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Integrated Farming System: Prospects in Bangladesh

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Abstract

Farmers of Bangladesh generally practice subsistence farming where they need to produce a continuous, reliable and balanced supply of foods, as well as cash for basic needs and recurrent farm expenditure. Therefore, there is a need to develop suitable integrated farming systems for such farmers since single crop production enterprises are subject to a high degree of risk and uncertainty because of seasonal, irregular and uncertain income and employment to the farmers. Integrated Farming System (IFS) can eradicate all these constraints by not only solving most of the existing economic and even ecological problems, but also provide other household needs like fuel, fertilizer and feed, besides increasing productivity of the farm manifold.

Key Words: Combined, management, economic and productivity

Introduction

The average holding of a farm in Bangladesh has been declining and number of marginal farm has been increasing from 4.48% in 1996 to 11.20% in 2005 with average size of 0.6 ha (BBS, 2009). Traditional farming is risky and farmers invest heavily in crop production to get maximum return. With increasing pressure from the growing human population, only vertical expansion is possible by integrating appropriate farming components, requiring lesser space and time and ensuring periodic income to the farmer. The integrated farming system therefore, assumes greater importance for the sound management of farm resources to enhance the farm productivity, reduce the environmental degradation, improve the quality of life for poor farmers and to maintain sustainability. Research exploring the linkages of components in the farming system has not been undertaken in the farmers' fields in Bangladesh before. Hence, this study is the review of the prospects of Integrated farming System (IFS) in Bangladesh with the objectives to evaluate the efficiency of integrated component technologies in terms of productivity, increase income, employment generation, energy production and to quantify the nutrient flow efficiency of linked components to soil.

Integrated Farming System (IFS) – An Introduction

At present, the farmers concentrate mainly on crop production which is subjected to a high degree of uncertainty in income and employment to the farmers. In this contest, it is imperative to evolve suitable strategy for augmenting the income of a farm throughout the year.

Integration of various agricultural enterprises *viz.*, cropping, animal husbandry, fishery, forestry etc. in the farming system has great potentialities in agricultural economy. These enterprises not only supplement the income of the farmers but also help in increasing the family labor employment throughout the year (Jayanthi *et al.*, 2002; Singh *et al.*, 1993 and Singh *et al.*, 1997).

The definition of IFS is varied and dependent on the context. Agbonlabor *et al*. (2003) in their studies undertaken in Nigeria defined the concept as a type of mixed farming system that combines crop and livestock enterprises in a supplementary and/or complementary manner. Okigbo (1995) defined these systems as a mixed farming system that consists of at least two separate but logically interdependent parts of a crop and livestock enterprises. Contrasting these definitions Radhammani *et al.* (2003) describes IFS's as a component of farming systems which takes into account the concepts of minimizing risk, increasing production and profits whilst improving the utilization of organic wastes and crop residues. Jayanthi *et al*. (2000) based on experiences from Tamil Nadu, India, described these systems as a mixed animal crop system where the animal component is often raised on agricultural waste products while the animal is used to cultivate the soil and provide manure to be used as fertilizer and fuel. Edwards (1997) narrowly defined the system as an aquaculture system that is integrated with livestock and in which fresh animal waste is used to feed fish. It is clear from the above that there are synergies and complementarily between enterprise that comprise a

crop and animal component that form the basis of the concept of IFS (Lightfoot and Minnick, 1991; Jitsanguan, 2001; Radhammani *et al*., 2003). In this respect integration usually occurs when outputs (usually by-products) of one enterprise are used as inputs by another within the context of the farming system.

Integrated Farming System (IFS) can be summarized as:

1. Introduces a change in the farming techniques for maximum production in the cropping pattern per unit area by taking care of optimal utilization of resources.

2. The farm wastes are better recycled for productive purposes in the integrated system.

3. A judicious mix of agricultural enterprises like dairy, poultry, fishery, sericulture etc. suited to the given agro-climatic conditions and socio-economic status of the farmers would bring prosperity in the farming.

Integrated crop and livestock production systems are highly efficient; potentially crop residues are used as livestock feed; the waste products (e.g. feces and urine) are fed into biogas digesters and the effluent used to fertilize ponds for aquatic plant/algae production, with fish farming as the terminal activity. These systems are very worthwhile pursuing as a means of providing nutrients/fuel for the family, minimizing fossil fuel combustion and methane generation and, thus, reducing environmental pollution (Preston, 1990).

Integration

Integration is done to recycle resources efficiently. In Asia, the integration of livestock, fish and crops has proved to be a sustainable system through centuries of experience. In China, for example, the integration of fishpond production with ducks, geese, chickens, sheep, cattle or pigs increased fish production by 2 to 3.9 times (Chen, 1996), while there were added ecological and economic benefits of fish utilizing animal wastes.

Even in integrated systems the exchange of resources such as dung, draught and crop residues takes place in degrees that differ among the so-called modes of farming (Schiere and De Wit, 1995), based on the availability of land, labor and capital respectively:

- Expansion agriculture (EXPAGR)
- Low external input agriculture (LEIA)
- High external input agriculture (HEIA)
- New conservation agriculture (NCA)

Environmentally sound integration is ensured where livestock droppings and feed waste can be poured directly into the pond to constitute feed for fish and zooplankton. Livestock manure can be used to fertilize grass or other plant growth that can also constitute feed for fish. Vegetables can be irrigated from the fishponds, and their residues and by-products can be used for feeding livestock. However, most of the manure usually lost up to half its nitrogen content before it became nitrate and was readily available as fertilizer to plants. The quantity also became inadequate as the population increased, so chemical fertilizers and artificial feeds had to be purchased, eroding the small profits of the small farmers.

The more recent integration of Fish with the Livestock and Crop has helped to improve the fertilizer and feed supplies, plus the high market value of fish as feed and/or food increasing the incomes substantially. Technically, this important addition of a second cycle of nutrients from fish wastes has benefited the enhanced integration process, and has improved the livelihoods of many small farmers considerably.

It should be noted that the first of the two cycles of nutrients from the livestock is used to fertilize the growth of various natural plankton in the pond as fish feeds. Yield of fish was increased up to three-to four-fold with polyculture of many kinds of compatible fish feeding at different trophic levels, as practiced in China, Thailand, Vietnam, India and also in Bangladesh. The fish, after consuming the plankton, produce their own wastes that are converted naturally into the second cycle of nutrients, which is then used to fertilize various crops on both the water surface with floats, as practiced in parts of China, and on the surrounding dykes.

However, even if this has been a big step forward, it still required some external input to increase farm productivity and produce processing in agro-industry. So it has remained inadequate to lift the small farmers out of poverty, because of the continuously rising costs of the inputs, such as chemical fertilizer, artificial feed and fossil fuel, which had adverse effects on yield and quality, produce processing, and farming economics.

Nature of integration

The integrated farming system is practiced in many different countries in many different ways. Yet, a common characteristic of the integrated farming system is a combination of crop and livestock

enterprises. Other forms of integrated farming include combinations with aquaculture or trees.

The fish cultivated and the general farming practices are amenable to easy integration, the grass carp feeds on grass and other vegetable matter which can be grown on the dikes and adjacent agricultural land. They also feed on aquatic plants which can be raised in canals and other adjacent water bodies. Aquatic plants such as Pistia stratiotes, Eichhornia crassipes, Alternanthera phyloxorides and duck weeds, are grown for feeding fish and poultry on land. Sugar cane, corn and bananas are some of the other crops grown in association with fish farms. Ipomea aquatica, Lolium perenne, sorghum, maize and mulberry are also grown in many areas. The leaves, stalks or other waste products are chopped or crushed and fed directly to the fish or composted to be used as fertilizer. Silver carp and big head feed on plankton which can be grown by the application of organic manures provided by cattle, and chicken raised by the side of fish farms. As mentioned, poultry farm are often built on pond dikes, facilitating the application of manure, either directly or after fermentation. Duck farming in association with fish, is also reported to be practiced in few places. In areas where silk production is prevalent, mulberries are planted on the pond dikes. The silkworm pupae and other wastes are used to feed the fish. Fish pond silt is an excellent fertilizer for land crops and is commonly used by farmers. In areas without adequate irrigation, pond water may also be used for irrigating crops, when necessary. The commune or production brigade members can also be considered as an element in this type of integration and recycling, as they eat fish and other farm products and human wastes are used to fertilize ponds and crop land.

The most significant innovation is the introduction of the digester and basin in the waste treatment processes of the integrated farming system. One big problem with livestock waste, which contains very unstable organic matter, is that it decomposes fast and consumes oxygen. So for any specific pond, the quantity of livestock wastes that can be added is limited, as any excess will deplete the oxygen and affect the fish population adversely, even resulting in fish kills.

The various agronomic approaches for increasing the overall productivity and sustainability of IFS are:

i) Adoption of improved cropping system according to the rainfall and soil moisture availability
ii) Selection of suitable grain crop species, tree species that supply pods/leaves for a longer period or throughout the year
iii) The surplus fodder leaves, crop residues etc. should be preserved as silage/hay for lean season.

There are some common mistakes practiced by the farmers:

- spreading the livestock wastes on land to let them rot away and hope that the small amount of residual nutrients left after losses of volatile ammonia and nitrite, if they are not washed away by rain or irrigation water, can improve the soil fertility
- composting the livestock wastes with household garbage to get a low-quality fertilizer, again because of the ammonia and nitrite losses, instead of digesting the livestock wastes into higher-quality fertilizer, and using the garbage to produce high-protein feeds such as earthworms and having their castings and garbage residues as better soil conditioner; and
- treating the livestock wastes ineffectively as well as inefficiently in outdated septic tanks for not much financial or other benefits, while the badly treated effluent is just as dangerous as the waste itself.

Digestion of the livestock waste under closed anaerobic condition is followed by oxidation in open shallow basins with natural algae providing the free oxygen through photosynthesis, before letting the treated waste effluent flow into the fish pond. This can convert almost 100% of the organics into inorganics, which will not consume any oxygen to deprive the fish of this important life-sustaining item. So, theoretically, it is possible to increase the quantity of waste ten-fold into the pond without any risk of pollution. Moreover, the big daily increase in readily usable nutrients can be beneficial to the system, provided that they are totally utilized in both fish and crop cultures, or they can create problems of eutrophication in bodies of water, including the fish ponds themselves, which are then counterproductive.

Components of Integrated Farming System

1. Crops, livestock, birds and trees are the major components of any IFS.
2. Crop may have subsystem like monocrop, mixed/intercrop, multi-tier crops of cereals, legumes (pulses), oilseeds, forage etc.
3. Livestock components may be milch cow, goat, sheep, poultry, bees.
4. Tree components may include timber, fuel, fodder and fruit trees.

Factors to be considered

The following factors have to be considered while selecting IFS. Soil types, rainfall and its distribution and length of growing season are the major factors that decide the selection of suitable annual crops, trees and livestock components. The needs and resource base of the farmers also decides the selection of IFS components in any farm.

1. Suitable grain crops: According to soil type suitable crops should be selected

2. Suitable forage crops: based on soil type and water availability forage crops should be selected.

3. Suitable tree species: based on the requirement and suitability tree species need to be selected for ails, dykes and road sides.

4. Suitable livestock and birds: Goat, sheep, cattle, buffalo, poultry and duck.

Advantages of Integrated Farming System

Continuous land degradation is endangering household food security in Bangladesh. To stop land degradation and regain productivity integrated farming system (IFS) can be the solution. This type of farming modifies the commercial farming system (CFS), which relies on rice-based monocropping, by adopting production of vegetables, trees, livestock and fish. The objectives of the IFS are multiple: to enhance food production for the household, to maintain the natural resource base that contributes to food security and the well-being of the rural people, to contribute to income generation, and to be accepted by local communities. Advantages of IFS can be described as follows:

- Higher food production to equate the demand of the exploding population of our nation
- Increased farm income through proper residue recycling and allied components
- Sustainable soil fertility and productivity through organic waste recycling
- Integration of allied activities will result in the availability of nutritious food enriched with protein, carbohydrate, fat, minerals and vitamins
- Integrated farming will help in environmental protection through effective recycling of waste from animal activities like poultry and duck rearing
- Reduced production cost of components through input recycling from the byproducts of allied enterprises
- Regular stable income through the products like egg, milk, mushroom, vegetables, honey and silkworm cocoons from the linked activities in integrated farming
- Inclusion of biogas & agro forestry in integrated farming system will solve the prognosticated energy crisis
- Cultivation of fodder crops as intercropping and as border cropping will result in the availability of adequate nutritious fodder for animal components like milch cow, goat and sheep.
- Firewood and construction wood requirements could be met from the agroforestry system without affecting the natural forest
- Avoidance of soil loss through erosion by agro-forestry and proper cultivation of each part of land by integrated farming
- Generation of regular employment for the farm family members of small and marginal farmers.

Case study 1

Integrated farming system (IFS), comprising the components like cropping, vegetables, fishery, poultry and goat rearing was undertaken at Agricultural Research Station, Siruguppa, Karnataka, India during the wet and dry seasons of 2003- 04 and 2005-06 to study the productivity, profitability, energy flow, employment generation and water requirement of IFS over conventional rice-rice system in Tungabhadra project area of Karnataka. Integrated farming system approach recorded 26.3 and 32.3 per cent higher productivity and profitability, respectively over conventional rice-rice system. Among the components evaluated, the highest net returns was obtained from crop (63.8 %), followed by goat (30.9 %), fish (4.0 %) and poultry (1.3 %), respectively. Employment generation and water requirement was 275 Man days/ha/year and 1247 mm, respectively under the integrated farming system. Specific energy was low in IFS (3.09 MJ/kg) (Channabasavanna *et al*., 2009).

Constraints of Integrated Farming Systems

Although the aforementioned studies have clearly shown that the system is feasible with respect to socioeconomic imperatives, actual adoption rates of integrated farming are limited and unevenly spread among farmers.

The study by Ngambeki *et al*. (1992) in the Cameroon revealed that the major production constraints are animal feed shortages throughout the year, labor

bottlenecks, and soil degradation. Csavas (1992) reported that in most farms studied in China there was a dependency on imported feed rather than internal recycled inputs. This was concluded to be due to resource-poor farmers in general not having feedlot type systems in which to undertake livestock production. Lightfoot (1997) suggested that the four main constraints to adoption of integrated farming systems in the Philippines and Ghana were: 1) the long transition period that often occurs when implementing an integrated production system. This lead-in time can vary between 3 to 10 years. Farmers could not forgo declines in food production and income generation over this period; 2) labor shortages, especially where the family size is small, which effectively prevented them from adopting integrated farming techniques; 3) lack of secure land rights; and 4) disincentives to adopting integrated farming resulting from government subsidies, credits for fertilizers, and herbicides. Banerjee *et al*. (1990) assessed the impact on allocation of the farm area to different types of crops and livestock. The study revealed that there are few opportunities for increasing farm net returns with the limited amount of capital available. This conclusion is supported by the study of Tipraqsa *et al*., (2007) who alludes to the fact that high start-up costs may constrain farmers from switching to integrated farming and from exploiting the benefits of resource integration.

In the case of Northeast Thailand, the study by Thamrongwarangkul (2001) reported that resource-poor farmers often cannot go beyond the transition period due to their need for food and for immediate economic returns to meet cash needs such as schooling, medical treatment, and loan-repayment. A similar conclusion was reached in a study by the FAE-KU (2000). Contrasting this Tokrishna (1992) pointed out that a farmer who becomes successful and wants to expand the area of his integrated farm in Thailand would be limited by access to adequate water supply, animal feed, and market outlets.

Integrated farming systems – the practice

Integrated farming systems are effectively systems that have traditionally been undertaken by farmers in countries that include Indonesia, China, Malaysia, Vietnam, Rwanda and Thailand (Gliessman *et al.*, 1981; Csavas, 1992; Tokrishna, 1992; Choosakul, 1999 and Praphan, 2001). However, in many countries these traditional systems have been replaced by the establishment of commercial cash and staple crop production systems that have been promoted by governments (Ruaysoongnern and Suphanchaimart, 2001).

Continuous production of crops without external inputs reduce the ability of the soil resource base to both provide and retain nutrients which often results in a decline in productivity (Willett, 1995; Craswell, 1998; Limpinuntana *et al*., 2001; Noble and Ruaysoongnern, 2002). In addition, the reliance upon a few crops in combination with a high risk of crop failure due to a range of factors (i.e. disease, drought) exposes farmers to a high degree of variability with respect to yields and income and therefore risk (Reijntjes *et al*., 1992 and Ashby, 2001). Further, some authors indicate that commercial farming systems are a threat to the environment through a loss of genetic diversity and the possible negative impacts of these systems and their associated inputs (Ashby, 2001).

Integrated farming systems are often viewed as a sustainable alternative to commercial farming systems particularly on marginal lands with the objective of reversing resource degradation and stabilizing farm incomes. Lightfoot and Minnick (1991) reported that the integration of trees into these systems offers income security and ecological protection. Added to this, the use of diverse plants and animals broadens possible sources of income generation. The generation of wastes and by-products from these entities are transferred between enterprises, thereby reducing the need for external inputs such as feeds and crop nutrients (Cavas, 1992; Little and Edwards, 2003). Animals on a farm provide inputs to other enterprises and constitute a source of meat and milk, a means of savings, and a source of social status (KKU, 2001; Schierre *et al.*, 2002; Little and Edwards, 2003).

Diversification of farming activities should invariably improve the utilization of labor, reduce unemployment in areas where there is a surplus of underutilized labour and provide a source of living for those households that operate their farm as a full time occupation (Thamrongwarangkul, 2001; van Brakel *et al*., 2003).

The synergy between enterprises increases with on-farm diversity and is fundamental to the integrated farming system concept. The commercial system cannot be moved to the direction of the integrated system if there are no synergies between enterprises through the integration of activities. Therefore, the distinction between the integrated farming system and the commercial farming system is not absolute, but is rather a matter of degree of integration of resources in the farm system (Tipraqsa, 2006).

Case study 2

A significant number of studies have been undertaken in Thailand into the financial viability of IFS. In a study by Tokrishna (1992) integration of duck raising and fish enterprises resulted in farmers being able to earn a net profit of US$ 1,850 ha^{-1} of which 87% came from fish with yields of 3.5 t ha^{-1}. In the Nakhon Ratchashima and Khon Kaen provinces, Kaewsong *et al*. (2001) evaluated the socioeconomic status of 30% of the members of a farmer network that promoted IFS in 2001. The study revealed that the average total income of the members was higher than in other areas in the northeast region.

Integrated Farming System for Various Agro-Climatic Zones

Integrated farming system models will vary widely in each agro-climatic zones with very high location specific natural resource availability like rainfall, and other climatic factors, soil types and market demand. Based on the agro-ecological condition and successful cropping systems adopted in each zone specific faming system models should be developed through field research and could be recommended with slight modification for each agro-climatic zone of Bangladesh.

Management of integrated farms

The social and political setting of the country is highly favorable for such development. From the literature it is found that the introduction of integrated farming can play a major role in rural development in developing countries. However, the Chinese system cannot be transplanted as such to other countries. Species of fish, crops and livestock to be raised will have to be selected on the basis of local conditions and requirements. In most other developing countries the objectives of integrated farming will have to be heavily oriented to economic, social and nutritional benefits. Farmer cooperatives or other associations may have to be built up to meet the manpower requirements for economically viable units. Suitable pilot projects will have to be designed and implemented to test the systems and based on the results of such projects, further development will have to be planned.

The increasing pressure on land and the growing demand for livestock products makes it more and more important to ensure the effective use of feed resources, including crop residues.

An integrated farming system consists of a range of resource-saving practices that aim to achieve acceptable profits and high and sustained production levels, while minimizing the negative effects of intensive farming and preserving the environment. Based on the principle of enhancing natural biological processes above and below the ground, the integrated system represents a winning combination that (a) reduces erosion; (b) increases crop yields, soil biological activity and nutrient recycling; (c) intensifies land use, improving profits; and (d) can therefore help reduce poverty and malnutrition and strengthen environmental sustainability.

The following systems can be adopted and modified according to agro-climatic zone.

Integration: Livestock with Crops

The integration of livestock with crop production is a means of establishing sustainable farming systems that aim to optimize resource use. The realization of such aims will maximize the degree of self-reliance of the systems, since a variety of products will be obtained with minimum inputs to maintain soil fertility. The varied activities on the integrated farm create employment opportunities for all members of the extended family.

Mechanized cropping systems tend to be high cost since they use a lot of fossil-fuel-derived inputs. In Bangladesh the relative unavailability to small farmers of fossil fuels (because of cost) has encouraged greater self reliance on home-grown draught power, fuel and food. This is best accomplished by integrating crop and animal production and by recycling wastes (to minimize the need for outside inputs and to reduce pollution) (Figure 1).

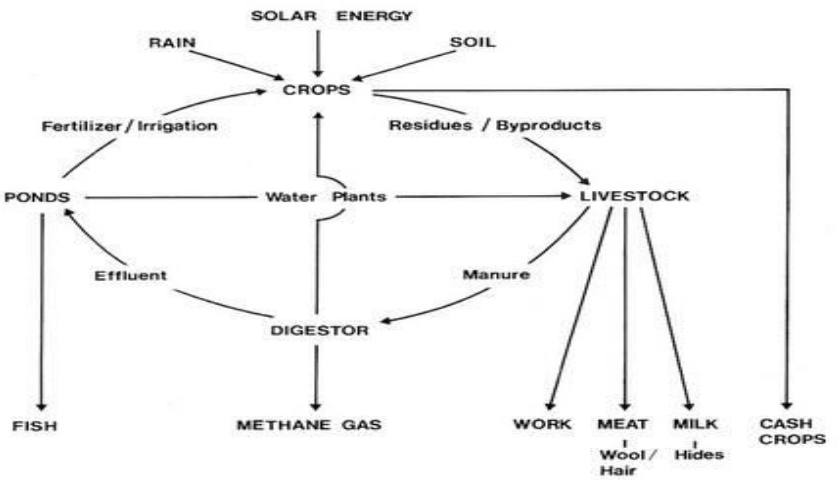

Figure 1: Flow diagram for integrated farming systems (Preston and Leng, 1987)

Use of native pastures, crop residues and fibrous agro-industrial byproducts by ruminants do not contain the balance of nutrients needed to support both efficient rumen fermentation and high animal productivity.

The supplements needed to balance these feed resources for ruminants are largely high in protein and arise from a variety of sources. Oilseed cakes and byproducts of animal processing are the first choices in situations where these are available and under-utilized. The amounts available are, however, limited. There are therefore many advantages from growing protein supplements on the farm.

A legume plays two roles in a crop rotation: it fixes N which can be used by a subsequent crop and provides a fodder supplement that supplies fermentable N, other nutrients for the rumen microbes, readily fermentable cellulose and bypass protein. Legume crops should be assessed in terms of their ability to provide these factors. In addition the possible presence of phenolic compounds and other chemicals that may affect the availability of these nutrients should be investigated. It is logical to use legumes as a supplement (i.e. they should be fed as a small proportion of the diet).

Native tree crops are highly appropriate for IFS. They capture a large amount of solar energy and they produce sustainable yields of biomass. They reduce erosion, improve soil structure and fertility and plants with shallow roots can be grown under the trees.

Many of the fodder trees are leguminous and therefore have the added attribute of fixing atmospheric N. They are also a timber cash crop, a fuel bank and provide shade. Animal productivity could be increased by establishing legumes under the trees, which would benefit both trees and livestock. The legumes grown would be ideal supplements in livestock systems based on crop residues.

New uses for tree crops are as sources of fuel, timber and feed. Their advantages as sources of forage are the high protein content and high digestibility of the leaves, which do not decrease as the tree matures. The specific role of forage trees is as a supplement to crop residues and they should not be considered as forming the basis of the diet.

Bio-diverse Multi-tier System

Rainfed agriculture is being adversely affected by four-fold problems of land degradation, degeneration of bio-diversity due to open grazing, climate change, and poverty driven over utilization of natural resources. All these problems together lead to increasing challenges for sustainability of dryland crop production.

These problems can be reversed, stopped, or at least reduced by adopting economy driven enterprises within the farming system and thus farmers can have higher and staggered income from the small land holding. A bio-diverse multi-tier system of farming, a kind of integrated cropping system, can thus be the answer. This system envisages a coupling of multipurpose trees, horticultural plants, health herbs, food/ oilseeds/ pulses, etc., with livestock rearing. The tangible benefit from this system could be the efficient nutrient and hydrological cycling, which can impart resilience by building soil quality with time. The staggered income is envisaged from the annual

crops and livestock periodically from the horticultural plants of short duration species on long duration from woody species and from the bi/tri annual species and others in the system.

Prospects in Bangladesh

Agriculture in Bangladesh is dominated by rice-rice mono cropping system. Rice covers about 77% of the total cultivated area in Bangladesh (BBS, 2008). The farmers are mainly marginal and small, who have already exploited 80 per cent of the potential of rice and further scope for enhancing yield is limited. The natural resource is exhausted. The need for diversification of farming practice is thereby needed as the income of farmers who depend solely on the produce of their traditional mono crop of rice pattern is decreasing due to narrow margin of profitability and changed food consumption habits.

Over the last two decades dietary pattern has been changed due to higher income generation, change in food habit, population explosion has also changed the supply and demand profiles of food. Integrated farming systems (IFS) seems to be the possible solution to meet the continuous increase in demand for food, stability of income and diverse requirements of food grains, vegetables, milk, egg, meat etc., thereby improving the nutrition of the small-scale farmers with limited resources. Integration of different agriculturally related enterprises with crops provides ways to recycle products and by-products of one component as input of another linked component which reduce the cost of production and thus raises the total income of the farm.

Multiple land use through integration of crops, livestock and aquaculture can give the best and optimum production from unit land area. In other words, Integrated farming system is a resource management strategy to achieve economic and sustained production to meet the diverse requirement of farm household while preserving resource base. IFS can be practiced as micro business by farm youth for attaining regular income. IFS reduces the risk of failure as often one component or one crop based business leads to market instability. The other advantages of IFS include effective recycling of residues within the farm there by reducing the cost of production per unit area.

The IFS can remove all these constraints by not only solving most of the existing economic and even ecological problems, but also provide the needed means of production such as fuel, fertilizer and feed, besides increasing productivity many-fold. Moreover, the expenditure on fertilizers also declined due to availability of a good amount of manure, which resulted into a saving of 50% expenditure on fertilizers as compared to arable farming (Faroda *et al.,* 1978 and Tomer *et al*., 1982).

It can turn all those existing disastrous farming systems in Bangladesh into economically viable and ecologically balanced systems that will not only alleviate poverty, but can even eradicate this source completely.

The prospect of improved research methods for the integrated farming system is also an issue. This method should be tested in different agro-climatic zones and improve it for wide-scale use with low invest capital for small and marginal farmers.

Conclusion

Agriculture is still the major sector providing employment in Bangladesh. However, the small and marginal farmer families and agricultural laborers have to face employment and under employment due to seasonal work in crop production and also due to the natural calamities occurring at one or the other seasons of the year. In this study, the mixed farming system suggested better means for providing regular employment to the farmers. The employment potential of mixed farming system was higher than arable farming with almost uniform distribution throughout the year.

In view of the pressure of population on land there is no alternative to meet the demand for food and other agricultural raw materials except through increase in agriculture- animal production per unit land per unit time on one hand and concern of humanity regarding pollution and environment on other. Good amount of feed for animals was also available from the system itself. The farmyard manure available from the animal was used for manuring of crops and 30-35% savings in fertilizer use could be affected in mixed farming system.

Through the period, farming systems can be developed for each AEZ to suit the requirements for maintaining soil fertility and production related issues. The soil and water can be conserved through the integrated system and can provide livelihood security to the farmers. As integrated farming is economically and environmentally sound, the motivation for integration would appear to be the national policy of diversification of production in Bangladesh.

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