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Research Note

COMPARATIVE STUDY ON INTEGRATED FARMING IN BANGLADESH AND OTHER COUNTRIES

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ABSTRACT

This paper evaluates the different variations of integrated farming that are prevalent in developing countries in Asia. A cross-country comparison was done using productivity analysis on duck-fish integrated farming in India, poultry-fish in Thailand, rice-fish in the Philippines, and crop-livestock-fish-homestead integrated farming in Vietnam. The study findings indicate farmers in Bangladesh could add additional components to their on-going farming practices to increase not only the productivity of land and other inputs but also improve economic conditions.

I. INTRODUCTION

Because of food demands, agriculture has been intensified through the use of higher amounts of chemicals. In Bangladesh, the depletion of soil fertility is mainly due to the depletion of organic matter in the soil, caused by intensive cropping of land year after year without proper soil management practices (BARC, 1999). The situation is more alarming in areas where high yielding varieties are being cultivated using seed-irrigation-fertilizer technology with little or no organic recycling. To sustain productivity, soil must be enriched with organic manure. Realizing the importance of the soil fertility problem and its probable consequences on crop production, farmers in Bangladesh are being encouraged to integrate different farming enterprises in order to face the new challenges of the changing world.

At first blush, it may appear that over the past few decades, farmers have clung to conventional farming when in fact integrated farming is economically more profitable. However, a considerable number of methods to increase agricultural productivity have been carried out in different countries (Wenhua and Qingwen, 1999). Integrated farming emphasizes the strong interdependence between different agricultural products and the protection of natural resources, including maintaining water, soil and air quality. This need for such interdependence is greatly enhanced by the fact that land is scarce and pressure on land

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by people and animals is high which is the case in many Asian countries like Japan, China and Korea (Kada, 1994).

Land and environmental degradation can be directly controlled and improved through integrated farming. This type of farming highlights mutual benefit between different farming enterprises, and helps take advantage of a farmer's resources without damaging the environment (Morris and Winter, 1999). It is a half way or middle course between organic and intensive farming which is pursued in European countries for maintaining environment friendly farming. It improves space utilization and recycles resources among different agricultural enterprises. The goals of integrated farming are to sustain agricultural production, maintain farm incomes, achieve nutritional improvement and safeguard the environment.

According to Pillay (1990), the basic principles involved in integrated farming are the utilization of the synergetic effects of inter-related farm activities, and the conservation, including the full utilization, of farm wastes. It is based on the concept that `there is no waste', and `waste is only a misplaced resource which can become a valuable material for another product' (FAO, 1977).

Integrated farming with crops, livestock, and aquaculture can be used for potential yield improvements and monetary advantages as well as positive implications for food security, dietary balance, and nutrition. It reduces the risk of enterprise failure and offers increased protection from disease and pest damage, thus potentially increasing profitability and income. Integrated farming with a mixed cropping can extend the harvest period and help to alleviate seasonal food shortages, thus enhancing the stability of household food access. It can also reduce erosion risks by providing increased soil cover and additional crop residues to use as green manure and mulch.

Integrated farming is practiced widely in Asia and other regions of the world. To date, no cross-country study has been conducted. This study, therefore, intends to highlight ways to improve the present status of integrated farming in Bangladesh based on the experiences of other developing countries.

II. RATIONALE FOR INTEGRATED FARMING

The rationale behind integrated farming is to minimize wastes from various agricultural enterprises. Wastes or by-products from each enterprise are used as inputs for other enterprises to improve productivity and lower the cost of production. Integrated farming is generally considered, particularly, beneficial for the rural poor (Vincke, 1991). It can play a role in increasing employment opportunities, nutrition, and income of rural populations and has received considerable attention in repent years. Aside from the many developing countries of Asia, some in Africa and South America have introduced this practice. Countries in Eastern Europe have expanded and improved the practice of integrating animal production with fish culture (Pillay, 1990).

In many countries over the last decade, nutrient management on farms with livestock and crop production has emerged as a major environmental issue. In this paper, an attempt was

made to examine the performance of some forms of integrated farming practiced in different countries. The findings would have important implications for improving the farming income of the landless, marginal, and small farmers, who account for nearly 80% of total farm households in Bangladesh.

III. METHODOLOGY

The study is based on primary fieldwork conducted in 2003 in Bangladesh in three districts namely Mymensingh, Netrokona, and Kishoregonj. In total, 110 farmers were selected, of which 30 were landless (below 0.20 hectares), 30 were marginal (0.21 to 0.60 hectares), 20 were small (0.61 to 1.0 hectares), 20 were medium (1.1 to 3.0 hectares), and 10 were large (more than 3.0 hectares). Among these, a total of 78 respondents were actual farmers who practiced integrated farming at the time of the survey. Primary data were collected for one year of operation of farms beginning from April 2002 to March 2003 by directly interviewing the selected farmers. This study covered rice and cash crops, vegetables, cattle, poultry, fish and homestead enterprises. A cross-country comparison was done using productivity analysis for different types of integrated farming and these were duck-fish integrated farming in India, poultry-fish in Thailand, rice-fish in the Philippines, and crop-livestock-fish-homestead integrated farming in Vietnam. Data and information for integrated farming in India, the Philippines, Thailand and Vietnam were obtained from secondary sources such as websites and academic papers in 2004 and 2005. A simple exchange rate was used for currency conversion in this study.

IV. JUSTIFICATION OF CROSS-COUNTRY COMPARISON

Keith et al. (2001) examined the impact of agricultural policies and investment in Zimbabwe and South Africa. The commercial and smallholder sectors in two countries exhibit potentially significant differences in resources, policy support, and market conditions and thus in the impacts of policy changes and investment on agricultural productivity. Chang and Zepeda (2001) examined trends in agricultural production and productivity growth in Asia and the Pacific and described a way to achieve sustainable food security in the region. They also explored the relative significance of these factors in determining a country's success in agriculture and paid special attention to the role of investment, both in physical and human capital, in maintaining and increasing agricultural productivity. Accordingly, the present study makes comparisons of agricultural productivity in integrated farming based on differences in material inputs, land, and labour use considering the supervisory aspect and the time of input use.

V. RESULTS AND DISCUSSIONS

Ideally, a farm in Bangladesh is an integrated unit of production which combines crops, livestock, fish, and homestead orchards and the interactions among these components. Although crops are dominant, the other enterprises are integrated and interdependent. These enterprises are complimentary and their products are additive. The integrated farming practice

was divided into four types: (1) duck- fish, (2) poultry- fish, (3) rice- fish, and (4) crop-livestock-fish-homestead.

Integration of duck-fish farming in Bangladesh and India

Raising ducks over fishponds fits very well with the fish polyculture, as the ducks are highly compatible with cultivated fishes. Ducks fertilize the pond with their droppings which increases pond productivity. Their shelter is constructed on pond dikes, hence, no additional land is required for duckery activities and the fecal material and uneaten food fall directly into the pond. Farmers normally feed ducks kitchen waste, molasses and rice bran.

Duck-fish rearing was introduced by Bangladesh Fisheries Research Institute in 1986 as a potential farming practice. In this farming, the ponds were stocked with carp fingerlings at a density of 7500 fingerlings/hectare (ha) and ducks were reared at 366 ducks/ha. Average production of fish and egg were 3.16 tons/ha/year and 155 eggs/duck/year, respectively.

In India, ponds were stocked with fingerlings at a density of 6000 fingerlings per 1.0 hectare. A basal dose of 5000 kg of cattle dung was dropped to fertilize the pond. Three hundred ducks were housed in different sheds constructed over the pond. About 3-4 months old ducklings were kept on the pond. A balanced feed was given at 50 grams (gm)/duck/day. Egg laying by the ducks was 253 eggs/duck/year and average fish yield in India was 4.0 tons/ha/year. Table 1 shows that higher returns were realized from duck-fish integrated farming in India.

Indian farmers applied lime and urea to remove all remaining fish stocked in the pond, including the predatory and weed fish. The ducks and fishes were given azolla as feed so that the fingerlings released grew well and brought higher returns. Khaki Campbell, India Runners breeds of duck were used, as the local ducks were not suitable for higher yields. The ponds were stocked after winter and harvested after about 12 months. Water temperature was kept below 18-20°C.

Table 1. Economics of duck-fish integrated farming in Bangladesh and India, 2003.

(Unit/ha)

Items	Duck-fish farming Bangladesh		Duck-fish farming India	
	Quantity	Value, US$	Quantity	Value, US$
Costs				
Lime, kg	-	-	150	201
Urea, kg	-	-	60	23
Manuring (cattle dung), kg	4500	61	5000	83
Fingerlings, no.	7500	84	6000	187
Ducklings, no.	366	419	300	524
Feed, kg	7500	352	8100	648
Medicines, US$	-	5	-	45
Others	-	45	-	85
Total costs		966		1796
Returns				
Fish, kg	3160	1842	4000	2707
Egg, no.	57000	1753	75900	2100
Duck, no.	295	276	274	325
Total return	-	3871	-	5132
Net return	-	2905	-	3336
Employment generation, man-days	140	-	125	-

Source : calculated by authors based on field survey for Bangladesh part and from www.fao.org/DOCREP/005/Y1187E/y1187e.htm for India part.

Integrated poultry-fish farming in Bangladesh and Thailand

Integrated production of poultry and fish is now common in many parts of the world. Waste recycling is the key feature of this practice, and integration of fish culture with raising poultry is one of the best ways to effectively managing the poultry waste. The direct discharge of fresh chicken manure to the fishponds produces enough natural fish feed organisms without the use of any additional fertilizer. (Table 2.)

The majority of the homestead ponds are suitable for this purpose in Bangladesh. A

stocking density was maintained about 6000-10000 fingerlings of carps, catla, rohu and mrigal for a pond of 1.0 ha. For the first 16 weeks, feed was given at the rate of 80-110 gm/bird/day and from 17th week onwards, 110-120 gm/bird/day for the poultry. This farming is both economical and technically viable to farmers' condition.

Table 2. **Productivity of integrated poultry-fish farming in Bangladesh and Thailand, 2003.**

(Unit/ha)

Items	Poultry-fish farming Bangladesh		Poultry-fish farming Thailand	
	Quantity	**Value, US$**	**Quantity**	**Value, US$**
Inputs				
Fingerlings, no.	6000-10000	102	12500	204
Piglets, no.	-	-	100	857
Chicks, no.	300	398	300	451
Feeds and medication, US$	-	355	-	1105
Others	-	50	-	211
Outputs				
Fish yield, kg	6000	1122	9660	2066
Pig yield, kg	-	-	750	630
Chicken eggs, no.	48750	1975	63880	2870
Total inputs cost		905		2828 ,
Total outputs value		3097		5566
Net return		2192		2738

Source : calculated by authors based on field survey for Bangladesh part and from

www.fao.org/ DOCREP/004/ AC155E/AC155E13.htm for Thailand part.

A three-tier based integrated farming practice consisting of poultry, pig and fish culture is very popular in Thailand. In this combination, the top tier was occupied by chickens, the droppings of which form the food of pigs in the middle tier (whatever was not consumed, was washed down to the pond with the pig manure), while the pig dung served both as manure and as direct food for the cultivated carps. Water hyacinth grown in a cordoned portion of fishponds was fed to pigs as supplementary feed and the pig dung and washings from the pigsty was used as manure in the pond.

The productivity analysis of this integrated farming showed that the yield and net return of poultry-fish integrated farming in Thailand were higher compared to Bangladesh (Table 2). Poultry-fish integrated farming in Thailand involved fish, poultry, and pig which ensured higher yields of meat and fish per unit of farmland through resource recycling.

Thailand has a well-developed livestock, fairly developed aquaculture and rich inland aquatic resources. Today, all the popular commercial swine and chicken hybrids developed in the United States and Europe are widely available in the country through local franchise hatcheries. Similarly, good quality formulated poultry and fish feed are locally produced and readily available. However, environmental pollution from intensive poultry and swine production is becoming a concern in Thailand today.

Rice-fish integrated farming in Bangladesh and the Philippines

This type of integrated farming typically involves a combination of agricultural production (rice crops in this instance) with aquaculture, and on-farm waste recycling. It is a traditional practice in freshwater areas that has become more popular for the past few years. Farmers have developed this practice under rain fed or irrigated conditions, in either direct seeded or in transplanted rice fields. The timing of seed sowing and transplanting activities is affected by many factors such as water availability and rice variety, but they are not usually affected by the fish culture component. This farming is generally characterized by three basic components: maximum use of land, low input, and high yield.

Farmers in Bangladesh released fingerlings of different species on an average of 6700 numbers/ha. They used 50 kg urea, 30 kg murate of potash and 300 kg manure per hectare. Fishes were given kitchen waste, rice bran, wheat bran etc. as supplementary feed. Feed varied depending on each farmer and local conditions. (Table 3.)

Table 3. Per hectare input used and yield of rice-fish integrated farming in Bangladesh and the Philippines, 2003.

(Unit/ha)

Items	Rice-fish farming, Bangladesh		Rice-fish farming, Philippines	
	Quantity	Value US$	Quantity	Value US$
Inputs used				
Labor, mandays	110	194	50	102
Fertilizer and manure, kg	Urea- 50, Potash- 30, and Manure- 300	188	Urea- 50, Potash- 30, and Manure 1500	280
Stocking density, no.	6700	94	5000-75	113
Others	-	104	-	282
Yields				
Rice, kg	2370	326	3500	515
Fish, kg	1157	442	2180	728
Total return		768		1243
Total costs		580		777
Net return		188		466

Source : Field survey for Bangladesh case and FAO Fisheries Technical Paper no. 407 for Philippines case.

The rice-fish integration practiced by farmers in Guimba, the Philippines was irrigation-based. Farmers flooded the field at an effective water depth for 1-2 weeks immediately after transplanting and maintain water depth around 3-5 cm when rice was newly transplanted. This was then gradually increased up to 20 cm to provide better living space for both rice and fish. Farmers applied 200 kg/ha ammonium phosphate during the wet season and 50 kg/ha urea for the basal application followed by 50 kg/ha through a top-dressing which was applied 30 days after transplanting. The stocking rate using tilapia and common carp was 5000-7500 fingerlings/ha. Ten days after transplanting, the fish stocked in the refuge were released to the field by making openings in the dividing dike.

Farmers selected large fish for consumption or disposal and kept the small fish for the second stage. One week before the rice harvest, water was slowly drained out so the fish had time to move into the refuge. After the harvest, the field was immediately reflooded to about 30 cm deep, and the small fishes in the refuge were released to allow them to grow for another 60 days before the dry season begins.

The study area in Bangladesh yielded 2370 kg of Aman rice along with 1157 kg of fish. These figures were lower than those in the Philippines (Table 3). At the study area in the Philippines, the small-sized fish culturing period after the rice harvest was prolonged for another 60 days before the dry season to maximize productivity.

The higher yield in the Philippines was management related which included better dike preparation to avoid fish loss, building perimeter trenches to provide additional refuges for fish and open more spaces for plankton production, and applying lime and organic fertilizers to condition the soil and reduce soil acidity problems. Techniques such as stocking with fingerlings and supplementary feeding would also result in better fish harvest. Yields of fish in the Philippines were considerably higher than in Bangladesh, due to intensification involving an increase in stocking density of fish, supplementary energy-rich fish feed (e.g., cereal or rice bran and complete pelleted feed) and aeration of pond water. Moreover, in areas like Bangladesh where rice is the major crop, rice-fish integrated farming does not thrive due to pressure on farmers to produce more rice for their survival.

Crop-livestock-fish-homestead integrated farming in Bangladesh and Vietnam

A typical farmer in Bangladesh produces neither specialized crops nor only rice crops, but combines other enterprises such as cattle, poultry and fish along with homestead component. The sampled farmers practiced integrated farming on 1.0 ha which was designed in such a way that they allocated a rice field (0.65 ha), vegetables farm (0.12 ha), other crops field (0.09 ha), a homestead (0.08 ha), a fishpond (0.06 ha) with 2.17 numbers of cattle head and 11.69 numbers of poultry birds.

Table 4. Comparison of cost and return of integrated crop-livestock-fish-homestead farming in Bangladesh and Vietnam, 2003 (in US$). (Unit/ha)

Items	Crop-livestock-fish-homestead farming, Bangladesh	Crop-livestock-fish-homestead farming, Vietnam
Crop		
Labour inputs	253	204
Materials cost	116	190
Others	15	36
Total cost	384	430
Total return	586	692
Net return	202	262
Livestock		
Labour inputs	333	210
Materials cost	98	165
Others	50	42
Total cost	481	417
Total return	651	678
Net return	170	261
Pond fish		
Labour inputs	5	9
Materials cost	46	25
Others	8	3
Total cost	59	37
Total return	123	75
Net return	64	38
Homestead		
Materials cost	14	15
Others	4	5
Total cost	18	20
Total return	135	65
Net return	117	45

Source: calculated by authors based on field survey for Bangladesh part and from www.mekarn.org/sarpro/binh.htm for Vietnam part.

In Vietnam, a country of small-scale farmers with rice production, an integrated farming system called VAC (vegetation, aquaculture and chuong or cage) rapidly gains interest. VAC farming is a highly intensive method of small-scale farming in which food gardening, fish rearing, and animal husbandry are integrated. As the VAC system is very labour intensive, it provides productive employment for people of all ages because hard manual labor is not required. VAC farming allows women to work in a healthy environment close to their home and children, rather than traveling to distant places or construction works.

The farmers in Vietnam were able to earn a higher return from crop and livestock production compared to farmers in Bangladesh (Table 4). However, farmers in Bangladesh achieved more from both pond fish and homestead gardening as these are managed through proper supervision.

With the Vietnamese government policy to promote family, self-reliance, and income, the VAC movement is increasing, rapidly and playing an important role in improving people's lives as well as in integrating Vietnamese agriculture and protecting natural resources and the environment. Annual income through VAC farming is three to five times higher than that derived in the same area from growing two rice crops per year.

VI. IMPLICATIONS OF THE RESULTS

This study has immense implications for agriculture in Bangladesh. Building on the experiences of integrated farming in other countries, farmers can benefit from low external input costs and preserve natural resource base at the same time.

Indian farmers used urea and lime before release the fingerlings into the pond. Azolla was given as feed and farmers earned more gross margin and net return compared to farmers in Bangladesh (Table 5). Farmers in Bangladesh can apply urea and lime at the pond and they can also produce azolla to increase their income.

In integrated poultry-fish farming, the pond embankment could be used to raise vegetables, bananas, cowpea or curry leaf to increase the overall farm production and income in Bangladesh. However, Bangladesh can raise high breed poultry birds adjusting to the weather, and stock fingerlings for a suitable time and at a suitable temperature.

Table 5. Comparative statement of integrated farming practiced by different countries, 2003 (in US$).

(Unit/ha)

Particulars	Duck-fish integrated farming		Poultry-fish integrated farming		Rice-fish integrated farming		Crop-livestock-fish homestead integrated farming	
	Bangla-desh (BD)	India	BD	Thailand	BD	Philipp-ines	BD	Vietnam
Gross Income, GI	3871	5132	3097	5566	768	1243	1496	1510
Total Variable Cost, TVC	921	1711	855	2617	476	495	865	818
Total Fixed Cost, TFC	45	85	50	211	104	282	77	86
Total Cost, TC	966	1796	905	2828	580	777	942	904
Gross Margin, GM (GM = GI - TVC)	2950	3421	1337	2949	292	748	631	692
Net Income, NI (NI=GI-TC)	2905	3536	2192	2738	188	466	554	606

Source : calculated by authors

As in the Philippines, Bangladesh can also lengthen the fish culture period after rice harvest and improve its intercultural operations to increase productivity. Farmers in the

Philippines grew taro, an aquatic plant and excellent food material, as an added commodity in a rice-fish farm. This component can easily be added as a cash or subsistence crop in Bangladesh as well.

Vietnam also produced multipurpose crops and forage trees such as cassava, sugar cane, banana and some grasses which can be used for animal feed and to improve soil fertility. The economic efficiency of livestock production was improved by using a variety of feeding techniques and processing the locally available feed resources. Farmers in Bangladesh could do this as well with proper training and information by the Department of Agricultural Extension.

The comparative assessment of integrated farming among these different countries is a meaningful undertaking and ultimately a determining factor for the adoption of those enterprises by the farmers in Bangladesh. This type of relative consideration among different countries on the topic of integrated farming has not been performed previously.

VII. CONCLUSION

This study aimed at advancing integrated farming in Bangladesh by building on the enterprises and experiences of other countries. The utmost importance should be placed on integrating the various agricultural enterprises. This will increase the productivity of available resources and maximize agricultural production from a limited amount of land, while decreasing pollution. The study reveals that higher returns were realized from duck-fish integrated farming in India, as the country raised high breeds of duck and stocked the ponds in a specific time. Poultry-fish integrated farming in Thailand ensured higher yields when compared to Bangladesh. In comparison to the return of the Philippines, the net return from rice-fish farming were lower in Bangladesh. The Vietnamese farmers earned higher returns from crop and livestock raising whereas farmers in Bangladesh generated more amounts from pond fish and homestead gardening. Multi-enterprise farming presented more advantages than mono cropping, though the enterprise integration must fit with a particular farmer's capabilities, resources, and need; as well as the social, economic, and environmental factors around him. Enterprise composition varied considerably from country to country, depending upon land topography, climate, individual preferences, etc. This study should be seen as a starting point that could be improved through the use of related methodologies.

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