growth rate against the present growth rate of 1 in the field of oilseeds. Hence our programmes should be targeted towards significant yield improvement in oilseeds. Shifting little area from staple to high value in the suitable region (based on agro-climatic condition and availability) can lead to a sizable increase in the returns for farmers. The existing crop geometry shows that in U.P., maximum area is occupied under foodgrains, followed by pulses. Area under horticultural crops is lower despite its potential to generate higher returns. While changing the crop geometry with diversification of high value enterprises it is necessary to strengthen programme with post harvest management system to strengthen the present farming system. There should be strategic plan to convert culturable waste, barren and unculturable land and fallow land into cultivable lands to enhance the productivity horizontally. As it is evident

that a significant area is prevailing under problematic conditions. These areas can be judiciously brought under cultivation following intense land management practices.

Horticulture

This sector includes Horticulture- a sunrise sector, (2) Sources of growth in horticulture, (3) Resource use efficiency or saving in cost of production, (4) Horticulture plus, (5) Focused initiatives for additional income, (6) Sensitive trio: tomato, potato, onion.

Horticulture has emerged as a core sector of agriculture over the past decade, growing steadily in annual area coverage and output. In the year 2016-17, horticulture stood at nearly 25 million ha and production was at a record 299.8 million tonnes of which 269.9 million tonnes was in fruits and vegetables alone. By 2022, 6.5 lakh ha of additional area will be brought under horticulture crops through area expansion and 1.75 lakh ha of additional area will be brought under protected cultivation. Horticulture is seen as optimal option for crop diversification in agriculture. The per unit earning capacity of farmers is much higher than in case of food grains and it also addresses environmental concerns. Nevertheless, most horticultural output requires specialised market linkages and connectivity, post harvest infrastructure and to make this sector more remunerative, there is a need to address the constraints involved. The productivity of vegetables and fruits was noticed 17.11 and 14.51 tonnes per hectare, respectively in India during 2017 but this was negligible in case of aromatic crops (1.56 tonnes per hectare) and spices (2.21 tonnes per hectare). Therefore, there is more need to focus on aromatic crops and spices in state programme as compared to other commodities.

Honey production is a potential sector in horticulture, hence apiculture should be integrated with fruit and vegetable production for increasing the income of farmers. Productivity growth in fruits and vegetable was meagre (1.57%) over the past decade. This is only due to non-availability of quality planting material, dwindling status of natural resources, abundance of resource poor farmers and low adoption of modern technologies. The challenge is to enhance productivity by increasing the factor productivity of all the horticultural production inputs, and at the same time sustaining it by adoption of good practices and precision farming principles. Hence, situation specific modern technologies should be identified/developed, refined/validated and popularized. High cost of input in horticulture crops, prevalence of old and senile orchards, unorganized supply chain are the major bottle neck, therefore, adoption of organic agriculture practices and farming system approach should be promoted for decreasing input cost and ultimately increasing the income. Moreover, rejuvenation of old and unproductive orchard and organized marketing are also very important for getting remunerative income. Facilitation of micro-irrigation in horticulture sector in rainfed areas.

As reported 30% produce of horticultural crops are being spoiled due to their perishability. So their perishable nature should be judiciously targeted based on assessment of production and availability of market to escape unexpected low prices of produce due to high level of production. Based on a survey, it is found that the major problems faced by horticulture farmers are finance, marketing, labour, storage, maintenance, education etc. Major thrust areas for horticulture development are cluster approach linked with post-harvest management and marketing, market intelligence to promote market led production, quality seeds and planting material,

adoption of improved varieties and rejuvenation with improved cultivars, hi-tech horticulture and precision farming, high density plantations, etc. Diversification of present farming system with horticulture crops, availability of micro irrigation, resource use efficiency, increase in cropping density, better agronomic practices, incorporation of improved varieties and technologies, area expansion may be taken under consideration as sources of income growth in horticulture sector. Popularization of hybrids may be proved as prompt effort for increasing the income. The hybrid technology has capacity to revolutionise the production of vegetable crops and demand for hybrid seeds is continuously increasing. At present, the area under vegetable hybrids accounts for 10 per cent of the total area. High production, earliness, superior quality, uniform produce and resistance to biotic and abiotic stresses are the main advantages of F1 hybrids. Adoption of hybrid varieties can increase 1.5-3 times more yields which mean more income from increased output from same area.

Appropriately selected rootstocks have potential to modify the architecture of plants for efficient utilisation of resources. It can ameliorate the soil, enhance nutrient and water use. Therefore, rootstocks have become integrated in the production system of grapes, citrus, apple and many fruit crops for successful production. Genetically dwarf cultivars in mango, banana, papaya, sapota and dwarfing rootstocks in mango, guava, citrus, ber suit high density planting system for accommodating more plants, increasing output and income. Rootstock technology has capacity to double the production and even make it possible to grow fruit crops under stress conditions. Use of CMS line for hybrid seed production in vegetables and floriculture. Use of good quality seed and planting material is a prerequisite for the production of high yields. High quality seeds and planting material help to increase horticultural productivity; improve food security; lower money spent on food purchases and imports and raise domestic economic activity. Various diagnostic methods viz. ELISA, Polymerase Chain Reaction (PCR), multiplex PCR, Real Time PCR are available for different viruses, bacteria and fungi in order to enhance the production with diverse escaping practices. Technologies for high density planting, canopy management and rejuvenation of old and senile orchards have been developed and successfully demonstrated at farmers' field. Precision farming application of fertilizers has proved to be profitable along with recommendations based on a package of practices. Protected cultivation is a good option for producing quality produce and efficient use of land and other resources in some horticultural crops. It is beneficial for nursery raising and cultivation of high value vegetables and flowers. Among various methods tried drip irrigation has proved successful in exhibiting high water productivity by saving irrigation water from 25 to 60 per cent in various orchard crops and vegetables with a 10 to 60 per cent increase in yield as compared to the conventional method of irrigation. It is one of the latest methods of irrigation which is becoming popular in areas with water scarcity and salt problems. The impact of micro-irrigation on resource conservation (saving in input costs to the farmer) is estimated in the range of 20 to 40 per cent in case of horticultural crops. The cultivation of horticultural crops is labour intensive and it needs timely operations for maximising the production. The availability of the labours is reducing in the villages. The end to end mechanisation of the horticultural crops is required to be adopted. Several machines and tools have been developed to enhance the efficiency of farm operation in high tech

nursery, precision farming, high density plantation, protected cultivation, etc.

Bio-fertilizers are microbial preparations containing living cells of different microorganisms which have the ability to mobilize plant nutrients in soil from unusable to usable form through biological process. Streamlining is required in the use of bio-fertilizers, VAM fungi, biological N fixers and other beneficial microbial agents for effective nutrient use efficiency. Nano encapsulated conventional fertilizers, pesticides and herbicides helps in slow and sustained release of nutrients and agrochemicals resulting in precise dosage to the plants. Horticulture based cropping system optimises use of the space and time and improves upon productivity from same piece of land. This has an income doubling impact for farmers. Promotion of Integrated farming system approach involving synergic blending of crops, horticulture, dairy, fisheries, poultry, etc. seems viable option to provide regular income and at site employment to small land holder, decreasing cultivation cost through multiple use of resources and providing much needed resilience for predicted climate change scenario. At present the cropping intensity in agriculture as a whole is 138.9 per cent, and segregated statistic is not available for horticultural crops. Any increase in the intensity would add to the production from farms accordingly. Higher cropping intensity is made possible with various measures, primarily irrigation, use of fertilizers, crop rotation, mixed cropping, relay cropping, etc. In perennial horticultural crops, the brown space available in the pre-bearing age of the orchard can be effectively utilised to grow short duration horticultural crops as intercropping or for interspaced planting and cultivation to gain higher income. Mechanical tools, tiller tractors, sowing gadgets, etc. can save critical time between crops thus enabling use of short duration crops or fast maturing varieties. There remains a considerable gap between the gross production and net availability of fruits and vegetables due to heavy post-harvest losses in case of horticultural produce. It is estimated that India incurs post-harvest fruits and vegetable losses worth over two lakh cores each year largely owing to the absence of modern cold storage facilities and lack of proper food processing units. More emphasis needs to be given to post-harvest management of fruits and vegetables. Besides storage and processing, the cold-chain is seen as a value adding activity as it allows farmers to capture greater value. Commercial floriculture has been steadily increasing with increased use of protected cultivation employing greenhouse, shade nets, polyhouse, etc. Commercial flowers cultivation in India provides an opportunity for rural development owing to its higher returns per unit area and the new employment opportunities. Nearly eighty per cent of area under floricultural crops is concentrated in seven states comprising Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal, Maharashtra, Haryana, Uttar Pradesh and Delhi. A major part of the area under flower cultivation is devoted to the production of Marigold, Jasmine, Rose, Chrysanthemum, Tuberose, etc., with considerable increase in the area under cut flower cultivation.

Share of Uttar Pradesh in floriculture is only 5% which is at near bottom as compared to other states of country even very small states like Karnataka, Tamil Nadu are far ahead (>10%). Therefore, this sector can be identified as grey area which can be directly included in different farming systems as a viable diversification from the traditional field crops because of higher returns. Spices sector is one of the most vibrant sectors of the Indian agricultural trade. The share of

spices in the total agricultural export works out to about 6 per cent annually. The world demand for organic spices is growing rapidly in developed countries like Europe, USA, Japan and Australia, India has a greater potential to encash this trend by diversifying into high-value-plus crops like saffron, cardamom, turmeric, chillies, ginger and vanilla beans. The demand for organic fruits and vegetables is increasing at a rapid pace. Such horticultural produce grown through organic means is nutritionally superior and free from the injurious pesticide residues. The protocol for organic production in many horticultural crops has been worked out which includes a use of resistant varieties, management of soil vermi-compost and bio-fertilizer, and management of disease and pests using biological control as well as bio-pesticides. Recently Sikkim has been announced as hundred per cent organic cultivation state. The country has a vast production base which offers growth opportunities for export. Mangoes, Walnuts, Grapes, Bananas, Pomegranates account for larger portion of fruits exported from the country while Onions, Okra, Bitter Gourd, Green Chillies, Mushrooms and Potatoes contribute largely to the vegetable export basket. The major destinations for Indian fruits and vegetables are UAE, Bangladesh, Malaysia, Netherland, Sri Lanka, Nepal, UK, Saudi Arabia, Pakistan and Qatar. Floricultural exports from India comprise of fresh cut flowers (to Europe, Japan, Australia, Middle East and USA) loose flowers (for expatriate Indians in the Gulf) cut foliage (to Europe) Dry flowers (To USA, Europe, Japan, Australia, Far East and Russia) Potted Plants (limited to Middle East) besides seeds and planting material.

Among fruits mango, guava, banana, papaya, aonla, bael, vegetables okra, onion, potato, cabbage, watermelon, flowers rose, tuberose, gladiolus, marigold and medicinal and aromatic plants artemisia, mentha, citronella, ashwagandha, palmarosa, brahmi, basil, damask rose, vetiver, lavender, are the potential crops. Standard of these crops may be validated/refined for export parameters in which APEDA and Directorate of Agriculture Marketing and Foreign Trade play a nodal role. Agroforestry conserves natural resources through various systems under different agro climatic regions. Millions of farmers are dependent on agroforestry farming systems as a way of increasing and sustaining agricultural productivity, as a source of essential food, fuel wood, fodder and building materials and as a supplementary source of income. In Uttar Pradesh enough forest cover is present in various pockets eg. Vindhyan, Tarai and Eastern Plain region where farming system based on agri-silvi pasture, horti-silvi pasture and other agro-forestry modules can be popularised to enhance the farmers' income. Quality seeds play significant role in the agriculture production. Farmers can enhance their income through participatory hybrid seed production programme for different seed companies. It is a form of contract farming where farmers are supplied with inbred lines for further crossing and production of hybrid seeds of vegetable crops.

Hybrid seed production and other open pollinated seed production including planting material of vegetable crops, floriculture and fruit plants is the potential sector for prompt enhancement in farmers' income. Hence, this sector should be promoted in PPP mode. The productivity of horticultural crops like fruits, vegetables, flowers, plantation crops and spice crops can be increased by supply of disease free quality planting material to farmers. Beekeeping is an agro-based activity which is being undertaken by farmers/landless labours in rural area as an integrated farming practice. In

various agricultural and horticultural crops, honey bees' pollination also improves the quality of produce. Honeybees, in addition to enhancing the yield of various crops also convert nectar and pollen into honey and other beehive products, viz. bees wax, royal jelly, propolis, etc. which provides additional income to the farmers/beekeepers. Mushroom cultivation can also represent a valuable small-scale enterprise option. Surplus crop residues which are being burnt in the country and becoming a threat for ecology should be utilised for casing preparation in mushroom production as example of 10% surplus provided significant gain in mushroom production. It is recommended that 7,000 producer organisation be created. These would organise farmers or entire villages into cluster based production. Each such organisation to cover 1000 farmers and/or 1000 hectares under cultivation. The PRAMs (Primary Rural Agri-Markets) would serve for direct marketing to local buyers. PRAMs created at village level be modernized and established as aggregation hub to ensure the marketing of produce. These market will work on the line of Horticultural Producers' Co-operative Marketing and Processing Society Ltd. (HOPCOMS) and Mother Dairy Fruit and Vegetable Pvt. Ltd. (SAFAL) programmes. At least one modern state-of-art terminal flower market is required to be developed near each major metropolitan cities.

Urban and peri-urban horticulture needs to be promoted as one of the facets that will keep cities clean, as it has highest potential to reutilise recycled water and solid waste (compost) for gainful purposes. Tomato, potato and onion are the most sensitive crops to price fluctuations form almost 50 per cent of the total fruit and vegetable sales. The prices of tomato, onion and potato fluctuates owing to disparity between demand and supply fuelled by the clash of interests between the consumer, the producer and the middlemen on account of a drop in production because of unfavourable weather, a rise in transport costs, seasonality and supply chain constraints. To reduce price fluctuations, a complementary storage option to be developed to locate buffers of onion and potato close to the markets. These need not be high technology systems but designed to cater to a two week inventory cycle from the buffer into market. All efforts to increase potato production must be balanced with developing external demand and hence export trade needs to be promoted if pursuing future growth in production. A favourable trade policy for potato will favour higher production and productivity and also promote growth in cold-chain. Potato seed production at present is being taken up only in a few states like Punjab, Haryana and Uttar Pradesh. The seeds produced in these states are supplied to other producing states of the country. Seed production in states like Karnataka, Madhya Pradesh, Gujarat and Odisha can be promoted, so that the farmers of these states may get quality seed at reasonable prices. Protected cultivation of tomato needs to be promoted in different peri-urban areas, to meet the demand during lean period, i.e., from July to October. Area expansion programme for kharif and late kharif onion can to be taken up in non-traditional states like Madhya Pradesh, Rajasthan, Haryana, Bihar, Odisha and Gujarat to avoid the pressure on Maharashtra, Karnataka, Andhra Pradesh etc. during lean period i.e., July to March.

Onion seed production is presently being undertaken by traders in the states of Maharashtra, Gujarat and some part of Madhya Pradesh, to supply the seed all over the country. Suitable seed producing pockets in other state like Rajasthan, Punjab, Bihar and Odisha can be developed so that there is more availability of seed at reasonable price across the

country. Onion storage capacity is required to be enhanced in the states of Madhya Pradesh, Rajasthan, Gujarat, Uttar Pradesh, Bihar, Odisha, etc. to cater the needs of north and north eastern regions of the country. The observations and recommendations for horticulture sectors are all encompassing. The recommendations on production through productivity, input management and resource-use efficiency, market linkage and trade, diversification into and in horticulture, credit and access to capital, dealing with crops and horticulture extension are listed by thematic activity with an approach to enhance the farmers' income.

Sericulture

This sector includes (1) Sericulture farming, an agri-business enterprise, (2) Sericulture adds vibrancy to village economies, (3) Strategic approach to sericulture development, Sericulture is a labour intensive sector and much suited to the countries like India wherein more than 85 per cent of the farmers are small and marginal. Sericulture farming supports village level cottage based industry. The sector involves four independent activities namely plant food cultivation, silk worm rearing, silk reeling and weaving, printing and dyeing. India has a unique distinction of being the only country producing all the four types of commercial exploited silks (mulberry, eri, muga and oak tasar) and is the second largest silk producer in the world after China. Mulberry silk is the dominant one and contributes to about 70 per cent of the country's raw silk production. China has advantage mainly because of large area under mulberry cultivation, use of bivoltine races, large scale operations in egg production, uniformity in quality, reeling and weaving operations having large economy of scale and reduced cost of production. When sericulture economics is compared with other agro-enterprises, farmers gets highest income and this income is spread over to 8 to 10 times in a year unlike other crops wherein farmers get annually ones or two times income. With respect to forest plentiful areas and landless labours of state, rearing of silkworm should be popularized specially the vanya silks where silkworms are reared on forest trees other than mulberry. In spite of huge work force, India's share in raw silk production is only 14.1%. Hence, this is a potential sector for increasing farmers' income with integration of sericulture in various farming systems.

It is surprising that mulberry plantation during 1992-97 was on 2.81 lac hectare which was declined to 1.81 lac hectare during 2007-12 due to improper focus on this sector. However, it again rose up to 2.27 lac hectare in 2016-17. Huge potentiality is privileged in this sector to increase the farm income. The participation of women in sericulture activities (rearing of silkworm, spinning or reeling of yarn and weaving) is significant compared to other agricultural or agro-based enterprises. Mulberry cultivation and silkworm rearing can provide employment for 1,255 man-days/ha/annum. The other associated non-farm activities generate 5,147 man-days by way of processing and value addition to the cocoons produced from one hectare of the land per annum. Thus, one hectare of mulberry can generate a cumulative employment of 6,402 human-days/annum. Many products such as silkworm powder, silkworm pupae as human food, pupae powder, health drinks, chlorophyll, sericin, fibroin etc., which are extracted from mulberry leaves, silkworm litter, cocoons etc., have a lot of value in the food, cosmetic and pharmaceutical industries and potential valuable foreign exchange earner for the country. In South India and under irrigated conditions, majority of the farmers are practicing two plot systems and taking 10 crops per year regularly at an interval of 30-35 days.

The average income from two acres of irrigated garden is around Rs. 2,00,000 per annum.

The by-products from sericulture, namely, uneaten young mulberry shoots and silk worm litter to be a good source of organic manure after decomposing. Un-eaten foliage and young shoots serve as a good feed for cattle and buffaloes. Leftover shoots serve as cooking fuel. Considering all these multiple advantages and recommended technologies, sericulture could be a good enterprise to double the farmers' income. Indian silk is also the potential sector for export as it is evident that during 2014-15 Rs. 2,829.95 crores earned through silk export from India. To improve production, productivity and quality of Indian silk in comparison to China, the three major factors namely expansion of area under mulberry with high yielding mulberry varieties, enhancing the capacity of egg production involving large scale egg producers and establishment of required number of automatic reeling machines needs to be considered on priority.

- The primary recommendations for adding greater impetus to sericulture farming are-
- Establish higher production, productivity and quality of silk output in various under tapped areas in the country.
- Establish and upgrade basic seed production units and in R&D to develop high yielding silk worm breeds. Similarly, new mulberry varieties with higher yield per hectare can be a focus area.
- In post-cocoon stage, enhance the automatic reeling capacity with integrated twisting, besides strengthening of silk weaving and the wet processing sector.
- Special attention on skill development, coordinated with the induction of new technologies on rearing, reeling and weaving to improve resource use efficiency.
- Diversification of silk into other material uses, new fabrics and utilities, besides meeting traditional demand of sarees, needs to be aggressively promoted.
- R & D into medicinal and other biomaterial applications of sericulture by-products need to be promoted. Corporate sector participation in sericulture R&D can be incentivised.

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