

Response of Integrated Farming Technologies to Rise Farm Productivity in Haor Areas of Bangladesh

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Abstract—The study examined the farm productivity through integration of field crop, homestead vegetables, livestock, fishes, and increase farm income after three years (2015-2018) of intervention in Noagaon village of Sunamgonj district, haor areas of Bangladesh. There were 25 (10 landless, 7 small, 7 medium and 1 large) farmers selected for integrated farming to conduct study. Interventions were given as per resources of the participating farmers. Field crops, vegetables, fertilizer, fish fry for the seasonal pond culture, poultry, duck, sheep, garole, regular vaccination program and deworming of livestock's were done regularly. Seed technologies, training and motivational support were given from the project. Family size of the farmers' was increased from 5.96 to 6.32 farm⁻¹. By utilizing the homestead area, they profit Tk.24364 farm⁻¹ which moved to increase after intervention. Productivity of fisheries was increased ranging from Tk. 20790 to 50793 through seasonal pond culture and fishing in haor areas. Livestock productivity also significantly increased from Tk. 34913 to 112326 farm⁻¹. Due to early flash flood last two years farmers couldn't harvest their main boro rice but they copped their livelihood with the help of integrated farming enterprises. It was very sharp that their farm⁻¹ income increased from Tk. 62463 to Tk. 200017 after intervention though last two years they experienced severe natural abnormalities. Labor productivity of that area was increased from 133.72 to 379.24. Farmers' realized their profitability after adopting integrated farming and increased productivity. Proper utilization of homestead area, pond, livestock and poultry rearing could increase farm⁻¹ income as well as productivity. Proper policy planning geared towards reduction input cost, increased farm output, enhanced farmers' knowledge and adoption of modern technologies by the farmers' would lead to farm profit day by day.

1. INTRODUCTION

Integrated farming is a most familiar and broadly used word to explain a combine approach to farming as compared to existing a simple approach. It refers to agricultural systems that include crop production, horticulture, livestock, and fisheries in farming activities. The Integrated Farming System (IFS) has revolutionized conventional farming of livestock, aquaculture, horticulture, agro-industry and allied activities in some countries especially in tropical and subtropical regions that are not arid [2]. Farming is not very performing over the

world as comparatively huge inputs needed to sustain farm yields and very often compromising economic viability as well as ecological sustainability. Integrated farming systems can mitigate all the farming constrains such as shortage and high cost of farming inputs improving the household income. The benefits of integrated farming system are enormous and encompass those of traditional farming system [10] and modern farming system [7]. Integrated farming has direct positive impact towards farm productivity. In Bangladesh, farm income inequality to agricultural sector is high because of farm fragmentation frequency among the farmers land and high cost of production. Traditional farming systems also a reason of hinders to make handsome profit from agriculture due to high cost of inputs and low yield. Day by day farmers are losing hope about agriculture and getting involved in non-farming activities due to huge constrains and less profit. Integrated farming would be a solution to get profit from the farm through productivity improvement. With a very low cost, farmer may start agricultural production around the household area with vegetables cultivation, rearing poultries, duck, livestock, planting fruit & timber tree species and utilization of seasonal ponds. These interventions will lead the farm productivity as well as increase farm income. From the FSES farming system experiences, it was observed that rural women were engaged in different types of activities including vegetable production, processing and preservation, home gardening, livestock and poultry rearing, fish culture and off-farm activities besides their traditional role as housewife.

The study was undertaken considering following objectives-

- i. To observe the effect of integrated farming systems among the farmers in the haorarea.
- ii. To analyze the comparative farm productivity at before and after intervention of technologies.

2. METHODOLOGY

The study was conducted in Noagaon village of DekarHaor of Sunamgonj district. There are 95 haors in Sunamgonj district among those, Dekarhaor is one of the big haors covered 252 sq. km of four upazilas named South Sunamgonj, Sunamgonj, Dowarabazar and Chhatak. The haor area with unique characteristics are large bowl shaped floodplain depressions situated in the north eastern part of Bangladesh. This area is typically lowland within the estuarine flood plain of Surma, Kushiya, Meghna, Dhenu and Ghoraure rivers under AEZ 21 [9]. People of this area practised only monoculture of *boro* rice from November to April because 6-8 months of the year land remains under water and it is not possible to cultivate crop in the field. Each year the people of haor area faces indescribable constraints about agricultural practice like early flood, flash flood, lack of agricultural tools, loan, improper education, unemployment problem, poor health condition etc. There were 157 families in Noagaon village. Twenty five respondents were selected for the study where 10 farms were of landless except homestead area, 7 small, 7 medium and 1 was of large farm based on baseline resource mapping as per human resource, land and attitude to adopt the interventions. Respondent farms were monitored regularly because different types of enterprises were given to them as supportive materials for integrated farming system (IFS) and to rise productivity of farm and increase income. Farmers were commonly practised the rice varieties viz. BRRI dhan28 and BRRI dhan29 applying imbalance fertilizer. But this area always remains under high risk of natural disasters. Last two years, early flash flood destroyed all the standing crops. The project activities were included balanced fertilization with BRRI dhan28 and BRRI dhan29. Comparatively short duration variety BRRI dhan58 was given instead of BRRI dhan29. Aromatic varieties were introduced to the haor area named BRRI dhan50 and BRRI dhan63. Field crops, mustard was also a new intervention to the farmers introduced by cultivation in farmers' field. Modern varieties were supported by fertilizer, spacing and pesticides as per needed of crops (Table 1).

Table 1: Interventions given to the participating farms during last three years

Production Component	Interventions
Crop (Rice, Field crops)	Modern varieties - BRRI dhan28, BRRI dhan29, BRRI dhan50, BRRI dhan58, BRRI dhan63, BARI sorisha-14, BARI sorisha-15
	Fertilizer - Balanced fertilizer application in different crops
	Spacing - As per BRRI standard
	Pest management - Insecticide, Fungicide, weedicide, bactericide as per needed
Vegetables (Summer & Winter)	Summer season - Jute, Lady's finger, Indian spinach, ash gourd, Ridge gourd, Snake gourd, Sponge gourd, Bitter gourd, Cucumber, Chilli.

	Winter season - Cabbage, Cauliflower, Bottle gourd, Pumpkin, Country bean, Radish, Red amaranth, Stem amaranth, Tomato, Eggplant, Spinach, Squash, Coriander, Cucumber, Yard long bean.
	Fertilizer - Balanced fertilizer
	Technology - Production technology of Summer & Winter vegetables
	Pesticides - As per requirement of crops
Agroforestry & Plantation	Fruits - Mango, Guava, Litchi, Coconut, Ber, Papaya, Jujube
	Timber - Mehogoni, Raintree, Hijol, Koroch
	Technology - Management technology
Livestock	New poultry breed - Fayoumi, Sonali
	New duck breed - Jhindin, Khaki Cambell
	Sheep - Local, Garole
	Feeds - Balance ration was given with local ingredient.
	Cattle fattening, Milch cow feed management - use of urea-molasses with concentrate
	Vaccination - Ranikhet, fowl pox, Duck plague, FMD*
	Deworming - As per requirement
	Medication - As per need of livestock
Fish	Fingerling - Tilapia, Shorputi, Carp
	Feeds - Balance ration was given with local ingredient
	Medication - As per need of fishes

* FMD - Foot and Mouth Disease

Homestead vegetables, summer and winter vegetable seeds were distributed with management technology to the participating farmers. Different fruits and timber saplings were supplied to the farm. All the field and horticultural crops were monitored regularly and as per requirement of crops, pesticides, agronomic practices were maintained. Considering farm size and available facilities of livestock farming, farmers were given new breed of poultry and duck. Regular vaccination and medications were given to the livestock among the participating farmers (Table 1). Cattles were taken under deworming program because it was very severe problem for the area. Also vaccination for FMD (Foot and Mouth Disease) program was started with regular basis. Cattle fattening and feed management of milch cow were also started among few of the respondent farms those had enough resources. Fish culture in seasonal pond and cage culture technology was tried by some of the participating farmers (Table 1). Details case studies were conducted to get productions and total income of the 25 (Twenty five) farms. Data on monetary value of their produces both from homestead and fields were analyzed. The productions and income were analyzed as per component as well as whole farm basis. Income of the farm was calculated on both consumed and present resources of the farm comparing before and after intervention of the integrated farming. The cost of crop cultivation, fish and livestock rearing and output from them were calculated at local market prices. Collected data were analyzed using simple calculation on total cost of farm,

gross margin and net return farm⁻¹ year⁻¹ comparing baseline data collected before intervention of integrated farming systems. Individual farm production (t ha⁻¹) were calculated on the basis of their farm condition. After that, 25 farm income was converted into Tk. Sum of the farm's income was divided by no. of farms. Finally average of farm income was calculated to find out integrated farm income. Labor productivity was calculated as total income divided by total labor utilized in the farm per year. Labor calculation was done as 1 male = 1.5 female = 2.0 child those involved in the farming activities.

3. RESULTS AND DISCUSSION

3.1 Family size and agricultural status of the farm

Average family size of the sampled farmer was changed from 5.96 to 6.32 after three years. The homestead area was about 0.08 hectare and seasonal pond was only 0.03 hectare on average (Table 2). Before intervention farm⁻¹ cultivated land was 1.49 hectare but it decreased to 0.94 hectare after intervention because last two years' *haor* people could not harvest their only lifesaving *boro* rice due to early flash flood. They lost their total *boro* rice and that was the only reason of reduced cultivated area. Waterlogged species like Hijal and Korochare available in the study area. As intervention, participating farmers were given some fruit saplings to plant around homestead and timber trees species. The number of fruit and timber species increased from 5.84 to 20.32 and 5 to 17.8, respectively. About livestock resources, chicken, duck and cattle number increased from 8.52 to 22.24, 5.0 to 74.76 and 2.12 to 2.44, respectively. Remarkable change observed in case of duck due to technological intervention because duck rearing is easy and more profitable in that area. Snail is main item for duck feed and egg lying depends on snail having. *Haor* is treated as snail harbor and habitat of other aquatic animals. There was very little changes found in number of cattle, sheep and pigeon (Table 2).

Table 2: Family and farm size with other farm resources of participating farms

Farm ⁻¹		
	Before intervention	After intervention
Family size (no.)	5.96	6.32
Farm size		
a) Homestead area (ha)	0.08	0.08
b) Pond (ha)	0.03	0.03
c) Cultivated land (ha)	1.49	0.94*
Agroforestry and Plantation crops		
a) Fruit trees	5.84	20.32
b) Timber trees	5.0	17.80
Livestock resources		
No. of Chicken	8.52	22.24

No. of Duck	5	74.76
No. of Sheep	0.84	0.84
No. of Pigion	0.48	0.40**
No. of Cattle	2.12	2.44

*Cultivated *boro* rice area was reduced due to damage of crops by heavy flash flood occurred during 2016 & 2017.

** Pigeon rearing was a challenge to the farmers due to natural disasters, proper habitat and enough feed for them.

3.2 Productivity of crops/enterprises

Table 3 showed the productivity of different crops/enterprises practiced by the sampled farmers. Rice production belonged with *haor* people before intervention but production undoubtedly increased after intervention from 6.62 to 7.89 (t ha⁻¹). The yield increase was due to intervention of modern varieties, balanced fertilization and better agronomic management. Mustard was introduced as new crop and farmer got seed yield of 1.47 t ha⁻¹. Homestead vegetable production practice changed the entire situation of sampled farm. They earned Tk. 24364 farm⁻¹ after intervention. Introduction of new crops viz. cabbage, cauliflower, tomato, eggplant, spinach and squash acquired positive response among the participating farmers. After intervention farmers produced 44.85, 20.89, 48.20, 54.00, 8.50 and 62.67 t ha⁻¹ yield from those crops, respectively. Yield of chili was 18.37 t ha⁻¹ which meet up the family demand. A few people practised radish around home area before intervention but production rise after intervention from 30.89 to 42.67 t ha⁻¹ due to balanced fertilization and improved agronomic practices. Red amaranth and stem amaranth also treated as popular crop among farmers as productions were 13.50 and 27 t ha⁻¹, respectively. Seasonal pond culture was also a new intervention because the main earning source of the people was fishing from *haor*. After adopting new technology like culture fish in seasonal pond, they realized about the benefit (6.67 t ha⁻¹) of their seasonal pond (Table 3).

Table 3: Production Increase in haor areas after adopting Integrated Farming System (IFS)

Crops/enterprises	Before intervention (t ha ⁻¹)	After intervention (t ha ⁻¹)
Rice	6.62	7.89
Mustard	-	1.47
Cabbage	-	44.85
Cauliflower	-	20.89
Tomato	-	48.20
Eggplant	-	54.00
Spinach	-	8.50
Squash	-	62.67
Chili	-	18.37
Radish	30.89	42.67
Red amaranth	-	13.50
Stem amaranth	-	27.00
Fish (seasonal pond culture)	-	6.67

Homestead (Tk farm ⁻¹)	vegetables	323	24364
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3.3 Per farm income against enterprises

3.3.1 Rice production. The main crop was the *boro* rice before intervention of IFS project in *haor* area. After recession of flood water, farmers involve themselves in *boro* rice cultivation to pill up their year round food security. Table 4 showed that Tk. 38539 farm⁻¹ was earned investing Tk. 14375 farm⁻¹ before intervention from rice cultivation. But after intervention the picture was quite different. Few number of farmers cultivated *boro* rice and invested more about Tk. 18197 farm⁻¹ and earned Tk. 44893 farm⁻¹ than before intervention. It was only because those farmers, decided to rice cultivation, selected short duration rice varieties like BRRI dhan58 as they took new technologies from IFS project and raised their income after intervention.

3.3.2 Homestead vegetable production. Vegetable production was rare among *haor* people. On an average they earned only Tk. 239 farm⁻¹ before intervention as vegetable production was done without planning. Normally consumption of vegetables such as bottle gourd, Indian spinach, bitter gourd, pumpkin, sponge gourd etc. was done from their homestead production and at lean period they bought from local market to fulfil the family demand. Trials of early winter vegetables (cabbage, cauliflower and tomato) enabled the poor farmers to fetch higher market prices with higher profits. The yields were 85.20, 48.35 and 49.90 t ha⁻¹ of cabbage, cauliflower and tomato, respectively. Similarly growing early summer vegetables produced 35.24, 17.16, 6.62 and 27.76 t ha⁻¹, of Indian spinach, amaranth, bitter gourd and lady's finger respectively [5]. After intervention of IFS project, every farm of the study area were supported by giving different seasonal vegetables seed like late winter vegetables (cabbage, cauliflower, tomato, eggplant, chili, bottle gourd, country bean, pumpkin, squash, red amaranth, spinach, etc. and summer vegetables (bitter gourd, ash gourd, ridge gourd, sponge gourd, snake gourd, Indian spinach etc. for year round cultivation of homestead vegetables with training of production technologies and management practices. After three years of intervention, the income of farm⁻¹ was appreciable than before intervention. Farmers were very responsive to vegetable cultivation and earned Tk. 23046 farm⁻¹ where cost was about Tk. 1320 farm⁻¹ (Table 4). Performances of different winter vegetables and spices in the *haor* area of Purbo Tethulia village were studied by BAU-FSR team. They found highest gross margin of Tk. 526000 ha⁻¹ obtained from the squash against the variable cost of Tk. 17000 ha⁻¹ incurred [8]. Farmers grow various local vegetables like cucumber, gourd and beans in the homestead on trellis. The improved management and intensive cultivation of three vegetables year⁻¹ on trellis was made possible through year round vegetables cultivation. It increased vegetable production year⁻¹ farm⁻¹ and supplied ample nutrients to rural people [6]. Due to early flash flood for last two years, farmers were in

severe food insecurities but most of them survived smoothly upon homestead vegetables. People had their homestead vegetables and also sold their produces in village market. After having, they gifted homestead vegetables to their neighbors as well as relatives.

3.3.3 Income from Livestock. Small, medium and large farmers had a few number of poultry, duck and livestock by which family purposes were met in occasion. Most of the time those domestic animals were effected by some common diseases like ranikhet, fowl pox, cholera, duck plague etc. Vaccination program were done regularly for these common diseases and tried to save the livestock properties that farmers' already had. In 1992, vaccination of chicken and ducks was carried out in Kazirshimla area against ranikhet, fowl pox, cholera, and duck plague diseases. Routine vaccination greatly reduced the mortality of poultry due to diseases [1]. Before intervention average farm⁻¹ income was about Tk. 13793 from egg, chicken and duck as meat which was totally consumed by family members. After intervention of different supportive materials like regular vaccination, feeding, regular monitoring etc. gross return was Tk. 112326 and gross margin was increased to Tk. 49688 farm⁻¹ (Table 4).

3.4.2 Fisheries in *haor* areas. The main occupation of *haor* people is fish catching during monsoon. Pond fish culture experiments were conducted in both homestead ponds and perennial ponds for three years. In homestead ponds the experiments were conducted by stocking *Catlacatla*, *C. mrigala*, *P. gonionotus* and *C. carpio* (mirror carp) in different species combinations under fertilized and feeding conditions. Farms those were feasible to fish culture, taken under consideration for seasonal pond culture. Monosex tilapia and shorputi fingerling were released in seasonal pond with training on fish culture. After analysis of farm income from fish, it lead to higher profit (gross return Tk. 50793 farm⁻¹ and gross margin Tk. 29840 farm⁻¹ after intervention (Table 3.3). They harvested their fish from pond after monsoon and used for family purpose. According to Dewan and Hossain in 1996, the yield of fish recorded to vary from 1385.54 to 2387.18 kg ha⁻¹. Among all tried species, *C. catla*, *C. carpio* and *P. gonionotus* showed better performance with respect to growth and yield [3]. Among the participants one farmer started to culture monosex tilapia in cage. After observing cage culture's output, all participants along their neighbors also appreciated the new technologies and expressed their positive response to practice further. An experiment was conducted in Purbo Tethulia I Mohangonj Upazila, Netrakona with monosex and GIFT tilapia in cage condition during 2010-2011 where monosex gave higher yield (69.47 kg cage⁻¹) compared to GIFT (64.99 kg cage⁻¹). Higher income (gross return Tk. 6947 and gross margin Tk. 1847) generated from GIFT than monosex tilapia (gross return Tk. 6499 and gross margin Tk. 1300). Therefore, GIFT tilapia is more suitable for cage culture in *haor* area [8].

3.3.5 Integrated farm income. After analysis of total intervention given to the sampled farm, remarkable reflections were shown by the farms. Before intervention, farm⁻¹ gross return was about Tk. 106837 and gross margin Tk. 62463 farm⁻¹ against cost Tk. 44327 farm⁻¹. After intervention of IFS project, farmers made gross income Tk. 200017 farm⁻¹ where gross return was Tk. 250613 farm⁻¹. As the total cost also higher but actual profit increased gradually due to interventions to sample farm (Table 4). Because of intensification of enterprises, the development of integrated farming was done through intervention of technology, management and addition of enterprises. Overall findings indicated that efficiency of productivity increase was the highest in small and medium farm than large farm. The interventions increased crop diversification, number of homestead production and productivity of all systems.

Table 4: Per farm income of participating farmers in the haor area due to use of Integrated Farming Technology(IFT)

Enterprises	Scenario of enterprises	
	Before intervention	After intervention
Rice		
Cost (Tk.)	14375	18197
Gross return (Tk.)	52934	63130
Net return (Tk.)	38539	44893
Vegetables		
Cost (Tk.)	83	1320
Gross return (Tk.)	323	24364
Net return (Tk.)	239	23046
Livestock		
Cost (Tk.)	21139	62638
Gross return (Tk.)	34913	112326
Net return (Tk.)	13793	49688
Fisheries		
Cost (Tk.)	8960	21358
Gross return (Tk.)	20790	50793
Net return (Tk.)	11830	29840
IFT*		
Cost (Tk.)	44327	103512
Gross return (Tk.)	106837	250613
Net return (Tk.)	62463	200017

*Integrated Farming Technology

3.4 Labor productivity

Interventions, technological knowledge and motivational speech lead the farmers to higher profit from farm. Training and motivational programs also effected positively on farmers activity and raised the farm productivity. After intervention, labor productivity sharply rise to 379.24 from 133.72 as they applied newly accepted technological knowledge on their agricultural production (Table 5). Their cultural and behavioral development were reflected through the family. Increased labor productivity ensured the positive responsesin family income, duties & responsibilities, cultural development among the farmers of the *haor* area

Table 5: Labour productivity status of Noagaon village of haor areas before and after intervention of integrated farming systems (IFS)

	Farm ⁻¹	
	Before intervention	After intervention
Labor productivity	133.72	379.24

4. CONCLUSION

From the study, it is distinctly clear that the efficiency of farms was improved in agro-economic productivity with intensification and diversification of farming enterprises. The labor productivity also increased after intervention due to use of modern technologies and generated more employment irrespective of male and female labor.

5. ACKNOWLEDGMENT

This study was under the project of “Farm Productivity Improvement in *Haor* Areas through Integrated Farming Systems Approach” founded by KrishiGobeshona Foundation (KGF), implemented by Sylhet Agricultural University, Sylhet-3100.

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