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RESEARCH ARTICLE

CROP-LIVESTOCK INTERACTION IN RURAL HOUSEHOLD OF BANGLADESH

Muhammad Shahinur Islam^{a,b*}, M. A. Hashem^a, Sadikul Islam^{a,c}, Md Hasanur Alam^a, Md. Akteruzzaman^d^aDepartment of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh^bForeign Exchange Policy Department, Bangladesh Bank, Head office, Dhaka, Bangladesh^cGovernment Poultry Farm, Department of Livestock Services, South Chartha, Cumilla, Bangladesh^dDepartment of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*Corresponding author email: sajeeb238@yahoo.com

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ABSTRACT

This study examined the crop livestock interaction in agrarian zone of Bangladesh. Quantitative data were collected with a questionnaire from a sample of randomly selected 458 respondents through personal interview. Two categories of respondent participated, such as old conservational agriculture research or farmer group and new conservational agriculture research or farmer group. Simple and direct questions with different scales were used to obtain necessary information. Data were analyzed using both descriptive and inferential statistics. The result showed that 54.15% of the farmers were range between 31 and 35 years of age, and their educational level was mainly in primary level (31.66%) in all categories. The farmer's family usually consist of more than six family members (42.58%). In rural household farmers used both own and lease land for crops production. Crops grown within the study area includes rice, wheat, jute, pulses, oilseeds, maize, vegetables etc. Livestock reared by respondent included cattle, buffaloes, sheep and goat, while their wives and children rear local chicken, duck and pigeon. Among annual household income crop provides 59.88% whereas livestock provides 13.23%. Extension services in the study areas of agricultural production should be provided in order to increase their level of production and greater crop-livestock interaction.

KEYWORDS

conservational, crop, household, interaction, livestock.

1. INTRODUCTION

In various forms, conservation agriculture is now being practiced on over 110 million ha of land globally (Derpsch et al., 2010). Development of conservational agriculture for smallholders, especially within rice-based systems remains limited and uptake by smallholders in Bangladesh remains low. In Bangladesh more than 60,000 farmers have adopted some level of conservation agriculture into their production to meet the demands of an expanding population, in spite of an increasingly unpredictable climate, is one of the foremost challenges facing our country. In Bangladesh, crop is dominant in mixed farming system where livestock kept in household condition. In tropics, 40 to 80% of the livestock are associated with mixed crop-livestock farming systems (McDowell, 1987). Because of this close relationship between crop and livestock production, animal scientists are highly concerned about mixed farming among crop and livestock.

Crop production has increased considerably during the last decade had a corresponding increase in livestock numbers in Bangladesh (Brumby, 1987). For this reason, when projecting farm output the interdependence of crops and livestock must be taken into consideration (Hart and McDowell, 1985). Thus, the present study has undertaken to examine the scenario of crop-livestock interaction that contributing to sustainable agriculture and rural development in Bangladesh.

An important component of the "agricultural revolution" of 18th century in Europe was the introduction of forages into crop rotations accelerated by crop-livestock interaction (Wolfgang and Waters-Bayer, 1986). These increased animal productions and, in turn, crop yields were raised through improvements in soil fertility due to higher manure output, and through the effects of the forage ley. There is a numerous links between crops and livestock have long existed in the tropics, but because they differ from those in temperate areas they tend to be overlooked. In the tropics, crops and livestock are often linked by way of: arrangements between specialist herding and arable farming groups, arrangements between two enterprises within the same family, such as when a man is engaged mainly in cropping while his son or wife migrates with the livestock or interactions within smallholdings, in which a few cattle, buffalo, small ruminants, pigs, poultry etc. are kept. In Bangladesh, about 87% of the animal feed comes from cropland in the form of crop residues, agro-industrial by-products, green forage and weeds. The available feed base in the country can support approximately 46% of ruminants and 21 % of poultry under normal levels of nutrition and management (Dickey and Huque, 1986).

Linkages between livestock-keeping and cropping found in many parts of the tropics includes, Food linkage; almost all livestock-keepers, including nomads, consume cereals, and many farmers consume some meat and

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milk products; Investment linkage; income from crops is used to buy livestock, and animals are sold to finance cropping inputs; Manure linkage; animal manure is used to fertilize cultivated fields and home gardens; Forage linkage; crop residues and fallow fields are used as fodder and pasture; Draught linkage; animal traction is used for cultivation and transportation, also of cropping inputs and outputs; and Employment linkage; pastoralists sometimes keep animals for farmers, or members of farm families may be employed by pastoralists for herding or cultivation (McCown, 1979).

There are various opportunities of crop-livestock integration in Bangladesh. The farming systems are basically agro pastoral and the proportion of mixed farmers is increasing, giving the opportunity for farmers to collect manure and use animal power. Intensification of agriculture which is currently occurring in most farming systems favors crop-livestock integration. Poor soil fertility, unavailability or increases in prices of fertilizers, and labor shortages, have forced farmers to rely on alternatives such as manure and traction. There is huge scope for improving the efficiency of the integration by diversifying the use of animals. For instance, the use of cows for traction will also provide milk and manure. Farmers can also crop in the wet season and engage in livestock enterprises in the dry season.

Livestock enterprises are more lucrative than crop farming so it is advantageous to integrate livestock into farm activities. Integration of crop and livestock systems will help in reducing conflicts between farmers and agro pastoralists. Integration promotes sedentarization where pastoralists will have access to facilities for their animals and animals will contribute more manure and urine. Many indigenous, emerging, and developed technologies are available to support sustainable crop-livestock integration. These include improved cereal and grain legume varieties, cropping systems, weed and nutrient management strategies, the eradication of most livestock diseases, and the development of modeling and all-year-round feed packages for animals. Therefore, the objectives of this study was to identify crop and livestock interaction in the study area of Bangladesh and the aim was to give an overview on overall scenario of crop-livestock integration in Bangladesh for making a long term planning for improving existence farming systems.

2. MATERIALS AND METHODS

The overall outlines of materials and methods is shown in figure 1. The whole procedure also briefly given in the subsequent sections.

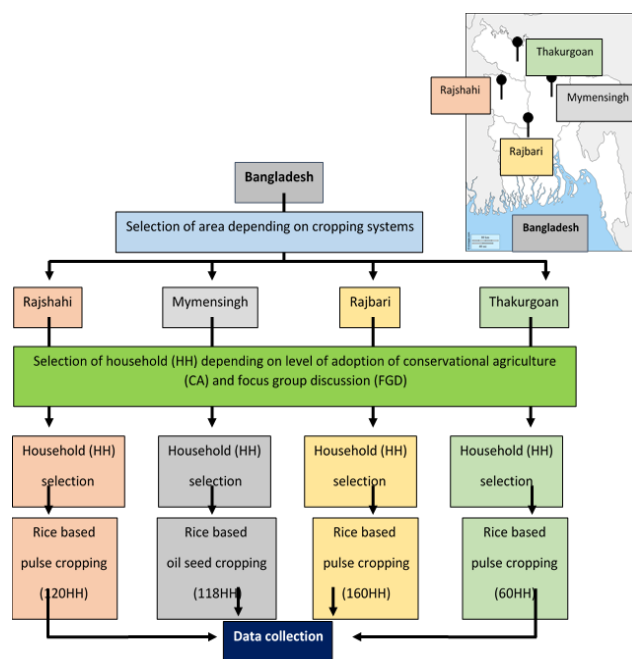


Figure 1: Selection and data collection procedure from household (HH) for the study

2.1 Study Locations

The study covered a range of soils and cropping systems in: Rajshahi; Mymensingh; Rajbari, and Thakurgaon regions in Bangladesh.

2.2 Source of Data

Data and information were gathered through focus group discussion (FGD), household survey, and case studies. Focus group were consisted of different sections of people such as Sub-assistant Agricultural Officer, 2-wheel power tiller, machinery and spare parts sellers, owners, operators, and few conscious local community people. On the other hand, quantitative and qualitative data and information were gathered from the randomly selected users and service providers of machineries through conducting household survey using pre-tested interview schedules, some suitable case studies of successful service providers were also conducted to supplement the study.

2.3 Sampling Technique

A multi-stage stratified sampling adopted in the study.

- ✚ Firstly, districts (such as Thakurgaon, Rajshahi, Rajbari and Mymensingh) were selected considering the soil type and cropping systems.
- ✚ Secondly, the households were selected considering the level of adoption of conservational agriculture (CA) through FGD.
- ✚ Thirdly, the households were categorized by cropping systems mostly rice based pulses or oilseed cropping systems.
- ✚ Thus, a total of 458 farms were selected followed by a field reconnaissance and key informants' interview with different stakeholders for the study (Table 1).

Table 1: Distribution of the Selected Sample Households in the Study	
Locations	
Major cropping systems in study location	No. of selected households
Rajshahi	
Rice-lentil-mung bean	120
Rice-wheat-mung bean	
Sub-total	120
Mymensingh	
Rice-mustard-mung bean	118
Rice-wheat-mung bean	
Rice-lentil-Aus rice	
Sub-total	118
Rajbari	
Rice-lentil-mung bean	160
Rice-lentil-jute	
Sub-total	160
Thakurgaon	
Rice-wheat-mung bean	60
Sub-total	60
TOTAL	458

2.4 Methods and Period of Data Collection

For collecting the necessary data, the study team explained to respondents the aims and objectives of the study before going to make the actual interview. The respondents were assured that the information given by them would not be used against their interest and that it would be useful to their households in many respects. Interviewees were requested to give correct information as far as possible. To ensure the quality of information the interview schedule was checked to ensure that information to each of the items had been correctly recorded. If there were any items overlooked

and misunderstood or found contradictory, these were corrected through re-interviewing on the spot.

2.5 Data Processing and Analysis

All the collected data were processed and analyzed in accordance with the objectives of the study. Data processing included field and office editing, coding and tabulation. The data entry template was designed in Microsoft Excel. Consistency checks and keystroke errors were also detected and

corrected accordingly before data analysis. The analysis was done using descriptive statistics like percentage, frequency distribution, mean, and rank where appropriate.

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Profile of the Respondent HHS

3.1.1 Age and Family Composition

Age class	Mymensingh		Rajbari		Rajshahi		Thakurgaon		All area average	
	% HH	AA (yr)	% HH	AA (yr)	% HH	AA (yr)	% HH	AA (yr)	% HH	AA (yr)
< 30 yr	38.46	25.89	26.88	27.14	23.33	27.25	22.95	27.43	28.38	26.76
31-50 yr	44.44	40.37	52.50	40.71	63.33	41.25	59.02	41.53	54.15	40.92
51-60 yrs	8.55	58.00	14.38	57.00	10.00	54.67	16.39	55.10	12.01	56.33
> 60 yr	8.55	67.60	6.25	69.50	3.33	66.00	1.64	64.00	5.46	67.96
Total	100.00	38.63	100.00	41.21	100.00	40.15	100.00	40.89	100.00	40.23

HH: Households; AA: Average age in years

Socioeconomic information about respondents in study areas discussed in this portion. Age group of the respondents shows in Table 2. Here age is grouped into four groups: below 30 years, 31 to 50 years, 51 to 60 years and above 60 years. In all areas, the percentage of age below 30 years was around 30% and average age was about 27 years old, percentage of age 31 to 50 years was around 55% and average age was 41.26 years, in age group 51 to 60 the percentage was 12 and average age was 56 years, and above 60 years age group the percentage of age was around 6 and average age was 70 years. So, the average percentage of all respondents (below 30 years, 31 to 50 years, 51 to 60 years and above 60 years) in study areas were 28.38, 54.15, 12.01, 5.46 respectively where the average age were 26.76, 40.92, 56.33, 67.96 years in according to the age group. The age variation was similar in all the four study sites.

Table 3 presents the family size of the respondents in study areas. Single member family size in previously CA research sites respondents was zero where in newly CA research sites respondents the single member family size was in number 1 and the percentage was 0.28. So, in case all respondents the number was 1 and percentage was 0.22. When family member is two in previously CA research sites, the number of family was 2 and the percentage was 1.92 where in newly CA research sites respondents the number of family was 9 and the percentage was 2.54. In case of all respondents the number of family was 11 and percentage was 2.40. In case of the family size of 3 members the new and previous CA research sites and all household respondents the number of family was 17, 45 and 62 respectively where percentage were 16.35, 12.71 and 13.54 respectively. In accordance with the family size with 4 and 5 the member of respondents, the number of households was 22 and 15 respectively and the percentage of household was 21.15 and 14.42 respectively, where in new CA research sites respondents, the number of family was 86 and 66 respectively.

Family size (no.)	Previously CA research sites by BARI (Rajshahi and Rajbari)		Newly CA research sites by BAU (Mymensingh and Thakurgaon)		All HHS	
	No. of HH	% of HH	No. of HH	% of HH	No. of HH	% of HH
	1	0	0.00	1	0.28	1
2	2	1.92	9	2.54	11	2.40
3	17	16.35	45	12.71	62	13.54
4	22	21.15	86	24.29	108	23.58
5	15	14.42	66	18.64	81	17.69
6+	48	46.15	147	41.53	195	42.58
All	104	100.00	354	100.00	458	100.00

CA: conservational agriculture; HH: Households

So, here in case of all respondents the number of respondents was 108 and 81 respectively and percentage was 23.58 and 17.69 respectively. The table shows when family member of the respondents in study areas were

above 6 the number of family in previously CA research sites respondents were 48 and percentage was 46.15 where in new research sites respondents number of family were 147 and percentage were 41.53 and in all respondents the number of family were 195 and percentage was 42.58.

3.1.2 Education Level

In this study the educational level of the respondents were included in the socioeconomic study. The educational level is represented in Table 4. The table consists with seven educational levels. In previous CA research sites the number of illiterate persons was 38 and percentage was 36.54 where the number of illiterate persons in new sites respondents was 105 and percentage was 29.66. In case of all respondents the number of illiterate respondents was 143 and percentage was 31.22. The primary educated respondents in previous, new sites and all households were 22, 123 and 145 respectively, where percentage was 21.15, 34.75 and 31.66 respectively. In lower secondary level respondents in previous, newly research sites and all households were 14, 36 and 50 respectively and percentage was 13.46, 10.17 and 10.92 respectively. The secondary level of education the number of adopter respondent were 6 and the percentage was 5.77 where in new sites the number was 71 and percentage was 20.06. All respondents in study areas the secondary level were 77 and percentage was 16.81.

Educational level	Previously CA research sites by BARI (Rajshahi and Rajbari)		Newly CA research sites by BAU (Mymensingh and Thakurgaon)		All HH	
	No.	%	No.	%	No.	%
Illiterate	38	36.54	105	29.66	143	31.22
Primary	22	21.15	123	34.75	145	31.66
Lower secondary	14	13.46	36	10.17	50	10.92
Secondary	6	5.77	71	20.06	77	16.81
SSC	8	7.69	9	2.54	17	3.71
HSC	11	10.58	8	2.26	19	4.15
Graduate+	5	4.81	2	0.56	7	1.53
All	104	100.00	354	100.00	458	100.00

CA: Conservation Agriculture; HH: Households

The SSC level respondents in old, new and all households were 8, 9, 17 respectively and the percentage was 7.69, 2.54 and 3.71. Among the old research sites respondents, the HSC level were in number 11 and percentage was 10.58 where the new sites respondents were 8 and percentage was 2.26. In this case the all respondents in the study areas the HSC level people were 19 in number and percentage was 4.15. Above the level of graduation old, new sites and all households were 5, 2 and 7 respectively and the percentage was 4.81, 0.56 and 1.53 respectively.

3.1.3 Occupation

Table 5: Respondents occupational diversity of the selected HHs in the study areas (in number)

Occupations	Previously CA research sites by BARI (Rajshahi and Rajbari)		Newly CA research sites by BAU (Mymensingh and Thakurgaon)		All HH	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
Agriculture	87	5	284	48	371	53
Service providers	6	4	0	9	6	13
Petty business	2	17	32	56	34	73
Services	6	18	16	23	22	41
Day laborer	0	8	5	31	5	39
Others	3	3	17	17	20	20
Total	104	55	354	184	458	239

CA: Conservation Agriculture; HH: Households

In study areas the main occupation was agriculture. Other occupations were service, business, day labor etc. Among all respondent's agriculture was considered as the main occupation by 371 and 53 respondents considered it secondary occupation (Table 5). 6 respondents were service provider as primary and 13 were as secondary. About 34 respondents were petty businessmen as their main occupation and 73 as secondary. In the selected HHs areas as primary occupation service was considered by 22 respondents and secondary by 41. There are 5 respondents were day laborer as their main occupation and 39 respondents were as second occupation. In the study areas, the main occupation of the respondents was agriculture.

3.1.4 Land Area

Land in the study areas was divided into two categories as Own land and the Lease in land (Table 6). In Rajbari, the respondents owned 2.39 acre as own land and lease in land 0.43 acre that was the total land 2.8 acres. In Rajshahi, Thakurgaon and Mymensingh the own land of the respondents were 1.26, 2.32 and 3.04 acres respectively where the lease in land were in above areas were 0.53, 0.38 and 0.11 acre respectively. So, the total land in Rajshahi, Thakurgaon and Mymensingh were 1.79, 2.70 and 3.16 acres respectively.

Table 6: Land area of the selected HHs in the study areas

Locations	All HH (land area in acres)		
	Own land	Lease in land	Total land area
Rajbari	2.39	0.43	2.80
Rajshahi	1.26	0.53	1.79
Thakurgaon	2.32	0.38	2.70
Mymensingh	3.04	0.11	3.16
Total	2.25	0.37	2.61

HH: Households

3.1.5 Cattle and Poultry Population

In socioeconomic profile of the respondents in the study areas, the distribution of the cattle and poultry is very important. The main species that all the respondents had were cattle, goat, ducks, chickens and pigeon. The distribution of these species among the respondents are shown in Table 7. Around 83% households had cattle and the numbers of cattle per households were 2.71. Goat, buffalo, sheep, duck, chicken and pigeon were farming by 56.77%, 1.09%, 0.22%, 55.02%, 72.05%, 5.24% respectively by the respondents, where the number of these species per households were 2.40, 1.80, 6.00, 5.40, 8.43, and 14.63, respectively.

Table 7: Distribution of cattle and poultry in the studied HHs

Species	Previously CA research sites by BARI (Rajshahi and Rajbari)		Newly CA research sites by BAU (Mymensingh and Thakurgaon)		All HH	
	% of HH	No./ HH	% of HH	No./ HH	% of HH	No./ HH
Cattle	77.88	2.35	84.18	2.81	82.75	2.71
Goat	59.62	2.26	55.93	2.44	56.77	2.40
Buffaloes	-	-	1.41	1.80	1.09	1.80
Sheep	-	-	0.28	6.00	0.22	6.00
Ducks	51.92	5.67	55.93	5.32	55.02	5.40
Chicken	72.12	8.13	72.03	8.51	72.05	8.43
Pigeon	7.69	15.50	4.52	14.19	5.24	14.63

CA: Conservation Agriculture; HH: Households

3.1.6 Annual Household Labor and Their Source

The source of income of the respondents of study areas was agriculture. In the source wise income in agriculture, the sub-sectors were crop, livestock, and rental from agricultural machineries, poultry and fisheries. Respondent's earned 75.01% of annual income from agriculture source where 24.99% income was earned from non-agriculture (Table 8). The sub-sectors in non-agriculture group were service, business, wage income and remittance. From agriculture sector the total quantity of annual income in the study area was BDT 161,710.53. The annual income from the sub-sectors of agriculture crop, livestock and rental from agricultural machineries, poultry, and fisheries were BDT 129,095.29; 28,526.14; 2,631; 650.23; and 807.86 respectively and the corresponding percentages to total annual income were 59.88, 13.23, 1.22, 0.30 and 0.37 respectively. The annual income by non-agriculture sub-sectors were BDT 13,872.97 (6.27%) in service; BDT 26,207.59 (12.16%) in business, BDT 3,301.10 (1.53%) in wage income; from remittance and others were BDT 6,753 (3.13%) and 4093 (1.90%), respectively.

Table 8: Annual household income and their sources by locations (in BDT)

Species	Previously CA research sites by BARI (Rajshahi and Rajbari)		Newly CA research sites by BAU (Mymensingh and Thakurgaon)		All HH	
	Quantity	% of income	Quantity	% of income	Quantity	% of income
Agriculture	194,227.78	76.55	152,229.50	74.45	161,710.53	75.01
Crop	150,934.74	59.49	122,747.71	60.03	129,095.29	59.88
Livestock	33,543.27	13.22	27,056.34	13.23	28,526.14	13.23
Rental from agric. Mach.	8,778.85	3.46	824.86	0.40	2,631.00	1.22
Poultry	788.24	0.31	609.06	0.30	650.23	0.30
Fisheries	182.69	0.07	991.53	0.48	807.86	0.37
Non-agriculture	59,490.20	23.45	52,255.88	25.55	53,872.97	24.99
Service	21,519.23	8.48	11,166.67	5.46	13,517.47	6.27
Petty business	20,686.27	8.15	27,835.26	13.61	26,207.59	12.16
Wage income	2,500.00	0.99	3,538.46	1.73	3,301.10	1.53
Remittance	6,730.77	2.65	6,760.56	3.31	6,753.81	3.13
Others	8,053.92	3.17	2,954.93	1.45	4,093.00	1.90
Total	253,717.98	100.00	204,485.38	100.00	215,583.49	100.00

CA: Conservation Agriculture; HH: Households; agric. Mach.: Agricultural Machineries

3.1.7 Correlation System Practiced

The total land cultivated by different crops in study areas are shown in Table 9. In study areas the main crops were rice, wheat, jute, pulses, oilseed, maize and vegetables. Rice was the main cultivated crop and vegetables were the second one. The total cultivated area by rice, wheat, jute, pulses, oilseed, maize and vegetables were 2.17, 0.43, 0.74, 1.02, 0.46, 0.66 and 1.09 acres respectively where the percentage of 20 total

cultivated land of the above crops were 83.14, 16.48, 28.35, 39.08, 17.62, 25.29 and 41.76 respectively.

Table 9: Crops cultivated by the sample households

Crops	All HHs (area in acres)	
	Area	% of total
Rice	2.17	83.14
Wheat	0.43	16.48
Jute	0.74	28.35
Pulses	1.02	39.08
Oilseeds	0.46	17.62
Maize	0.66	25.29
Vegetables	1.09	41.76

HH: Households

In the study areas of Rajbari, Rajshahi, Thakurgaon and Mymensingh the main cultivated crops were rice, wheat, jute, pulses, oilseed, maize and vegetables. Total land cultivated by study areas represented by Table 10. In Rajbari total cultivated land by crops rice, wheat, jute, pulses, oilseed, and vegetables were 1.07, 0.76, 1.15, 0.58, 0.51 and 1.43 acres respectively, whereas the percentage of total land of cultivation were 0.38, 0.27, 0.41, 0.21, 0.18 and 0.51 respectively. In Rajshahi total cultivated land by crops rice, wheat, jute, pulses, oilseed, maize and vegetables were 2.18, 0.42, 0.27, 0.87, 0.44, 0.65 and 0.22 acre, respectively, whereas the percentage of total land of cultivation were 121.79, 23.46, 15.08, 48.60, 24.58, 36.31 and 12.29, respectively. In Thakurgaon total cultivated land by crops rice, wheat, jute, pulses, maize and vegetables were 2.82, 0.68, 0.55, 0.65, 0.44, 0.74 and 0.59 acre respectively, whereas the percentage of total land of cultivation were 104.44, 25.19, 20.37, 24.07, 27.41 and 21.85, respectively. In Mymensingh total cultivated land by crops rice, wheat, pulses, and vegetables were 1.87, 1.02, 0.92 and 1.03 acres respectively, whereas the percentage of total land of cultivation were 59.18, 32.28, 29.11 and 32.59, respectively.

Table 10: Crops cultivated by the study locations

Crops	Rajbari		Rajshahi		Thakurgaon		Mymensingh	
	Area in acre	% of total	Area in acre	% of total	Area in acre	% of total	Area in acre	% of total
Rice	1.07	0.38	2.18	121.79	2.82	104.44	1.87	59.18
Wheat	0.76	0.27	0.42	23.46	0.68	25.19	1.02	32.28
Jute	1.15	0.41	0.27	15.08	0.55	20.37	0	-
Pulses	0.58	0.21	0.87	48.60	0.65	24.07	0.92	29.11
Oilseeds	0.51	0.18	0.44	24.58	0	-	0	-
Maize	0	-	0.65	36.31	0.74	27.41	0	-
Vegetables	1.43	0.51	0.22	12.29	0.59	21.85	1.03	32.59

The cropping pattern and intensity in study areas are represented in table 11. The main cropping seasons are Rabi, Kharif I and Kharif II. For the cropping first pattern in Rajbari boro rice grows in Rabi season, jute in Kharif I and aman in Kharif II and 22% respondents cultivated this pattern of cropping system. In second cropping pattern oilseed grows in Rabi season and aus grows in Kharif I and 33% household cultivated in this pattern. In third cropping pattern wheat grows in Rabi and jute in Karif I, where 45% people used this farming system and the cropping intensity in this study area was 196.43%. In Rajshahi boro rice grows in the first cropping pattern in Rabi season, jute in Kharif I and aman in Kharif II, where 12% respondents cultivated in this pattern. In second cropping pattern wheat grows in Rabi season and Aman grows in Kharif II and 57% household cultivated by this pattern. And at third cropping pattern vegetables/pulse grows in Rabi and aus in Karif I, where 31% people used this farming system and the cropping intensity in this study area was 282.12%.

Table 11: Major Cropping patterns and cropping intensity of the sample HH

Location	Pattern	Rabi	Kharif I	Kharif II	% of HH	Cropping intensity (%)
Rajbari	1	Boro rice	Jute	Aman	22	196.43
	2	Oilseed/Pulses	Aus	Fallow	33	

Rajshahi	3	Wheat	Jute	Fallow	45	282.12
	1	Boro rice	Jute	Aman	12	
	2	Wheat	Fallow	Aman	57	
Thakurgaon	3	Vegetables/Pulse	Aus	Fallow	31	223.33
	1	Boro rice	Fallow	Aman	48	
	2	Wheat	Fallow	Aman	28	
Mymensingh	3	Vegetables/Pulse	Aus	Fallow	24	153.16
	1	Boro rice	Jute	Aman	35	
	2	Wheat/Boro rice	Fallow	Aman	27	
Status of CA	Old CA research sites					228.05
	New CA research sites					214.86

CA: Conservation Agriculture; HH: Households

In Thakurgaon boro rice grows in the first cropping pattern in Rabi season, aman in Kharif II, where 48% respondents cultivated in this pattern. In second cropping pattern wheat grows in Rabi season and aman grows in Kharif II and 28% household cultivated by this pattern. And at third cropping pattern vegetables/pulse grows in Rabi and aus in Karif I, where 24% people used this farming system and the cropping intensity in this study area was 223.33%. In case of Mymensingh study area boro rice grows in the first cropping pattern in Rabi season, jute in Kharif I and aman in Kharif II, where 35% respondents cultivated in this pattern. In second cropping pattern wheat/boro rice grows in Rabi season and aman grows in Kharif II and 27% household cultivated by this pattern. And at third cropping pattern vegetables/pulse grows in Rabi and aman in Karif II, where 38% people used this farming system and the cropping intensity in this study area was 153.16%.

3.1.8 Availability of Farm Labor

Table 12 shows the level of labor availability and the wage rate in the study areas. In Rajbari labor was moderately sufficient in Rabi season that is 81.88 followed by insufficient and highly sufficient 11.88 and 6.25%, respectively. The wage rate was BDT 256 with food and BDT 266 without food. In Kharif I, the labor availability was as like as Rabi season that is labor is moderately sufficient in Rabi season (65%) followed by insufficient and highly sufficient 33.75 and 1.25%, respectively. The wage rate was BDT 260 with food and BDT 269 without food. In the season Kharif II, labor was moderately sufficient in Rabi season that was 51.25% followed by insufficient and highly sufficient 46.25 and 2.50%, respectively. The wage rate was BDT 257 with food and BDT 343 without food.

Table 12: Availability of labour and wage rate in the sample HH

Location	Seasons	Level of labour availability (%)			Wage rate (BDT)	
		Highly sufficient	Moderate sufficient	Insufficient	With food	Without food
Rajbari	Rabi	6.25	81.88	11.88	256	266
	Kharif I	1.25	65.00	33.75	260	269
	Kharif II	2.50	51.25	46.25	257	343
Rajshahi	Rabi	33.61	62.18	4.20	201	252
	Kharif I	34.45	48.74	16.81	206	254
	Kharif II	17.65	50.42	31.93	208	258
Thakurgaon	Rabi	4.92	34.43	60.66	216	300
	Kharif I	13.11	42.62	44.26	223	300
	Kharif II	8.20	31.15	60.66	218	301
Mymensingh	Rabi	10.17	74.58	15.25	250	300
	Kharif I	4.24	81.36	14.41	250	300

	Kharif II	0.85	76.27	22.88	250	300
All locations	Rabi	14.19	68.56	17.25	231	280
	Kharif I	12.23	62.01	25.76	235	281
	Kharif II	6.77	54.80	38.43	233	301

HH: Households

In Rajshahi labor was moderately sufficient in Rabi season that was 62.18% followed by highly sufficient and insufficient 33.61 and 4.20%, respectively. The wage rate was BDT 201 with food and BDT 252 without food. In Kharif I, the labor availability was as like as Rabi season that is labor was moderately sufficient in Rabi season (48.74%) followed by highly sufficient and insufficient 34.45 and 16.81% respectively and the wage rate was BDT 206 with food and BDT 254 without food. In the season Kharif II, labor was moderately sufficient as Rabi season that is 50.42% followed by insufficient and highly sufficient 31.39 and 17.65%, respectively. The wage rate was BDT 208 with food and BDT 258 without food.

In Thakurgaon labor was insufficient as Rabi season that is 60.66% followed by moderately sufficient and highly sufficient 34.43 and 4.92%, respectively. The wage rate was BDT 216 with food and BDT 300 without food. In Kharif I, the labor 24 availability was as like as Rabi season that is labor is insufficient in Rabi season (44.26%) followed by moderately sufficient and highly sufficient 42.62 and 13.11%, respectively. The wage rate was BDT 223 with food and BDT 300 without food. In the season Kharif II, labor was insufficient in Rabi season that was 60.66% followed by moderately sufficient and insufficient 13.15 and 8.20%, respectively. The wage rate was BDT 218 with food and BDT 301 without food.

In Mymensingh labor was moderately sufficient in Rabi season that is 74.58% followed by insufficient and highly sufficient 15.25 and 10.17%, respectively. The wage rate was BDT 250 with food and BDT 300 without food. In Kharif I, the labor availability was as like as Rabi season that is labor was moderately sufficient in Rabi season (81.36%) followed by insufficient and highly sufficient 14.41 and 4.24%, respectively. The wage rate was BDT 250 with food and BDT 300 without food. In the season Kharif II, the labor was moderately sufficient as Rabi season that is 76.27% followed by sufficient and insufficient 22.88 and 0.85%, respectively. The wage rate was BDT 250 with food and BDT 300 without food.

4. CONCLUSIONS

Based on the empirical findings through survey, FGD, personal interviewing, key informants' interviewing and field observations some

concluding remarks are made. In the crop-livestock integrated area farmers were usually in middle age having a family with more than 6 members and most of the farmers were illiterate. Agriculture was their main occupation and farmers produce crops along with livestock species. In crop-livestock interaction areas, livestock mainly used for income generation while some of farmers used livestock manure for composting to make land fertile. Thus the profit from livestock become the investment for crop production and vice versa. In this way there are always an interaction between crop and livestock in Bangladesh.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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