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A REVIEW :

Integrated farming systems –Action tool for climate risk mitigation

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BACKGROUND AND OBJECTIVES

It is projected that in our country population will touch 1370 million by 2030 and to 1600 million by 2050. To meet the demand, we have to produce 289 and 349 mt of food grains during the respective periods. The current scenario in the country indicates that area under cultivation may further dwindle and more than 20 per cent of current cultivable area will be converted for non-agricultural purposes by 2030 (Gill *et al.,* 2005).

The operational farm holding in India is declining and over 85 million out of 105 million are below the size of 1 ha. Due to ever increasing population and decline in per capita availability of land in the country, practically there is no scope for horizontal expansion of land for agriculture. Only vertical expansion is possible by integrating farming components requiring lesser space and time and ensuring reasonable returns to farm families. The integrated farming systems (IFS), therefore, assumes greater importance for sound management of farm resources to enhance the farm productivity and reduce the environmental degradation, improve the quality of life of resource poor farmers and maintain sustainability. In order to sustain a positive growth rate in agriculture, a holistic approach is the need of the hour. Farming system is a mix of farm enterprises in which farm families allocate resources for efficient utilization of the existing enterprises for enhancing productivity and profitability of the farm. These farm enterprises are crop, livestock, aquaculture, agro-forestry, agri-horticulture and sericulture (Varughese and Mathew, 2009). In such diversified farming, though crop and other enterprises coexist, the thrust is mainly to minimize the risk, while in IFS a judicious mix of one or more enterprises along with cropping there exist a complimentary effect through effective recycling of wastes and crop residues which encompasses additional source of income to farmer. IFS activity is focused around a few selected interdependent, inter-related and interlinking production system based on crops, animals and related subsidiary professions. Integrated farming system approach is not only a reliable way of obtaining fairly high productivity with

considerable scope for resource recycling, but also concept of ecological soundness leading to sustainable agriculture. With increasing energy crisis due to shrinking of non-renewable fossil-fuel based sources, the fertilizer nutrient cost has increased steeply and with gradual withdrawal of fertilizer subsidy. It is expected to have further hike in the cost of fertilizers. This will leave the farmers with no option but to fully explore the potential alternate sources of plant nutrients at least for the partial substitution of the fertilizer nutrients for individual crops and in the cropping systems.

Possible output of integrated farming system:

Since integrated farming system (IFS) is an interrelated complex matrix of soil, water, plant, animal and environment and their interaction with each other enable the system more viable and profitable over the arable farming system. It leads to produce the quality food. To strengthen the food chain, it is essential to eliminate nutritional disorder which has been realized on account of appearing deficiency of mineral nutrients and vitamins in food being consumed. Horticultural and vegetable crops can provide 2-3 times more energy production than cereal crops on the same piece of land and will ensure the nutritional security on their inclusion in the existing system. Similarly inclusion of bee-keeping, fisheries, sericulture, mushroom cultivation on account of space conservative also give additional high energy food without affecting production of food grains. The integration of these enterprises will certainly help the production, consumption and decomposition in a realistic manner in an ecosystem.

Likewise, it is pre-requisite in farming system to ensure the efficient recycling of resources particularly crop residues, because 80-90 per cent of the micronutrients remain in the biomass. In the Indo-Gangetic plains, where rice straw is not recycled in an effective way and even in Punjab where rice cultivation is practiced on 2.6 m ha produces about 16 million tonnes of paddy straw which is destroyed by burning. To curtail such precious input loss, the use of second generation machinery for efficient crop residue management to conserve moisture, improve soil micro-organism activities, regulate soil temperature, check soil erosion, suppress weed growth and on decomposition improves soil fertility. Its beneficial effect can also be accrued by incorporating with the soil. The crop residue can be used as floor thatch for cattle shed, composting and growing mushroom and for dry fodder also. Multiple use of water for raising crops, fruits, vegetables, and fishery may also enhance the water productivity. Likewise, in villages, the sewerage water can be purified through Hydrilla biomass before its release to fish pond. Besides, the community land in the villages, which are accessible to better use, must be used for productive purpose. Therefore, adoption of concept like social forestry, water harvesting and recycling fishery and stall feeding to the animals (goatery / piggery) will add to the profit margin with other numerous indirect benefits of employment and improved ecology of the area. Such types of enterprise integration generate additional income varying from Rs. 20, 000-25,000/ha under irrigated and Rs. 8,000-12,000 under rainfed ecosystem. The income enhancement due to integration of processing and on-farm value addition by 25-50 per cent, yield improvement on account of improved soil health by 0.5-1.0 tonne /ha, cost reduction by Rs.500 - 1,000/ha and employment generation by 50-75 man days/household have also been observed (Gill *et al.,* 2005).

Present status of farming system research:

The preliminary investigations clearly elucidated that integration of agricultural enterprises *viz.,* crop, livestock, fishery, forestry etc. have great potential towards improvement in the agricultural economy. These enterprises not only supplement the income of the farmer by increasing the per unit productivity.

But also ensure the rational use of the resources and further create employment avenues. The following of suitable crop choice criteria having deep and shallow root system, inclusion of legume crop as catch, cover and fodder crops and adoption of bio-intensive complimentary cropping system along with other enterprise will certainly prove as a self sustained production system with least cost of production. The farming system is governed by various forces *viz.,* physical environment, socio-economic conditions, political forces under various institutional and operational constraints and above all government favourable policies, which may keep the food security intact and livelihood fully protected. In traditional Chinese system, the animal houses were constructed over a pond so that animal waste fell directly into the water fueling the pond ecosystem, which the fish could then feast on for food. Not only were the fish harvested but the pond water, now with extra nutrients was used for irrigation in crops. The

maximum return (Rs.79,064/ha) was earned from fisheries + piggery + poultry as compared to Rs. 5,33,221 from the rice-wheat system and registered 48.6 per cent gain. This also generated additional employment of about 500 man days/ha/annum (Gill *et al.,* 2005). For poor people, it starts small with ducks and chickens; then a few goats are kept for milk or fattening and to slaughter for a day of sacrifice; next a milch cow; then a bullock for ploughing in co-operation with another one buffalo family; then two bullocks. These can be used to plough the fields of others- a very lucrative business in the planting season. In India, one would add a milch buffalo at the apex of desirable animals on the farm. In the Vietnamese concept, the pigs will be the second step in the ladder. The concept means to start with small livestock and women and then the household will step by step get out of poverty. The poorest households kept only poultry and these households were those most dependent on common property resources for their living (e.g. use and sale of firewood from the forest). A similar stratification has been reported in several studies from Asia (Lasson and Dolberg, 1995). Survey on farming systems in the country as a whole revealed that 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. However, from economic point of view, vegetables and fruits (mango and banana in many parts of the country) followed by bee keeping, sericulture, mushroom and fish cultivation was the most enterprising components of any of the farming systems prevalent in the country. The average yield gaps between 27 predominant and 37 diversified farming systems were examined across the agro-climatic zones through detailed survey on characterization of on-farm farming systems. Diversification of farming system by integration of enterprises in varied farming situations of the country enabled to enhance total production in terms of rice equivalent yield ranging from 9.2 per cent in eastern Himalayan region to as high as 366 per cent in Western-plain and Ghat region when compared to prevailing farming systems of the region. A number of success stories on IFS models including Sukhomajari Watershed of Chandigarh, Fakot Watershed in hilly areas of Uttarakhand. models for almost all the situations of Tamil Nadu (Jayanthi *et al.,* 2001), WTCER model for coastal and irrigated alluvial lands of Orissa, Model for irrigated conditions of Punjab. PDCSR model, for western Uttar Pradesh and many more in different parts of the country suggest that farmers' income can be increased manifold by way of diversification of enterprises in a farming system mode for sustainability and economic viability of small and marginal category of farmers.

Productivity enhancement by IFS:

In view of serious limitations of horizontal expansion of land for agriculture, only alternative left is vertical expansion through various farm enterprises requiring less space and time but give high productivity and ensuring periodic income especially for the small and marginal farmers. The highlights about the research investigations carried out in India towards farming system outcome are discussed to conceptualize its significance towards farming community livelihood. In Tamil Nadu, the IFS increased the net return on an average of Rs. 31,807/ha/year over the arable farming (Rs. 19,505/ha/year). While in Goa, when coconut was integrated with crop, vegetables, mushroom, poultry and dairy enabled to enhance Rs. 17,518/ha/annum over the cashew nut cultivation alone. In Madhya Pradesh, the integrated farming gave a margin in net return of Rs. 17,198/ ha/year over the arable farming. In Uttar Pradesh, the average enhancement in return was Rs. 45,736/ha/annum over the existing crop-based farming system. In Haryana, Singh *et al.* (1999) conducted studies of various farming systems on 1 ha of irrigated and 1.5 ha of unirrigated land and found that under irrigated conditions of mixed farming with crossbred cows yielded the highest net profit (Rs. 20,581/-) followed by mixed farming with buffaloes (Rs. 6,218/-) and lowest in arable farming (Rs. 4,615/-). In another study conducted with 240 farmers of Rohtak (wheat-sugarcane), Hisar (wheat-cotton) and Bhiwani (gram-*Bajra*) districts in Haryana which represented zones of different crop rotations revealed that maximum returns (Rs./ha) of 12,593, 6,746 and 2,317 were obtained from 1 ha with buffaloes in Rohtak, Hisar and Bhiwani, respectively. The highest net returns from Rohtak was attributed to the existence of a better soil fertility type and of irrigation facilities coupled with better control measures compared to other zones. In terms of total man days, Rohtak had the highest employment potential followed by Hisar and Bhiwani. The employment potential under mixed farming conditions was predominantly from livestock rather than crop production. Another study involving cropping, poultry, piegon, goat and fishery was conducted under wetland conditions of Tamil Nadu conducted by Jayanthi *et al.* (2001). Three

years results revealed that integration of crop with fish (400 reared in 3 ponds of 0.04 ha each), poultry (20 babkok layer bird), pigeon (40 pairs) and goat (Tellichery breed of 20 female and 1 male in 0.03 ha deep litter system) resulted in higher productivity, higher economic return of Rs. 1,31,118 (mean of 3 year). Integration of enterprises created the employment opportunities where in comparison to 369 man days/year generated in cropping alone system, cropping with fish and goat created additional 207 man days/annum. The resources were recycled in such a way that fish were fed with poultry, pigeon and goat dropping. Similarly, extra poultry, pigeon and goat manure and composted crop residue of banana and sugarcane were applied to the crops. The four conventional cropping system tried were rice-rice-blackgram, maize-rice-blackgram, maize – rice - sunhemp and rice – rice - sunhemp. Balusamy *et al.* (2003) explained that rice + *Azolla*-cum-fish culture is one of the economical options in such type of area. Monoculture system relies mainly on external inputs while in integrated system, recycling of nutrients takes place that help in reducing the cost of production for economic yield. The fish in rice field utilized the untapped aquatic productivity of rice ecosystem as the rice bottom is highly fertilized on account of the production of zoo and phytoplankton and these resources are fully utilized by the fish. The gross income obtained in rice + *Azolla* + fish was 25.7 per cent more over the rice crop and 6.9 per cent more over the rice + fish. The net income followed the same trend. Thus, rice + *Azolla* + fish on an average gave Rs. 8,817/ha more over the rice monoculture and Rs.3,219/ha over the rice + fish. This model was proposed for extensive scale adoption in Tamil Nadu. Results discussed revealed that IFS enables the agricultural production system sustainable, profitable and productive. About 95 per cent of nutritional requirement of the system is self sustained through resource recycling. As the number of enterprises is increased, the profit margin increases but simultaneously coupled with increase in cost of production and employment generation though the profit increase was marginal. Further, it is evident that profit margin varied with the ecosystem (rained / irrigated), management skill and socio-economic conditions. On an average profit margin on account of IFS varied from Rs. 15,000 to Rs. 1,50,000/ha/annum. Simultaneously it takes care of the food and nutritional security of the farming family. The study further revealed improvement in the net profit margin varying from 30-50 per cent. The resource characterization study revealed that/ha improvement in profitability varied from Rs. 20,000 to 25,000 under irrigated condition, resource recycling improve fertility led to 5 to 10 q/ha crop yield increase, generate 50-75 man days/family/year and reduce the cost of production by Rs.500-1,000/ha. Therefore, there is an urgent need to promote the IFS concept under all agro-climatic conditions of the country.

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