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A REVIEW :

Enhancing farmers' income through integrated farming system: An economic review

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SUMMARY : The farmers are sensitive to the economical benefits of the improved agricultural practices while adopting the practices for enhancing the income of farm families. Higher is the benefit obtained from the introduced enterprise combinations; the easier it is to motivate the farmers to adopt them in their farms. With the aim of doubling farmers' income, identification of suitable farming system is the need of the hour. It is a very complex and serious problem, when share of agriculture in gross domestic product is declining, average size of land holding is gradually shrinking and number of operational holdings is increasing. It is imperative to develop strategies that enable adequate income and employment generation, especially for small and marginal farmers who constitute large majority of the farming community. In this circumstances of decreasing land holding size, it is essential to integrate enterprises such as dairy, piggery, goatery, fishery, poultry, duckery, apiary, along with field and horticultural crops so as to make farming more remunerative and reliable options for the farmers. The literature related to integrated farming systems (IFS) has been reviewed carefully in terms of economic contribution, employment generation, vulnerability reduction and constraints in IFS.

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KEY WORDS :
Integrated farming system, Economic contribution, Employment generation, Vulnerability reduction

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BACKGROUND AND OBJECTIVES

The vision of doubling farmers' income by 2022 is now worth serious attention of the Govt. of India. According to the reports published from Niti Aayog, doubling real income of farmers till 2022-23 over the base year of 2015-16, requires annual growth of 10.41 per cent in farmers' income. This implies that the on-going and previously achieved rate of growth in farm income has to be sharply accelerated. In adoption of improved agricultural practices for doubling the income of farm families, the farmers are sensitive to the financial gains of the practices. Higher the benefit obtained from the introduced enterprise combinations; the easier it is to persuade farmers to adopt them in their farms (Ponnusamy and Devi, 2017). 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 average size of holdings has shown a steady

declining trend over various Agriculture Censuses since, 1970-71. The average size of the holding has been estimated as 1.15 hectare (GoI, 2010). 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. Under this circumstances of shrinking land holding size, it is necessary to integrate enterprises such as dairy, fishery, poultry, duckery, apiary, along with field and horticultural crops etc. so as to make farming a more profitable and dependable options for the farmers (Behera *et al.,* 2004).

Integrated farming system approach :

Integrated farming system (IFS) approach focuses on a few selected interdependent, interrelated and interlinking enterprises of crops, animals and other related subsidiary professions. Thus, it is helpful in enhancing productivity, profitability and nutritional security of the farmer and various enterprises involved sustains the soil productivity through recycling of organic sources (Yogeesh *et al.*, 2016). 'Farming' is a process of harnessing solar energy in the form of economic plant and animal products. 'System' implies a set of interrelated practices and processes organized into functional entity, *i.e*. an arrangement of components or parts that interact according to some process and transforms inputs into outputs (Frescolo, 1988). FAO (1977) stated that "there is no waste", and "waste is only a misplaced resource which can become a valuable material for another product" in IFS. Integration of IFS enterprises is made in such a way that product *i.e*. output of one enterprise / component should be input for other enterprises with high degree of complementarity effects (Panke *et al*., 2010). Radhamani *et al.* (2003) reviewed several studies on the financial viability of integrated farming system and concluded that they positively influenced the economic viability of these systems. The basic aim of IFS is to derive a set of resource development and utilization practices, which lead to substantial and sustained increase in agricultural production that contribute to food security and income generation to the rural poor (Kumar and Jain, 2005). Besides, it is important for achieving environmental and ecosystem services and ensures agricultural sustainability. It is considered as an alternative to commercial farming systems because it helps in preventing resource degradation and stabilization of farm income of the marginal land holders (Lightfoot and Minnick, 1991).

The adoption and use of diversified approach of IFS are gaining widespread acceptance among the producers. For these newer IFS systems to be sustainable in the long term, however, they must: be technically feasible (*i.e.*, suited to the soil and climatic conditions of the area, practical to implement and capable of producing acceptable yields and quality); ensure that the quality of the soil, water, and air resources are maintained or enhanced and be economically viable (Young *et al.*, 1999). This review paper focuses primarily on economic factors *i.e*. income and employment generation influencing producers' choices of these newer combinations of IFS. The discussion draws primarily on data and findings from field experiments conducted by various researchers across India.

Impact on income generation :

Economic contribution from IFS had been reported from various researchers that the magnitude of income ranges from Rs. 55000 (Ramrao *et al.*, 2005) to Rs. 80000 (Dasgupta *et al.,* 2014). The adoption of IFS could generate additional income ranging from Rs. 9,000 to Rs. 2,00,000 per hectare, depending on inclusion of number and kind of additional farm enterprises and their effective combination as reported by Dawood Sheik *et al.* (1996); Rangasamy *et al.* (1995); Meshram *et al.* (2003); Rautaray *et al.* (2005); Murugan and Kathiresan (2005); Ponnusamy (2006) and Ponnusamy and Gupta (2009).

Lightfoot and Minnick (1991) reported that the integration of trees into these systems offered income security and ecological protection. Added to this, the use of diverse plants and animals broadened possible sources of income generation. The generation of wastes and by-products from these entities were transferred between enterprises, thereby reduced the need for external inputs such as feeds and crop nutrients (Csavas, 1992).

Animals on a farm provided inputs to other enterprises and constituted a source of meat and milk, a means of savings and a source of social status (Schierre *et al.*, 2002). Diversification of farming activities improved the utilization of labour; reduced unemployment in areas where there was a surplus of underutilized labour

and provided a source of living for those households that operated their farm as a full time occupation (Thamrongwarangkul, 2001 and Van Brakel *et al*., 2003).

San and Deaton (1999) reported that integration of sheep in rubber plantation had a scope to increase the net income by 38 per cent in small holding. Maximum net return of Rs.12,593 was obtained from one hectare of wheat-sugarcane rotation with a buffalo in Rohtak (Singh *et al.*, 1999). While working on the profitability of different combination of farm enterprises, Basavaraj and Gangadharappa (1999) recorded an average net profit of Rs. 42984/ha from sugarcane + dairying + sheep rearing.

In an integrated silvi-pasture based farming system for dry land, among the animal components, rearing goat recorded higher income followed by milch cows (Vairavan *et al.*, 2000). Radhamani (2001) reported that integration of crop + tree + goat system provided higher net return than cropping alone for western zone of Tamil Nadu under rainfed situation.

In the rainfed black soil areas in southern Tamil Nadu, tree legumes like *Leucaena leucocephala, Acacia senegal, Prosophis cineraria* and perennial fodder grass with inclusion of six goats yielded an additional income of Rs. 12500 per year from a farm area of 1.6 ha (Ramasamy *et al.*, 2007).

De Jong and Ariaratne (1994) indicated that dairying contributed most to the total gross margin of the 0.2, 0.4 and 0.8 ha units of 31, 63 and 69 per cent, respectively, followed by crops (29%, 37% and 19%), poultry (22%, 0% and 9%) and goats (18%, 0% and 3%). The overall ratio of cash income per Sri Lankan rupee spent was 3.2 for dairying, 1.1 for poultry, 4.5 for goats and 9.9 for crops. Dairying and goats proved to be attractive cash earners with a high labour productively and high capital requirement, while manure to improve soil fertility and biogas to replace domestic fuel were important benefits.

Kumar *et al.* (1994) showed that the comparative productivity and economies of dairy enterprises (mixed farming with three crossbred cows on one hectare of canal irrigated land versus mixed farming with three Murrah buffaloes) indicated that mixed farming with crossbred cows under canal-irrigated conditions was more efficient for the utilization of land, capital, inputs and the labour resources of the farmer. They also studied the financial viability of a poultry and fish culture system and concluded that under the prevailing conditions, higher incomes and on farm labour use can be achieved by integrating different enterprises on the farm. Singh (1994) reported that 1ha canal irrigated land gave net return ranging from Rs. 14,000 to Rs. 32,700 in different years in mixed farming with 3 crossbred cows. Whereas, it was observed to be ranging from negative to Rs. 19,700 in mixed farming with 3 buffaloes. Comparative figures for arable farming were between Rs. 3,300 and Rs. 12,400. Similarly, Rangasamy *et al.* (1996) studied the integration of poultry, fish and mushroom with rice cultivation over a five-year period. The study concluded that the integrated system that included the aforementioned three components increased net farm incomes and on-farm labour when compared with the conventional rice cropping system. Devasenapathy *et al.* (1995) identified that integrated farming groundnut-black gram-maize and groundnut-gingelly-ragi with integration of other enterprises such as dairy, fish culture, poultry and rabbit rearing resulted in higher net income as compared to conventional cropping system.

Ravi (2004) studied relative profitability of that agriculture + poultry, agriculture + sheep rearing and agriculture + sericulture both in small and medium farms and it revealed that the farming system, agriculture+ sheep was most profitable among the selected farming systems with an annual net return of Rs. 0.43 lakhs/ farmer and Rs. 0.76 lakhs/farmer in small and medium farmers, respectively. Integration of rice, vegetable and sheep rearing had a net income of Rs. 71180 /acre with a B:C ratio of 3.4 (Bandumula and Waris, 2016).

Dwivedi *et al.* (2007) concluded that an economic return from agri-horticultural system was increased by 16.5 to 136.2 per cent than sole cropping under different fruit crops. Senthilvel *et al*. (1998) suggested the integration of cropping with rainfed fruit trees and goat rearing in dry land resulted in a considerable increase in income of small and marginal farmers of southern zone of Tamil Nadu. Jayanthi *et al*. (2009) observed the mean maize grain equivalent yield was about 9,417kg/acre/year under traditional cropping system whereas under IFS, the maize grain equivalent yield was about 22,754 kg/ acre/year. As compared to traditional cropping system, IFS brought increased revenue, which might be due to resource recycling. The net return from inclusion of allied enterprises in IFS is about 60,141 and the increase in income over traditional cropping system was about 43.6 per cent.

Ugwumba *et al*. (2010) in their study highlighted the impact of IFS on farm cash income. Majority of the

farmers in the study area practiced partial integration. Results revealed that all types of IFS are on the average profitable. Net farm income realized by farmers who maintained crop-livestock-fish integration was the highest.

Ponnusamy and Devi (2017) reported large ruminants like cow and buffalo could provide 29-32 kg manure and 12-14 litres urine per day which in fact enriches the soil by way of structure, texture and nutrients, leading to ultimate productivity enhancement. Small ruminants also contribute in a similar fashion. The farmers reported that poultry manure has a higher market demand and returns from its sale. The market price of one litre of cow urine after purification ranged from Rs. 85 to Rs. 150.

Among different components studied in irrigated IFS method, field crops + diary + vermi-composting unit was more profitable than growing of single crop. This system has recorded average net returns of Rs. 72835 with 2.87 B: C ratio and gives 24.53 per cent higher net returns compared to farmers practice method (Kamble *et al*., 2017).

Deoghare and Bhattacharya (1993) reported that goat and sheep provided the most valuable source of income in the semiarid tropics and the sale of goat contributed 30 per cent of total farm income in India. Milk yield was sustained in buffaloes when integrated with the crop component sorghum and cowpea raised at 2:1 ratio was reported by Gupta *et al*. (1994). Channabasavanna *et al*. (2009) reported the benefit cost ratio of 1.97 in IFS over conventional system which was of 1.64. Among the various components of Palladam district of goat recorded the highest benefit cost ratio (2.75) followed by fish (2.23), vegetables (2.00) whereas poultry showed the lowest benefit cost ratio (1.13) as a result of high cost of maintenance. Tripathi *et al*. (2010) reported that integration of 7 different enterprises namely, crop+ fish+ goat+ vermicompost+ fruit production+ spice production+ agro forestry obtained the net return to the tune of Rs. 2,30,329 annually with the benefit cost ratio (BCR) of 1.07:1 and also reported the maximum per cent contribution of the enterprise is the fish production (68.53 %) followed by vermicomposting (9.9%), spices (8.46 %) and animal production (7.4%). The BCR was found to be highest for fishery (2.25:1) followed by spice production (1.83:1) and vermicomposting (1.45:1).

Impact on employment generation :

The various enterprises linked in the integrated farming system increase the scope for labour employment. More than 450 mandays/ha/year can be generated in a pond based IFS (Behera and Mahapatra, 1999). Similarly, Jayanthi *et al.* (2000) and Ramrao *et al*. (2005) reported that mixed integrated systems generated 575 and 950 mandays/ha/year, respectively.

Kumar *et al.* (2011) conducted a study of different IFS models and to identify a suitable combination of components for maximum returns and employment generation under lowland situation of Bihar. Among 7 IFS models, crop + fish + duck+ goat emerged as the best integrated farming system in terms of productivity, sustainability index (80%), net return (Rs. 1,59,485/yr.) and employment generation (752 mandays/yr.).

Jayanthi *et al*. (2009) reported that cropping in traditional system generated 25 mandays/acre/year, while the various cropping systems under IFS generated 49 mandays of employment. A maximum of 183 mandays/ acre/year was generated from animal components in IFS, whereas in traditional cropping system it is only about 80 workdays.

Solaiappan *et al*. (2007) evaluated five models of IFS in Tamil Nadu to identify a superior model for attaining maximum net returns and benefit : cost ratio, and for employment generation and improving soil fertility in a semi-arid verticinceptisols. The different IFS models assessed were: (A) conventional cropping; (B) crop + poultry (20) + goat (4); (C) crop + poultry (20) + goat (4) + dairy (1); (D) crop + poultry (20) + goat (4) + sheep (6); and (E) crop + poultry (20) + goat (4) + sheep (6) + dairy (1). Among the models examined, model (E) recorded a maximum net income of Rs. 17,598/ha/year, with maximum employment generation (389 mandays/ ha/yr.). It was followed by model C, with a net income of Rs. 14,208/ha/year and employment generation of 343 mandays/ha/yr. Based on the sustainability index derived for different models, the model E was found superior with a maximum sustainability for net returns (65.3%) and for employment generation (79.9%).

Average labour employment per household per year from goat, sheep, buffalo and crop farming were 23.3, 1.9, 33.1 and 41.1 per cent, respectively in Uttar Pradesh (Deoghare, 1997). In arid zone of Rajasthan, additional employment was generated through adoption of silvi-pastoral or horti-pastoral systems with sheep or goat

rearing (Gajja *et al.*, 1999).

Radhamani (2001) reported that the additional employment gains (314 mandays/year) through integrated farming system with crop+ goat under rainfed vertisols. IFS with six buffaloes generated employment of 904 mandays against raising of crop alone generated 400 mandays (Pandey and Bhogal, 1980). Nageswaran *et al.* (2009) showed that farming systems of crop + dairy (3 milch cows), crop+ poultry (6 layers), dairy cum poultry (3 milch cows+ 6 layers), improved cropping alone and farmers' cropping alone were taken. Of all the farming systems, dairy based farming gave the maximum income (Rs. 12,180/ha/yr.) and employment (518 mandays/yr.) in Paiyur. In Yercaud, dairy cum poultry farming gave the maximum income (Rs. 13,822/ ha/yr.) and employment (556 mandays/yr.).

Sivamurugan (2001) stated that integration of cropping with dairy + biogas + mushroom generated the highest employment of 875 mandays.

Integrated farming system in dry lands with sorghum + cowpea, *Leucaena leucocephala*+ *Cenchrus ciliaris, Acacia senegal*+ *Cenchrus ciliaris* with integration of goat generated an additional employment of 113 mandays / ha annually. Integration of crop + dairy + biogas + silviculture + spawn production could generate an additional employment of 562 mandays than cropping alone under irrigated garden lands. A herd of 200 goats under integrated farming system provided full time employment for two persons throughout the year (Ramasamy *et al.*, 2007).

Yogeesh *et al*. (2016) reported that cost of cultivation under IFS was reduced to 6.85 per cent (Rs. 81500) when compared to before practice of integrated farming system by farmers (Rs. 87500). The employment generation under IFS was 193 days in a year. It was increased to the tune of 17.10 per cent when compared to before practice of IFS (160 days/year) and the B:C ratio was 4.58.

Rangasamy *et al.* (1995) revealed that integration of sorghum grain crop (0.20 ha) + sorghum fodder crop (0.20 ha) + Subabul and *Cenchrus ciliaris* as an intercrop (0.20 ha) + *Acacia senegal* and *Prosopis cineraria* (0.20 ha) with tellichery goats (20+1) increased the net income. Out of the total income from IFS, 59 per cent was from goat rearing. The additional net income realized and additional employment gained from IFS was Rs. 5672/ha/year and 314 mandays/ ha/year as compared to cropping alone.

Singh (1994) compared three types of farming system and found that the mixed farming with 3 cross bred cows gave the highest net return of about Rs. 21,000 and also generated highest mandays of employment.

Vulnerability reduction :

Integrated farming systems are often less risky, if managed efficiently, they benefit from synergisms among enterprises, diversity in produce, and environmental soundness. For this reason, IFS models have been suggested by several workers for the development of small and marginal farms across the country (Rangaswamy *et al.*, 1996; Behera and Mahapatra, 1999 and Singh *et al.*, 2006).

Venkatadri *et al.* (2008) showed that about 98 per cent of the farmers opined that livestock rearing reduces vulnerability in drought years, a 97.8 per cent expressed that dairy farming provides sustainable livelihoods, a 97 per cent of the sample respondents indicated that farmers suicides are less in dairy developed areas and commercial agriculture increased suicidal rate in Andhra Pradesh (96.0%).

Felipe *et al.* (2007) concluded that 40 per cent of the organic farmers almost consider that the risk of crisis of market prices affects them less than to conventional farmers. The organic farming helps to increase amount of organic matter in the soil which contributes to conserve better the humidity. It makes organic farmers less vulnerable to drought. Similarly, vegetal covers contribute to reduce the vulnerability against irradiation frosts. It affirmed that organic farmers have minor risk sensation than conventional farmers.

Fraser *et al*. (2005) concluded that the greater diversity is believed to increase the ability of systems to with stand shocks and thereby decrease vulnerability. It has been demonstrated that temporal stability of a natural ecosystem increases with increasing species diversity. Also for agricultural systems, it has been suggested that a greater diversity can decrease vulnerability, but empirical evidenceis lacking.

Constraints in adopting IFS :

Lack of marketing for produces from different enterprise, heavy investment in the initial stage of starting and labour unavailability and its high cost were the three main constraints in IFS (Ponnusamy and Devi, 2017). Poorani *et al*. (2011) reported that the integrated farmers of Tamil Nadu indicated insufficient quantity of fodder

to their livestock during off season as a constraint. Abiona *et al*. (2011) reported that higher numbers respondents of the integrated fish farmers have identified price fluctuation, exploitation by the middlemen and inadequate finance as a major problem compared to non-integrated fish farmers. Kadam *et al*. (2010) observed that high cost of concentrate feed and unavailability of green fodder (40%) followed by lack of market facilities (30%) and absence of co-operative societies 30 per cent. Pushpa (2010) pointed about nine major constraints in adoption of IFS and the most important constraint reported was lack of co-ordinated extension services (86.19%) followed by lack of demonstration on integrated farming system (80.95%) and lack of knowledge on integration aspects of enterprises (67.62%). Nageswaran *et al*. (2009) identified constraints in IFS such as procuring the improved breeds of livestock, timely availability of fish seed and feed, low cost energy efficient pumping machine, information on government schemes and credit support from financial institutions. Tipraqsa *et al*. (2007) reported that the high startup costs may constrain farmers from switching to integrated farming. Thamrongwarangkul (2001) reported that resource poor farmers are not able to invest more capital as initial investment as a constraint since there is need of immediate economic returns to meet their food requirements, schools, medical treatments and loan repayment.

Conclusion :

Integrated farming system help resource poor farmers, who have very small land holding for crop production and a few heads of livestock to diversify farm production, increase cash income, improve quality and quantity of food produced and exploitation of unutilized resources. Integrated farming system is important for the marginal and small farmers under the changing scenario of global climate. In this context, better understanding of the nature and extent of the interactions among various enterprises and natural resources is essential for the economic benefits as well as livelihood security. IFS is capable of producing diverse social, economic and environmental benefits besides ensuring food security and employment opportunity.

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