Agric. Rev., 25 (3) : 219 - 224, 2004

INTEGRATED FARMING SYSTEM APPROACH FOR SUSTAINABLE YIELD AND ECONOMIC EFFICIENCY - A REVIEW

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ABSTRACT

There are limited possibilities of increasing additional area under cultivation. It is of immense importance to produce more for ever- increasing population in the years to come. Efficiently integration of crops with animals (cow, buffalo, pig, goat, sheep, fish), birds (poultry, pigeon, duck), multipurpose trees and agroforestry systems, and other enterprises (bio-gas, apiary, mushroom etc.) clearly showed the best advantages over conventional system of cropping under irrigated and rainfed/dryland conditions as well as in tribal areas.

The average holding of land in India has been declining and over 80 million out of 105 million operational holdings are below the size of one hectare (Mahapatra and Bapat, 1992). Because of ever-increasing population and decline in per capita availability of land in India (at present 0.15 hectare per capita), there is hardly any scope for horizontal expansion of land for food feed and fibre production. Vertical expansion by integrating appropriate farming components requiring lesser space and time, and ensuring higher total productivity of the system is the only alternate option left out. Hence, sustainable farming systems, both economically viable and ecologically compatible, encompassed with higher total productivity to meet the present and future needs without jeopardizing the potential, are to be optimized for specific agricultural domain. This could be possible through optimal crop and component link in accordance with the farm resources available in the farming system (Jayanthi *et al.*, 1997). Therefore this review depicts the significance of an integrated farming system (IFS) and its advantages over a conventional cropping system (CCS).

INTEGRATED FARMING SYSTEM

Farming includes crop, livestock, poultry, fishery, tree culture etc. An integrated farming system is defined as an integration of different cropping and farming systems in accordance with needs and resource base of farmers (Chellamuthu and Balusamy, 1999). The integration of the cropping enterprise with other enterprises should be done in such a manner that it ensures recycling of crop residues, optimum resource use, higher employment generation and minimum of risks and uncertainties (Senthilvel *et al.*, 1998). A combination when carefully selected and planned by keeping in view the soil and environmental conditions will pay greater dividends (Throve and Gangolikar, 1985). They also envisaged that to mitigate the risks and uncertainties of income from conventional cropping and to reduce the time lag between investment and returns, it is essential to use integrated farming system approach in production programme that yields regular and evenly distributed income throughout the year and is not subjected adversely to vagaries of nature.

INTEGRATED FARMING SYSTEM UNDER IRRIGATED CONDITION

The biggest edge such farming systems have on other types of farming system is the abundance of water available for crop growth. This makes it possible for the cultivators to expect a decent harvest, thus earning a reasonable income from cropping enterprise. But if other enterprises were taken along with crop husbandry in properly selected combinations, it would increase the productivity of the farm many folds and thus would virtually change the economic scenario of the place.

Higher contribution of rice-based cropping component in low land IFS in Cauvery Delta region of Tamil Nadu was recorded by Govindan *et al.* (1990) and in Western Zone by Rangaswamy *et al.* (1992) and Rangaswamy *et al.* (1995). By virtue of inclusion of high yielding and nutrient-responsive varieties in the study by replacing the local varieties popular among the farmers, and the use of composted and recycled organic manures from allied enterprises linked would have helped in the productivity of crops in the integrated farming system (Jayanthi *et al.*, 1997).

As pointed out by Rangaswamy *et al.* (1992), the traditional cropping system followed in the low lands of India includes mainly two crops of rice during the monsoon season, followed by a pulse or a green-manure crop. The income from this system is hardly sufficient to sustain the family of grower. So, an increase in income is possible through optimal crop and livestock mix, consistent with the farm resources immediately available.

Integrating cropping with fishery and poultry enterprises realised an additional net income over the conventional system. Out of the income obtained from the IFS, 70% was from cropping, 9.4% from poultry and 20.6% from fishery. Also additional employment generated in the IFS was 275 man-days ha^{-1} $year^{-1}$. The reduction in feed cost of poultry and the fish by way of effective recycling of the waste products of each enterprise reduced the cost of production and increased the net income (Rangaswamy *et al.*, 1992). By incorporating mushroom production as an enterprise, Rangaswamy *et al.* (1995), in the IFS comprising cropping, poultry and fishery, proved that the IFS generated more net income (Rs. 12025) than conventional cropping (Rs. 6334), improved the standard of living, helped in effective utilization of family labourers round the year and also minimized the risks associated with mere crop production. The efficiency of component linkage was evaluated predominantly on the basis of productivity of each component in the system. The advantage of poultry droppings as fish-feed provided wider scope for inclusion of poultry/pigeon as a component in low-land farming along with fish and mushroom associated with cropping. Similar increase in the total productivity of the IFS was reported by Devasenapathy *et al.* (1995) by integrating cropping with dairy, fish, poultry and rabbit as compared to conventional cropping alone.

Jayanthi *et al.* (1997) undertook an investigation of an integrated farming system with components like cropping, fishery, poultry, pigeon and mushroom production. Pigeon droppings with comparable composition as that of poultry droppings, not being tried earlier, was also included to identify the feasibility to linkage in the low-land farming systems. They found that integration of cropping with poultry, fish and mushroom; with pigeon, fish and mushroom; and with fish and mushroom resulted in 168%, 188% and 129% higher porductivity respectively as compared to cropping alone.

In low land rice areas there is considerable scope for growing of fish along with rice (Sivakumar and Balasubramaniam, 2000). They observed that inoculation of azolla with rice + fish farming system enhanced the income and the nutrient uptake of low-land rice. Azolla as a component in the rice and rice + fish farming system helped to record higher grain yield by improving its manurial value and by smothering the aquatic weeds. This is in line with the results obtained by Shanmugasundaram and Ravi (1992) and Kathiresan and Ramah (2000). The favourable effect of rice + azolla +fish was also reported by Shanmugasundaram and Balusamy (1993). Some more related studies were undertaken, the results of which are as follows: Integration of rice + fish in low-lying wetlands would improve the farm productivity through recycling of nutrients (Light Foot *et al.*, 1990). More N- uptake, grain and straw yields of rice were the highest when azolla was inoculated one week after transplanting (Satapathy, 1993; Singh and Singh, 1995). Inoculation of azolla to rice + fish farming system provided feed for fish and supplied nutrient to rice crop. In addition, this system reduced the use of fertilizers and pesticides (Liu Chung Chu, 1995).

INTEGRATED FARMING SYSTEM FOR DRY LANDS AND RAINFED AREAS

In India nearly 100 million hectares of land is under rainfed cultivation, and rainfed cultivation shall continue to play an important role in Indian economy. The human population has already crossed the one billion mark. In view of this, there is a need to give more emphasis on boosting the productivity of rainfed agriculture in the coming years.

Risk in dry land farming due to uncertain rainfall leads to adoption of diverse activities, otherwise called farming system approach. A judicious mix of any one or more with cropping complements cropping enterprise through effective recycling of residue/waste (Venkataraman *et al.*, 1983). Similar statements have been issued by Throve and Gangolikar (1985) and by Hart (1987).

The average farm holding in Tamil Nadu is 1.0 to 2.6 ha and thus the income from cropping for dry land farmers is inadequate to sustain their families (Throve and Gangolikar, 1985). Preliminary studies indicated that inclusion of goat rearing proved viable for increasing income and for providing more employment opportunities in rainfed areas. The screening of arid fruit trees has indicated that ber, amla, custard apple and sapota are suited for cultivation in semi-arid conditions of Southern Zone of Tamil Nadu (Pothiraj, 1994).

Sivasankaran *et al.* (1995) found that an additional net income of Rs. 3760 ha^{-1} $year^{-1}$ could be obtained by integrating crop husbandry with goat rearing over conventional cropping system. The Farming System Research (FSR) Unit also generated an additional employment of 113 man-days ha^{-1} $year^{-1}$ over the CCS. Thus it was evident that by integrating farming with cropping and goat rearing under dry lands, income of small and marginal farmers would be greatly enhanced.

Senthilvel *et al.* (1998) studied IFS with cropping, fruit trees and goats as components. They inferred that among the crop components, the yield of cotton was considerably higher in IFS crop (41%) than in conventional cropping system; the yield of sorghum was also higher in IFS (18.5%) as compared to CCS.The yield increase was mainly due to adoption of dryland packages and recycling of organic wastes, especially goat manure. This is in conformity with the results reported by Venkataraman *et al.* (1983). The former group of scientists also reported that the IFS greatly enhanced income of small and marginal dry land farmers, minimized risks on account of crop failure due to uncertainties of rainfall and provided adequate employment opportunities (an additional employment of 78 man-day ha^{-1} $year^{-1}$) round the year.

EFFICIENCY OF MIXED FARMING IN TRIBAL AREAS

Raheja and Oberai (1953) have defined mixed farming as a system of crop and animal husbandry for efficient and effective use of land, labour and capital.

Fitch and Nordblom (1977) reported that new technologies of crop rotations giving due importance to cereals and legumes, forage crops and livestock production may have more chances of success than cereal production alone. With the limited possibility of expansion of land for cultivation in hilly areas, integration of enterprises such as crop, livestock, poultry, and farm forestry appears to be a logical approach towards the improvement of tribal farmers.

Chaurstylan Lee (1980) had reported the contribution of different cropping- based enterprises (crop, crop-fish, crop-livestock, crop-livestock-fish-based farming) to the total income and better utilization of family labour when mixed farming practices were followed.

Chinnaswamy *et al.* (1980) observed higher net income under dairy-based mixed farming and the added employment generated under dairy-based mixed farming was 174 man-days over mono cropping. Their findings conformed with that of Reddy *et al.* (1975) who also reported the advantage of higher income with integrated farming over arable farming. They reported that the farmers could obtain higher profit if cross-bred dairy animals were maintained. Elivino (1980) reported the practice of pig-crop-fish system and poultry-cattle-vegetable system for higher income and better recycling of farm and biological wastes.

Poverty, under-employment and malnutrition were the major causes for the poor status of tribal farmers (Mohamed Ali *et al.*, 1984). They observed that dairy (three milch cows)-cum-poultry (six layers)- based IFS gave a higher net annual income (Rs. 5529) and provided more employment (556 man-days) per year as against Rs. 1107 and 304 man-days respectively from the tribal method of cropping alone.

Hence, with the objective of increasing income and employment of tribal farmers, mixed farming system could be recommended.

DAIRY- BASED INTEGRATED FARMING SYSTEM

Integration of a remunerative enterprise like dairy with conventional enterprise like crop husbandry can greatly enhance the net income obtained from the limited land area and thus improve the standard of living of farmers.

Rangaswamy *et al.*, (1995) studied an integrated farming system with cropping, dairy, spawn production, biogas and silviculture as components and obtained remarkably higher additional net income. Furthermore, out of the total income obtained from integrating allied agricultural enterprises, 26% was from cropping, 45% from dairy, 7% from biogas, 8% from silviculture and 14% from mushroom production. The additional employment generated through the IFS was 770 man-days ha^{-1} $year^{-1}$ over CCS. The results are in conformity with that of Rajakumar (1998).

POND-BASED INTEGRATED FARMING SYSTEM

With the gradual decline in farm size, it would be increasingly difficult to produce enough food for the farm family in coming years. Under such circumstances, undertaking a pond-based IFS comprising some land-based enterprises which will complement their existing farming activity, and also ensure that the limited area around the pond is utilized to the maximum possible extent to get more income and employment will largely benefit the small and marginal farmers on the long run.

Behera and Mahapatra (1999) compared the performance of interdependent supplementary sub-systems and observed that supplementary enterprises resulted in income and employment in the order of multi-storeyed cropping > olericulture > field crops > pomology > floriculture, while in sub-systems, it was in order of pisciculture > mushroom > bio-gas> apiary > poultry > duckery. An overall net return of Rs. 58360 per year was realised from an area of 1.25 ha. A similar study was made in the Farming System Research (FSR)-adopted village Rautrapur (Balasore District) and Ratanpur (Mayurbhanj District) of Orissa though questionnaire and the results were in conformity with that of Behera and Mahapatra (1999). The aforementioned scientists reported that in the composite pisciculture system, gross and net returns of Rs. 20325 and Rs. 16603 respectively were generated with an expenditure of Rs. 3722. Total 6650 kg of manure--cowdung, bio-gas digested slurry, droppings of poultry and duckery--yielded a fish biomass of 813 kg, with a conversion ratio of 8.2 kg of manure to yield 1 kg of fish biomass. Similar observations were reported by Jhingran and Ghosh (1998), Dutta and Goswami (1998), Patro and Rai (1998) and Banerjee *et al.* (1989).

Multi-storeyed cropping gave the maximum net return of Rs.9089 (Rs. 43697 ha^{-1}) and maximum return of Rs. 3.37 per rupee invested. The second best remunerative cropping programme was olericulture, which gave a net return of Rs.8301 (Rs. 13397 ha^{-1} obtained as gross returns) and return per rupee invested Rs. 3.18. From the field crop unit, a net return of Rs. 5638 (Rs.7066 ha^{-1}) was obtained with return per rupee invested being Rs. 2.70 and generating 98.2 man-days of employment. Similar results were obtained from the two villages that have been mentioned earlier in the topic.

CONCLUSION

An integrated farming system fulfills the multiple objectives of making farmers self-sufficient by ensuring the family members a balanced diet, improving the standard of living through maximizing the total net returns and providing more employment, recycling of crop residues, optimizing resource use, minimizing risks and uncertainties and keeping harmony with the environment by comprising a combination of carefully selected components/ enterprises under a given set of agro-climatic conditions.

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