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Livestock Based Integrated Farming System: Opportunities and Challenges in Current Scenario

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ABSTRACT

Livestock based integrated farming system is one of the rising agriculture systems for the northeastern region. The practice of this type of farming system has been continued in this region in a traditional way from time immemorial. The basic principles of the farming system are productive recycling of farm wastes. Different subsystems work together in integrated farming system resulting in a greater total productivity than the sum of their individual production. Fish-Livestock along with Livestock-Crop farming is the major concept in Livestock based integrated farming system. An "integrated crop-livestock system" is a form of mixed production that utilizes crops and livestock in a way that they can complement one another through space and time. The backbone of an integrated system is the herd of ruminants (animals like sheep, goats or cattle), which graze a pasture to build up the soil. Eventually, sufficient soil organic matter builds up to the point where crops can be supported. Animal can also be used for farm operations and transport. While crop residues provide fodder for livestock and grain provides supplementary feed for productive animals.

Animals play key and multiple roles in the functioning of the farm, and not only because they provide livestock products (meat, milk, eggs, wool, and hides) or can be converted into prompt cash in times of need. Animals transform plant energy into useful work: animal power is used for ploughing, transport and in activities such as milling, logging, road construction,marketing, and water lifting for irrigation. Animals also provide manure and other types of animal waste. Animal excreta have two crucial roles in the overall sustainability of the system:

- *Improving nutrient cycling: Excreta contain several nutrients (including nitrogen, phosphorus and potassium) and organic matter, which are important for maintaining soil structure and fertility. Through its use, production is increased while the risk of soil degradation is reduced.*
- *Providing energy: Excreta are the basis for the production of biogas and energy for household use (e.g. cooking, lighting) or for rural industries (e.g.powering mills and water pumps). Fuel in the form of biogas or dung cakes can replace charcoal and wood.*

One key advantage of crop-livestock production systems is that livestock can be fed on crop residues and other products that would otherwise pose a major waste disposal problem. For example, livestock can be fed on straw, damaged fruits, grains and household wastes. Integration of livestock and crop allows nutrients to be recycled more effectively on the farm. Manure itself is a valuable fertilizer containing 8 kg of nitrogen, 4kg of phosphorus and 16 kg of potassium per tonne. Adding manure to the soil

not only fertilizes it but also improves its structures and water retention capacity. It is also opined that where livestock are used to graze, the vegetation under plantations of coconut, oil palm and rubber, as in Malaysia, the cost of weed control can be dramatically reduced, sometimes by as much as 40 percent. In Colombia sheep are sometimes used to control weeds in sugarcane. Draught animal power is widely used for cultivation, transportation, water lifting and powering food processing equipment.

KEYWORDS: livestock, integrated, farming, system, opportunities, challenges, scenario, energy, production

INTRODUCTION

Fish- livestock farming systems are recognized as highly assured technology where predetermined quantum of livestock waste obtained by rearing the live stock in the pond area is applied in pond to raise the fish crop without any other additional supply of nutrients. The main potential linkages between livestock and fish production concern use of nutrients, particularly reuse of livestock manures for fish production. The term nutrients mainly refer to elements such as nitrogen (N) and phosphorus (P) which function as fertilizers to stimulate natural food webs rather than conventional livestock nutrition usage such as feed ingredients. Both production and processing of livestock generate by-products that can be used for aquaculture. Direct use of livestock production wastes is the most widespread and conventionally recognized type of integrated farming. Production wastes include manure, urine and spilled feed; and they may be used as fresh inputs or be processed in some way before use.Based on the type of livestock used for integration there are many combinations in livestock-fish systems. Some of the combination are listed and discussed below.

Cattle-Fish Culture

Manuring of fish pond by using cow dung is one of the common practices all-over the world. A healthy cow excretes over 4,000-5,000 kg dung, 3,500-4,000 lt urine on an annual basis. Manuring with cow dung, which is rich in nutrients results in increase of natural food organism and bacteria in fishpond. A unit of 5-6 cows can provide adequate manure for 1 ha of pond. In addition to 9,000 kg of milk, about 3,000-4,000 kg fish/ha/year can also be harvested with such integration.[1,2]

Cowshed should be built close to fishpond to simplify handling of cow manure. A cow requires about 7,000-8,000 kg of green grass annually. Grass carp utilizes the left over grasses, which are about 2,500 kg. Fish also utilize the fine feed which consists of grains wasted by cows. In place of raw cow dung, biogas slurry could be used with equally good production. Twenty to thirty thousand kg of biogas slurry are recycled in 1 ha water area to get over 4000 kg of fish without feed or any fertilizer application.

Pig-Fish system

The waste produced by 30-40 pigs is equivalent to 1 tonne of ammonium sulphate. Exotic breeds like White Yorkshire, Landrace and Hampshire are reared in pig-sty near the fish pond. Depending on the size of the fishponds and their manure requirements, such a system can either be built on the bund dividing two fishponds or on the dry-side of the bund. Pigsties, however, may also be constructed in a nearby place where the urine and dung of pigs are first allowed to the oxidation tanks (digestion chambers) of biogas plants for the production of methane for household use. The liquid manure (slurry) is then discharged into the fishponds through small ditches running through pond bunds. Alternately, the pig manure may be heaped in localized places of fishponds or may be applied in fishponds by dissolving in water.[3,4]

Pig dung contains more than 70 percent digestible feed for fish. The undigested solids present in the pig dung also serve as direct food source to tilapia and common carp. A density of 40 pigs has been found to be enough to fertilize a fish pond of one hectare area. The optimum dose of pig manure per hectare has been estimated as five tonnes for a culture period of one year. Fish like grass carp, silver carp and common carp (1:2:1) are suitable for integration with pigs.

Pigs attain slaughter maturity size (60-70 kg) with in 6 months and give 6-12 piglets in every litter. Their age at first maturity ranges from 6-8 months. Fish attain marketable size in a year. Final harvesting is done after 12 months of rearing. It is seen that a fish production of 3,000 kg/ha could be achieved under a stocking density of 6,000 fish fingerlings/ha in a culture period of six months.

Poultry-Fish Culture

Poultry raising for meat (broilers) or eggs (layers) can be integrated with fish culture to reduce costs on fertilizers and feeds in fish culture and maximize benefits. Poultry can be raised over or adjacent to the ponds and the poultry excreta recycled to fertilize the fishponds.

Poultry housing, when constructed above the water level using bamboo poles would fertilize fishponds directly.In fish poultry integration, birds housed under intensive system are considered best. Birds are kept in confinement with no access to outside. Deep litter is well suited for this type of farming. About 6-8 cm thick layer prepared from chopped straw, dry leaves, saw dust or groundnut shell is sufficient.[5,6]

Poultry dung in the form of fully built up dip litter contains: 3% nitrogen, 2% phosphate and 2% potash, therefore it acts as a good fertilizer which helps in producing fish feed i.e. phytoplankton and zooplankton in fish pond. So application of extra fertilizer to fish pond for raising fish is not needed. This cuts the cost of fish production by 60%. In one year 25-30 birds can produce 1 tonne dip litter and based on that it is found that 500-600 birds are enough to fertilize 1 ha water spread area for good fish production. Daily at the rate of 50 kg/ha water spread area poultry dung is applied to the fish pond. When phytoplanktonic bloom is seen over the surface water of fish pond then application of poultry dung to the pond should immediately be suspended. Poultry-fish integration also maximizes the use of space; saves labour in transporting manure to the ponds and the poultry house is more hygienic and water needed for poultry husbandry practice can get from fish pond.

a) Duck-Fish Culture

A fish-pond being a semi-closed biological system with several aquatic animals and plants,provides excellent disease-free environment for ducks.In return ducks consume juvenile frogs, tadpoles and dragonfly, thus making a safe environment for fish. Duck dropping goes directly in pond, which in turn provides essential nutrients to stimulate growth of natural food.This has two advantages, there is no loss of energy and fertilization is homogeneous. This integrated farming has been followed in West Bengal, Assam, Kerala, Tamil Nadu, Andhra Pradesh, Bihar, Orissa, Tripura and Karnataka. Most commonly used breed for this system in India is the 'Indian runners'.[7,8]

It is highly profitable as it greatly enhances the animal protein production in terms of fish and duck per unit area. Ducks are known as living manuring machines.The duck dropping contain 25 per cent organic and 20 percent inorganic substances with a number of elements such as carbon ,phosphorus, potassium, nitrogen, calcium,etc. Hence, it forms a very good source of fertilizer in fish ponds for the production of fish food organisms.Besides manuring, ducks eradicate the unwanted insects,snails and their larvae which may be the vectors of fish pathogenic organisms and water-borne disease-causing organisms infecting human beings. Further, ducks also help in releasing nutrients from the soil of ponds,particularly when they agitate the shore areas of the pond.

For duck-fish culture, ducks may be periodically allowed to range freely, or may be put in screened resting places above the water. Floating pens or sheds made of bamboo splits may also be suspended in the pond to allow uniform manuring. The ducks may be stocked in these sheds at the rate of 15 to 20/m^2. It is better if the ducks are left in ponds only until they reach marketable size. Depending on the growth rate of ducks, they may be replaced once in two to three months. About 15-20 days old ducklings are generally selected. The number of ducks may be between 100 and 3,000/ha depending on the duration of fish culture and the manure requirements.

For culturing fish with ducks, it is advisable to release fish fingerlings of more than 10 cm size, otherwise the ducks may feed on the fingerlings. The stocking density of fingerlings also depends on the size of pond and number of ducks released in it. As the nitrogen-rich duck manure enhances both phyto and zooplankton production, phytoplankton-feeding silver carp and zooplankton-feeding catla and common carp are ideal for duck-fish culture. The fish rearing period is generally kept as one year and under a stocking density of 20,000/ha, a fish production of 3,000-4,000 kg/ha/year has been obtained in duck-fish culture. In addition to this, eggs and duck-meat are also obtained in good quantity on an annual basis.[9,10]

DISCUSSION

Over all Advantages of Integrated Farming System

1. Productivity: IFS provides an opportunity to increase economic yield per unit area per unit time by virtue of intensification of crop and allied enterprises especially for small and marginal farmers.
2. Profitability: Cost of feed for livestock is about 65-75% of total cost of production; however use of

waste material and their byproduct reduces the cost of production, conversely it is same for the crop production as fertilizer requirement for crop is made available from animal excreta no extra fertilizer is required to purchase from out side farm as a result the benefit cost ratio increases and purchasing power of farmers improves thereby.

3. Sustainability:In IFS, subsystem of one waste material or byproduct works as an input for the other subsystem and their byproduct or inputs are organic in nature thus providing an opportunity to sustain the potentiality of production base for much longer periods as compare to monoculture farming system.
4. Balanced Food: All the nutrient requirements of human are not exclusively found in single food,to meet such requirement different food staffs have to be consumed by farmers. Such requirement can be fulfilled by adopting IFS at farmer level, enabling different sources of nutrition.
5. Environmental Safety:In IFS waste materials are effectively recycled by linking appropriate components, thus minimize environment pollution.
6. Recycling: Effective recycling of product, byproducts and waste material in IFS is the corner stone behind the sustainability of farming system under resource poor condition in rural area.
7. Income Rounds the year: Due to interaction of enterprises with crops, eggs, meat and milk, provides flow of money round the year amongst farming community.
8. Saving Energy: Cattle are used as a medium of transportation in rural area more over cow dung is used as such a burning material for cooking purpose or utilized to generate biogas thereby reducing the dependency on petrol/diesel and fossil fuel respectively, taping the available source within the farming system, to conserve energy.
9. Meeting Fodder crisis: Byproduct and waste material of crop are effectively utilized as a fodder for livestock (Ruminants) and product like grain,maize are used as feed for monogastric animal (pig and poultry).
10. Employment Generation: Combining crop with livestock enterprises would increase the labour requirement significantly and would help in reducing the problems of under employment to a great extent IFS provide enough scope to employ family labour round the year.

RESULTS

In recent years, food security, livelihood security,water security as well as natural resources conservation and environment protection have emerged as major issues worldwide, Developing countries struggling to deal with these issues and also have to contend with the dual burden of climate change and globalization. It has been accepted by everyone across the globe that sustainable development is the only way to promote rational utilization of resources and environmental protection without hampering economic growth. Developing countries around the world are promoting sustainable development through sustainable agricultural practices which will help them in addressing socioeconomic as well as environmental issues simultaneously. Within the broad concept of sustainable agriculture "Integrated Farming Systems" hold special position as in this system nothing is wasted, the byproduct of one system becomes the input for other. Integrated farming is an integrated approach to farming as compared to existing monoculture approaches. It refers to agricultural systems that integrate livestock and crop production. Moreover, the system help poor small 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.

- Incorporating the latest technologies of livestock management into the farming system is a better option for doubling farmers' income, which will lead to better livelihood and nutritional security of small and marginal farmers in the country.[11]
- It is worth noting that about 60 integrated farming systems have been identified and developed according to irrigated and non-irrigated conditions for different climatic zones across the country.
- In research, scientists have found the integrated farming system to be the most suitable means of increasing the income of the farmers of the country.
- Integrated farming system is a complete agricultural management system, which aims to provide more sustainable agriculture. It integrates

livestock and crop production into agricultural systems.

- Integrated farming systems have revolutionized the traditional farming of livestock, aquaculture, horticulture, agro-industry and allied activities. The system includes an interrelated set of other industries with crop activity as the basis, wherein 'waste' from one component becomes an input to another part of the system, thereby reducing costs and improving soil health. Along with this there is an increase in production and income.

Different approaches under Integrated Livestock Farming System (ILFS)

There are different approaches farmers can adopt to implement ILFS for better utilization of their landholdings and to establish a source of sustainable income round the year as explained below in brief:

1. Crop livestock farming system

Combinations for adoptions can be:

- Horticulture-Agriculture-Cattle/Goat/sheep farming system.
- Fodder-Vegetable-Dairy farming system.

In integrated crop livestock farming system, agriculture crop residues can be used for feeding animals, while livestock manure can increase agricultural productivity by improving soil fertility and fortifying nutrients that reduce the use of chemical fertilizers. A healthy cow excretes over 4,000-5,000 kg dung, 3,500-4,000 L urine on an annual basis which can be applied as manure to the fields as a replacement of chemical fertilizers after proper composting.

- Crop livestock fishery farming system

Under this different crop, livestock and fisheries components can be combined as:

- Crop-Goat/Cow-fish farming system
  - Crop-Azolla-cattle-fish farming system
  - Crop-Fish-Pig farming system

In this crop residue i.e. paddy straw after rice crop harvesting can be fed to livestock. The manure from livestock can be applied in agriculture fields to improve soil fertility by increasing the availability of nitrogen and phosphorus in the soil. On the other hand fish production can be associated in rice fields where rice fields can provide better planktonic, periphytic and benthic food to fishes. In Livestock plus crop farming system the fishes are reared without any additional feed, with the help of available dung from livestock which is used to initiate zooplankton and phytoplankton growth. Fishes like rohu, catla, mrigal, grass carp, common carp and silver carp are well adopted in integrated system.

The fish stocking rates may vary from 8000 to 8500 fingerlings per hectare. A species ratio of 40% surface feeder (Silver carp and catla), 20% column feeder (rohu), 20 to 30% bottom feeder (common carp and mrigal) and 10 to 20% macro vegetation feeder (grass carp) are preferred for higher fish yields under integrated farming sysems.[12]

- Crop livestock backyard poultry farming system

Integration of livestock with crop and backyard poultry farming can improve the food security as well as farmers' incomes. Backyard livestock comprising of sheep, goats, pigs and poultry provide emergency sources of income for family. Bird scavenges on the undigested grains in dung as well as on the threshing wastes in the fields. Backyard poultry also predates the insect and pests which are responsible for incidence of diseases in the crops.

- Crop livestock poultry fishery farming system
- Horticulture/Agriculture-Pig-Poultry-Fisheries farming system.
- Horticulture/Agriculture -Goat/Sheep-Duck-Fish-Poultry farming system

Duck/Pig/Poultry plus fish farming system can be integrated to reduce the cost of fertilizers and feeds in fish farming. Poultry can be reared near or over the fish ponds in which the poultry excreta will directly drop

into fish pond and get recycled. In two tier housing system in integrated farming the upper floor can be used for rearing poultry and lower for pig over a fish pond. Excreta from poultry utilized by pig and pig excreta by fish and further it helps in better growth of zooplankton and phytoplankton which are eaten by fish and in this way the resources get recycled.

- Crop livestock fishery biogas/vermicomposting system
- Agriculture-Dairy- biogas-fisheries farming system.
- Horticulture/Agriculture-Goat/sheep-vermic omposting farming system.

Dung from livestock used for biogas production which can be utilized in cooking and electricity production etc. and slurry produced used as a fertilizer for crop production. Vermicompost can be produced from the cow dung which has better quality as a fertilizer for field crops in terms of high fertility and productivity.

- Small ruminants-Silvipastoral farming system

In this system, a combination of improved pasture species or a mix of grasses is grown on one piece of land along with perennial trees. The animals graze on tree leaves and loop the leaves as fodder. During the lean period, this system reduces the cost of concentrate feed for animals by solving the problem of green fodder.Livestock species mainly include cattle, buffalo, sheep, goat and pigs. Neither fisheries nor poultry are considered livestock, even as they have been studied together, and forestry, sericulture, and apiculture are not included but have been integrated into livestock farming.

Scope of ILFS

A system of integrated farming is meant to mimic the natural principle of producing food throughout the year by using animals, plants, birds, fishes and other aquatic organisms. Farming enterprises include crop, livestock, poultry, fish, tree crops, plantation crops, etc. A combination of one or more enterprises with cropping, when carefullychosen, planned and executed, gives greater dividends than a single enterprise, especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity. Integration of farm enterprises should be done based on many factors such as:

1. Soil and climatic features of the selected area.
2. Availability of resources, land, labour and capital.
3. Present level of utilization of resources.
4. Economics of proposed integrated farming system.
5. Managerial skill of the farmer.

In the context of India, there are a number of situations and conditions that can be alleviated by an ILFS. The situations ideal for the introduction of ILFS where farmer wishes to improve the soil quality, earn more profits, reduce waste disposal and use of chemical fertilizers.

CONCLUSIONS

Opportunities

1. Intensification of agriculture which is currently occurring in most farming systems favours livestock based integration.
2. Poor soil fertility, unavailability or increases in prices of fertilizers, and labour shortages, have forced farmers to rely on alternatives such as manure and traction.
3. Farmers can grow crop in the wet season and engage in livestock enterprises in the dry season.
4. Livestock enterprises are more lucrative than crop farming so it is advantageous to integrate livestock into farm activities.
5. Many indigenous, emerging and developed technologies are available to support sustainable crop–livestock integration.

A sustainable livestock development must encompass an integrated farming system that includes efficient soil, water, crop, and pest management practices, which are cost-effective and environmentally friendly. The system allows for self-sustainability since the system is self-sustaining and reduces dependency on external inputs such as seeds, fertilizers, etc. The system provides balanced and rich nutrition to the farming family as well as reduces the money spent on cultivation and increasing profit margins on the same piece of land, which is a part of maintaining sustainability. On any

farm, four natural ecosystem processes like energy flow, water cycle, mineral cycle and ecosystem dynamics work. By balancing food production, profitability, safety, animal welfare, social responsibility, and environmental care, the principles of ILFS are meant to be reconciled with those of sustainable development. A livestock-based integrated farming system improves the economic viability of small and marginal farmers by increasing the yield per unit area per unit time. In integrated farming system, since more than one component is involved, yields and net returns assessment of this system becomes important. ILFS generate incomes to other families as labour requirement generally increase and labour will be busy round the year than traditional farming. Based upon economic returns, desired models can be promoted among the farmers.[13]

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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