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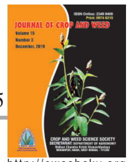

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Economic impact of integrated farming systems on small and marginal farm households in lower Gangetic plains of West Bengal, India

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ABSTRACT

Integrated farming system refers to agricultural systems that integrate livestock and crop production. So there is a mutual dependency between agricultural and livestock activities. It is a whole farm management system which aims to deliver more sustainable agriculture. According to a given site and situation, this process uses the best combination of modern tools and technologies with traditional practices. This study analyses the economic impact of integrated farming system over traditional farming practices in the lower Gangetic plains of West Bengal, India. Under integrated farming system, the overall gain in system productivity is 14.97%. The estimated change is attributable to the relative change in input use. Quantity of organic manure use (-7.42%) followed by bullock labour use (-5.03%) and hour of irrigation use (-2.52%) have played negatively significant role on crop productivity change. Whereas, the use of machine labour (4.69%) and human labour (4.23%) have shown positively significant effect on crop productivity change. The return per rupee of investment was found to be sufficiently higher for farm households following integrated farming system (1.60) compared to the traditional farm families (1.30).

***Keywords*:** Economic impact, integrated farming system, productivity, traditional farming, technology

As different production systems have been industrialized and commercialized in developing countries, people with more disposable income to spend on food items, are possessing serious challenge to meet the demand for food (Cirera and Masset, 2010). Thus, food demands will increase eventually and a rise of at least 50% of total food production will require very soon to meet the future food demand (The Royal Society, 2009). Almost 70% of our nation's population directly or indirectly depends on agriculture but unfortunately it has become a non-profitable occupation due to low profit and occurrence of natural calamities. Since majority of farmers are small and marginal in India, little incentives are not enough to hold them back in farming. In India, the traditional farming technique is mostly used, in which a specific crop is chosen for a specific season. Planting the same crop year after year results in a decrease in nutrient levels in the soil, making it impossible to support healthy plant growth, forcing farmers to apply chemical fertilisers to promote plant growth, which has severe effects on environment and ultimately leads to pollution. The Department of Agriculture and Co-operation launched a new mission named "National Mission for Sustainable Agriculture" (NMSA) in 2014-15 to address this urgent situation, with the Integrated Farming System (IFS) as one of the primary components. "There is no waste" and "waste is only a misplaced resource which can become valuable material for another product" in this farming system (FAO, 1977). Wastes get eliminated as used as resources in this system, and it also provides an overall rise in production for the entire agriculture system by maintaining economic balance (CARDI, 2010). IFS is reported to gain higher farm income and profitability compared to the conventional farming, especially in case of small sized farms (Edwards, 1989). Use of various organic waste components having different nutritional values enables to produce a complete and balanced source of nutrition. It provides better food diversity than traditional farming, results in improved household food consumption (Prein and Ahmed, 2000). This whole process does not cause any threat to environment in altogether and minimizes the environmental pollution to a great extent by effective recycling of waste materials. IFS is reported to generate more man-days in the farm than traditional farming (Tipraqsa *et al*., 2007), as integration of different enterprises requires ample amount of labours whole round the year, which solves the problem of unemployment to a greater extent. The integration of enterprises like crops, fishery, poultry, duckery, mushrooms, *etc*. provides income to the farmers throughout the year which reduces the financial crisis in the farmers' family. Regular and even income distribution throughout the year makes the farm resilient to uncertainties and also reduces vulnerability against climatic and market variations (Pretty, 1997).

The current study aims to assess the profitability of small and marginal farm households adopting integrated farming system (IFS) over traditional growers in Lower Gangetic Plains of West Bengal, India. System produc-

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tivity and system net return have been obtained from different crops and livestock enterprises by fitting econometrical model dealing with multiple regression analysis by using Ordinary Least Square (OLS) method. In order to estimate and compare regression coefficients of two types of farming situations, Bisaliah (1976) method of decomposition has been followed.

Theoretical background

The following hypotheses were being tested in this study:

H_0 (the null hypothesis) indicates no significant change in the system productivity between IFS farm households and the traditional cultivators in the study area.

H_1 (the alternative hypothesis) indicates a significant change in system productivity between IFS farm households and the traditional cultivators in the study area.

Sampling approach

The research was carried out during the year 2019-20, mainly focuses on three villages- Atiliya and Kumarpur villages of Chakdaha block and Jalalkhali Village of Krishnanagar-1 block of Nadia District, West Bengal situated under lower Gangetic Alluvial Plains of India, where farmers are practicing traditional farming system as well as integrated farming system. Primary data had been collected from a total number of 36 sample farm households, among which 18 farmers were following integrated farming system and the rest 18 were following the traditional one. 12 farmers were interviewed from each village in such a way that among them equal no of farmers (that is 6) were practicing IFS and the rest were following traditional farming.

Summary of data

Paddy was the main basic food crop grown there, both in rainfed and irrigated condition along with jute, khesari, mustard, banana and few flowers (marigold and tuberose). The major livestock components reared by IFS farmers were milch cows, goats and poultry (duck+hen) (Table 1).

The social and economical condition of sample respondents were demarcated as IFS and non-IFS farms (Table 2). The average age of the cultivators in this region was 54 years with a maximum of 25 years of farming experiences, educated up to class VIII and so. The region was dominated with marginal and small households with an average farm size of 1.11 hectare (1.25 hectare for IFS farm households and 0.97 hectare for the traditional farm households). Regarding average annual non-farm income of the family, non-IFS farms were exhibited higher income than IFS farms as they were mainly engaged in other concerns (like seasonal hired labourers) as they did not have much scope to exhibit income from their existing farming components. However, IFS farms have exhibited 57.75% higher income from crop and livestock sector as compared to non-IFS farms in this region (Table 2).

Regarding identification of predominant sub-farming systems in the context of farm typology of studied locations, two distinct blocks of Nadia District of West Bengal had shown different farming component arrangements where cereal and fibre based farming systems existed in Chakdah Block and horticulture based farming systems dominated in Krishnanagar-I block. Cereals+Fibre+Oilseeds/Pulses+Livestock+Poultry became the predominant farming components for Atilia and Kumarpur villages in Chakdah block while Fruits+Flower+Cereals+Oilseeds/Pulses+Livestock became the predominant farming components for Jalalkhali in Krishnanagar-I block (Table 3).

Empirical strategy

The log linear production function (Cobb-Douglas production function) was utilised in both situations to determine the contribution of technological and resource use variations from the total productivity difference. The production function is defined as per hectare basis as our goal was to compare productivity differences per hectare between two different farming systems.

$$Y = ax_1^{b1}x_2^{b2}x_3^{b3}x_4^{b4}x_5^{b5}x_6^{b6}\,X_7b^7\,x_8^{b8}ui \qquad ...1$$

Where,

Y is denoted as the system Rice equivalent yield (kg ha^{-1})

X_1 is denoted as the total quantity of seed used (kg ha^{-1})

X_2 is denoted as the total quantity of NPK used (kg ha^{-1})

X_3 is denoted as the total quantity of Organic Manure used (kg ha^{-1})

X_4 is denoted as the total hour of irrigation given (hour ha^{-1})

X_5 is denoted as the total quantity of plant protection chemicals used (gm ml^{-1} ha^{-1})

X_6 is denoted as the total hour of machine labour used (hour ha^{-1})

X_7 is denoted as the total hour of bullock labour used (pair hour ha^{-1})

X_8 is denoted as the total man-days of human labour used (man-days ha^{-1})

U_i is denoted as a random disturbance term in conformity with the ordinary least squares assumptions

B_i indicates a regression coefficient of respective parameters

A denotes a scale parameter or intercept.

It is important to find out the presence of a structural break in the production relations before proceeding with the decomposition analysis to estimate the difference in system productivity between IFS and conventional cultivators. To determine this, the output elasticities of IFS and traditional cultivators were calculated using the ordinary least square approach by fitting the log linear regression separately. The pooled regression analysis was used for both IFS and traditional farming practices, including a dummy variable for IFS farm households only. The value of dummy variable was set at 1 for IFS and 0 for the traditional cultivators.

$$\ln yifs_{imp} = \ln\beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 \ln x_4 + \beta_5 \ln x_5 + \beta_6 \ln x_6 + uifs_{imp} \quad ......2$$

$$\ln y_{trad} = \ln\alpha_0 + \alpha_1 \ln x_1 + \alpha_2 \ln x_2 + \alpha_3 \ln x_3 + \alpha_4 \ln x_4 + \alpha_5 \ln x_5 + \alpha_6 \ln x_6 + u_{trad} \quad ......3$$

$$\ln y_{pooled} = \ln \gamma_0 + \gamma_1 \ln x_1 + \gamma_2 \ln x_2 + \gamma_3 \ln x_3 + \gamma_4 \ln x_4 + \gamma_5 \ln x_5 + \gamma_6 \ln x_6 + \gamma_7 \ln x_7 + u_{pooled} \quad ......4$$

The multiple regression equations for IFS and traditional cultivators are represented by equations (2) and (3), respectively. Equation (4) represents the pooled regression model, which includes both traditional and IFS cultivators as well as a dummy variable (X7). As the region predominantly followed rice based cropping systems, the productivity of various crops is converted into the respective rice equivalent yield (REY).

SREY = Rice yield + [Crop (1) yield × {Price of crop (1)/ Price of Rice}] + [Crop (2) yield × {Price of crop (2)/ Price of Rice}] +..............................+ [Crop (n) yield × {Price of crop (1)/ Price of Rice}]

Analytical model

The ordinary least square (OLS) technique is used to estimate equations (2) and (3). Multi-collinearity was not an issue because the production function is taken as per unit area (hectare) basis, as evidenced by the zero-order correlation matrix. The following decomposition model was created by taking the difference between equations (2) and (3), doing minor algebraic manipulations, and rearranging some terms:

$$[\ln yifs - \ln ytrad] = [\ln b_0 - \ln a_0] + [\ln x_{1trad}(b_1 - a_1) + \ln x_{2trad}(b_2 - a_2) + \ln x_{3trad}(b_3 - a_3) + \ln x_{4trad}(b_4 - a_4) + \ln x_{5trad}(b_5 - a_5) + \ln x_{6trad}(b_6 - a_6)] + [b_1 \ln(x1ifs/x_{1trad}) + b_2 \ln(x2ifs/x_{2trad}) + b_3 \ln(x3ifs/x_{3trad}) + b_4 \ln(x4ifs/x_{4trad}) + b_5 \ln(x5ifs/x_{5trad}) + b_6 \ln(x6ifs/x_{6trad})] + [uifs - utrad] \quad ....5$$

The entire difference in system productivity of IFS farm households (represented as a percentage) over conventional cultivators is given on the left-hand side of the equation.

The gap responsible for the neutral component of technology is represented by the first bracketed term on the right-hand side, that is the difference between the natural logarithms of the constant terms.

The gap responsible for the non-neutral component of technology by input use of traditional cultivators is represented by the second bracketed term. The non-neutral technology gap is measured after adjusting the level of input use between two farming systems.

The gap responsible for the difference in input utilisation is represented by the third bracketed term, measured by the slope coefficient of the productivity function fitted for IFS farm families.

The random error term is the last component, which the model could not analyze (Bisaliah, 1977; Feder and O'Mara, 1981).

Overall regression analysis with F test was used to examine the differences between traditional and IFS farmers. If parameters are to be estimated from n data points then F statistic can be calculated as follows:

$$F = \frac{(RSS1 - RSS2)/(p2 - p1)}{(RSS2/n - p2)}$$

The residual sum of squares of model *i* is denoted by rss_i. rss_i needs to be replaced with χ^2, the weighted sum of squared residuals, if the regression model was constructed with weights. F will have a F distribution with (p2-p1, n-p2) degrees of freedom under the null hypothesis that model 2 does not provide a significantly better fit than model 1. The null hypothesis is rejected if the *F* calculated from the data is greater than the critical value of the *F*-distribution for some desired false-rejection probability (e.g. 0.05). The *F*-test is considered as Wald test.

To judge the variability explained by the different socio-economic attributes regarding farm households under IFS and non-IFS situation, Principal component analysis (PCA) has been performed. Eigen value greater than 1 followed by sufficient variability in proportion of the component has given priority under consideration.

Economic impact assessment of IFS

Economic impact of integrated farming system in lower Gangetic alluvial plain of West Bengal is performed with the help of multiple regression models. For both IFS and non-IFS situations, various system input parameters and REY were investigated to observe whether there are any major changes or not. To quantify the actual change in crop productivity on a hectare basis, the geometric mean level of various inputs and REY were calculated under both farming systems.

Geometric mean level of system input use and REY under IFS and non-IFS farms

The geometric mean level of various system input use and SREY among IFS and non-IFS farm households had been compared subsequently (Table 4). Barring

Table 1: Various crop and animal components identified among sample farm households

Items	
Crop components	*Kharif* Rice, *Boro* Rice, Mustard, Jute, Khesari, Marigold, Banana, Tuberose
Animal components	Cows, Goats, Poultry (Duck+Hen)

Table 2: Details of social and economical condition of sample farm households under IFS and non-IFS situations in Nadia district of West Bengal (India)

Parameters	Units	IFS households		Non-IFS households		Total farm households under IFS and non-IFS situations	
		Mean	SD	Mean	SD	Mean	SD
Farmer's age	Years	52	12.60	56	9.95	54	11.39
Sex/Gender	Code	1	0.00	1	0.00	1	0.00
Education	Code	3	0.64	3	0.57	3	0.62
Caste	Code	3	0.97	3	1.14	3	1.04
Cultivated own land	Hectare	1.14	0.55	0.97	0.42	1.05	0.49
Leased in land	Hectare	0.11	0.23	0.00	0.00	0.05	0.17
Leased out land	Hectare	0.00	0.00	0.01	0.06	0.01	0.04
Operational holding	Hectare	1.25	0.60	0.97	0.42	1.11	0.53
Non-farm income	annum^{-1}	25,333/-	50,223/-	63,333/-	99,705/-	44,333/-	80,156/-
Total valuation of assets (land, pond, dwelling house, farm machineries, animals etc.)	annum^{-1}	61,02,966/-	28,05,595/-	35,18,875/-	17,83,758/-	48,10,920/-	26,61,907/-
Total return from crops	annum^{-1}	1,53,066/-	1,35,494/-	1,14,094/-	84,286/-	1,33,580/-	1,12,952/-
Number of milch cow per family	Number	1	1	0.00	0.00	1	1
Number of poultry birds per family	Number	6	10	0.00	0.00	3	7
Number of goats per family	Number	1	4	0.00	0.00	1	3
Gross return from animals	annum^{-1}	26,926/-	25,038/-	0.00	0.00	13,463/-	22,157/-
Gross return from crop+animals	annum^{-1}	1,79,992/-	1,41,406/-	1,14,094/-	84,286/-	1,47,043/-	1,19,497/-
Total consumption expenditure	annum^{-1}	1,12,853/-	62,971/-	1,14,178/-	56,940/-	1,13,515/-	59,171/-

Note: SD: Standard deviation; IFS: Integrated farming system
Code to denote Sex/Gender: Male-1, Female-2
Education: Illiterate-1, Upto primary-2, High school-3, Graduate and above-4
Caste: Scheduled Caste-1, Scheduled Tribe-2, Other backward class-3, General-4, Others-5

quantity seed use, all other inputs have shown higher use (2.34% in NPK, 125.15% in organic manure, 8.99% in quantity irrigation hours, 2.42% in plant protection chemicals, 5.29% in machine labour hours, 13.97% in paired bullock labour hours and 4.95% in human labour use) under IFS as compared to traditional farms due to inclusion of more crop components. Moreover, a 14.97% increase in system productivity under IFS farm has been registered with respect to traditional farm households that could sustain the integrated farming systems in this region. Incorporation of crop and animal residues in the field and subsequent resource recycling would generate adequate system crop productivity as well as system net return to the IFS farm-families (Table 4).

Comparative economics of IFS and non-IFS farms in Nadia district of West Bengal

IFS farm-family with an average of 1.25 ha land following Crop+Livestock farming system, which has exhibited net income of Rs. 76,032/- per annum with a return-cost ratio of 1.60. Whereas, conventional non-IFS farm with an average of 0.97 ha land size has exhib-

Table 3: Identification of the most common sub-farm types under each farm type in the villages

Farming Systems	Sub-farming systems across villages Chakdah Block		Krishnanagr-I Block
	Atilia	**Kumarpur**	**Jalalkhali**
Cereal based	Cereals+Fibre+Livestock+Pulses Cereals+Poultry Cereals+Poultry+Goatery Cereals+Livestock+Fibre+Pulses Cereals+Livestock Cereals+Fibre+Pulses Cereals+Fibre+Oilseeds Cereals	Cereals+Fibre+Oilseeds+Livestock+Poultry Cereals+Fibre+Pulses+Livestock+Poultry+Oilseeds Cereals+Fibre+Poultry+Pulses+Oilseeds Cereals+Livestock Cereals Cereals+Fibre+Oilseeds Cereals+Fibre+Pulses+Oilseeds	
Fibre based	Fibre+Cereals+Pulses+Oilseeds Fibre+Cereals+Pulses	Fibre+Cereals+Poultry+Oilseeds	
Horticulture based			Fruits Fruits+Fibre+Cereals+Oilseeds Fruits+Livestocks Fruits+Livestocks+Fibre+Cereals+ Oilseeds+Poultry Fruits+Flowers+Livestocks Flowers+Fruits Flowers Flowers+Fruits+Cereals+Pulses
Goatery based	Goatery+Cereals+Fibre+Poultry+Oilseeds		

Table 4 : Geometric mean level of SREY and various input use under IFS and non-IFS farms in Nadia district of West Bengal (India)

Particulars	IFS farms	non-IFS farms	Relative change(%)
No. of observations	50	50	-
System quantity seed (kg ha^{-1})	91.67	95.78	-4.30
System quantity NPK (kg ha^{-1})	451.97	441.62	2.34
System quantity organic manure (q ha^{-1})	7.27	3.23	125.15
System irrigation (hour ha^{-1})	231.94	212.80	8.99
System quantity PPC (g ml^{-1} ha^{-1})	16202.95	15820.43	2.42
System machine labour (hour ha^{-1})	14.60	13.87	5.29
System bullock labour (pair hour ha^{-1})	4.53	3.97	13.97
System human labour (mandays ha^{-1})	293.53	279.68	4.95
SREY (kg ha^{-1})	12729.36	11071.93	14.97

Note: SREY: Systematic rice equivalent yield, IFS: Integrated farming system

Table 5: Comparative economics of IFS and non-IFS farms in Nadia district of West Bengal

Particulars	IFS farms	non-IFS farms	Overall
No. of observations	50	50	
Size of farm (hectare)	1.25±0.60	0.97±0.42	1.11±0.53
System Gross Return Crop (annum^{-1})	1,80,878±1,32,672	1,26,487±82,291	1,53,683±1,12,247
System Gross Return Livestock (annum^{-1})	26,926±25,038	0±0	13,463±22,157
System Gross Return Crop+Livestock (annum^{-1})	2,07,805±1,37,626	1,26,487±82,291	1,67,146±1,19,120
System Cost of Cultivation (annum^{-1})	1,31,773±72,040	95,370±39,538	1,13,571±60,173
System Net Return (annum^{-1})	76,032±81,907	31,117±55,655	53,575±72,675
System Return-Cost Ratio	1.60±0.38	1.30±0.45	1.45±0.44

Note: Mean±SD, IFS: Integrated farming system

Table 6: Regression estimates of various input coefficients for IFS and non-IFS farm households

Particulars	Parameters	IFS farm households	non-IFS farm households	Pooled
Number of farm households	N	50	50	100
Intercept	a	2.26^{NS}	1.02^{NS}	1.21^{NS}
System quantity seed (kgha^{-1})	X_1	-0.12^{NS}	0.03^{NS}	-0.03^{NS}
System quantity NPK (kgha^{-1})	X_2	0.16^{NS}	0.46^{NS}	0.36**
System quantity organic manure(qha^{-1})	X_3	-0.09^{NS}	0.02^{NS}	-0.05^{NS}
System irrigation (hour ha^{-1})	X_4	-0.29^{NS}	-0.35^{NS}	-0.01^{NS}
System quantity PPC (g ml^{-1} ha^{-1})	X_5	0.17^{NS}	0.07^{NS}	0.02^{NS}
System machine labour (hour ha^{-1})	X_6	0.91^{NS}	-0.01^{NS}	-0.03^{NS}
System bullock labour (pair hour ha^{-1})	X_7	-0.38*	-0.13^{NS}	-0.19**
System human labour (mandays ha^{-1})	X_8	0.88*	1.19***	1.12***
Dummy variable for pooled analysis				0.15**
Coefficient of multiple determination	R^2	0.97	0.98	0.97
Adjusted R square	R^2	0.94	0.96	0.95
F value (p = 0.05)	F	35.84	48.49	82.97
F critical (p = 0.05)	F	2.17	2.17	1.99

Note: * ** *** significant at p = 0.10, p = 0.05 and p = 0.01 respectively; NS: Non-significant; IFS: Integrated farming system

Table 7: Regression estimates of various input coefficients for IFS and non-IFS farm households

Particulars		Difference between IFS and non-IFS farms(%)
I)	Total difference in system productivity (kg ha^{-1}) between conservation and conventional practices	**14.97**
	1) Gap due to technology difference	18.68
	a) Neutral technological gap	123.76
	b) Non-neutral technological gap	-105.08
2)	Gap responsible for relative change in input use level weighted by the slope coefficient of productivity function	-4.73
	a) Contribution of seeds	0.53
	b) Contribution of NPK fertilizer	0.37
	c) Contribution of organic manure	-7.42
	d) Contribution of irrigation	-2.52
	e) Contribution of plant protection chemicals	0.42
	f) Contribution of machine labour	4.69
	g) Contribution of bullock labour	-5.03
	h) Contribution of human labour	4.23
II)	Total estimated difference in system productivity (kg ha^{-1}) between IFS and non-IFS farming situations	**13.95**
III)	Experimental Error	1.02

Note: IFS: Integrated farming system

Table 8: Variability of different socio-economic component for IFS and non-IFS farms

Socio-economic Attributes	Eigen value	Difference	Proportion (%)	Cumulative (%)
Age	174.795294	99.591364	0.3872	0.3872
Education	75.203930	23.306788	0.1666	0.5539
Cultivated own land	51.897142	7.156843	0.1150	0.6688
Operational holding	44.740299	8.508534	0.0991	0.7680
Crop Diversification Index	36.231765	10.820605	0.0803	0.8482
Total Assets	25.411159	8.627348	0.0563	0.9045
GR from Cereals	16.783811	5.273064	0.0372	0.9417
GR from Oilseeds	11.510747	2.781382	0.0255	0.9672
GR from Pulses	8.729365	3.881206	0.0193	0.9865
GR from Orchard	4.848159	3.995104	0.0107	0.9973
GR from Floriculture	0.853055	0.677711	0.0019	0.9992
GR from Fibre crops	0.175344	0.093190	0.0004	0.9996
GR from Livestock	0.082154	0.033629	0.0002	0.9997
GR from Poultry	0.048525	0.012180	0.0001	0.9999
GR from Goatery	0.036345	0.011995	0.0001	0.9999
Consumption Expenditure per annum	0.024350	0.018805	0.0001	1.0000
Non-farm income per annum	0.005544		0.0000	1.0000

Note: GR: Gross return, IFS: Integrated farming system

ited poor net return of Rs. 31,117/- with a return-cost ratio of 1.30 without animal component. Thus IFS farm have shown opportunity to enhance overall livelihood of the marginal and small farm-family which could sustain the socio-economic structure of the rural poor in this region (Table 5).

Comparative study on regression estimates of IFS and non-IFS farms

A significant difference between IFS and non-IFS farming practice has been found, as calculated value of F has been found to be more than its critical value and dummy coefficient is appeared to be significant at 5%

Table 9: Component scores of different socio-economic attributes for IFS and non-IFS farms

Attributes	PC 1	PC 2	PC3	PC 4	PC 5
Age	0.008	0.004	-.006	-.003	-.003
Education	-.003	0.001	0.008	0.002	-.006
Cultivated own land	0.006	0.001	0.031	-.026	-.011
Operational holding	0.016	0.002	0.024	0.000	0.012
Crop Diversification Index	-.027	-.007	-.008	0.011	-.022
Total Assets	0.000	0.016	0.035	0.014	-.011
GR from Cereals	0.461	-.212	-.024	0.017	-.109
GR from Oilseeds	0.358	0.392	-.038	0.217	0.391
GR from Pulses	0.245	0.111	0.319	-.629	0.018
GR from Orchard	-.443	0.271	0.218	0.114	0.452
GR from Floriculture	-.321	0.058	0.037	-.221	0.390
GR from Fibre crops	0.477	0.393	0.169	-.127	0.218
GR from Livestock	-.070	0.096	0.843	0.298	-.356
GR from Poultry	0.175	0.053	-.073	0.593	0.150
GR from Goatery	0.068	0.115	-.105	0.175	-.184
Consumption Expenditure per annum	-.003	0.029	-.013	-.003	0.000
Non-farm income per annum	-.177	0.729	-.300	-.083	-.497

Note: GR: Gross return, IFS: Integrated farming system

level. In order to detect the changes in input use and system productivity, it would be highly permissible to perform regression analysis of IFS and non-IFS farms individually. It has been revealed from the pooled analysis that human labour utilization and bullock labour use exert significant contribution to changes in system productivity while bullock labour use coefficients are appeared to be negative for both the farming activities and envisages negative impact on farming. Barring human labour utilization, non-IFS farming situation has featured non-significant effect of all inputs on system productivity. So, sustainable integrated farming systems feature efficient and optimum utilization of human labour. Inorganic fertilizer use has shown significant positive impact overall while it has no significant effect on IFS and non-IFS farms individually (Table 6).

Decomposition analysis of IFS and non-IFS farms

The estimated productivity change was to the tune of 13.95% in IFS over non-IFS farming situation while the actual change was found to be 14.97%. However, the estimated change in system productivity was divided into two categories: technological differences and subsequent changes in input utilization. The total change in system productivity was accorded to the technological change in farming situations while neutral technological gap attributes positive impact over non-neutral technological change (18.68%). The production function assumes constant return to scale regarding technological gap for the IFS farms. Also there was a negative impact of input substitution on IFS approach in this region (-4.73%). So, overall the system productivity gain in IFS farms features neutral technological gap that leads to subsequent change in intercept coefficients between two farming situations. The gap is due to the inherent fertility status of soil, crop and animal residue incorporation in field and resource recycling in IFS farms. So, change in the method of farming plays the major role to enhance system productivity for IFS farms rather than input substitution (Table 7).

Variability test of different socio-economic component for IFS and non-IFS farms

It has been observed that, first ten components out of seventeen have shown Eigen value greater than one, exhibiting almost cent percent cumulative variability (99.73%). Out of which, the first principal component has contributed 38.72% variability followed by component two with 16.66% variability, component three with 11.50% variability, component four with 9.91% variability and component five with 8.03% variability and so on. These five components have collectively exhibited 84.82% variability of the attributes. Thus, age of the farmers followed by their educational background and availability of land with extent of crop diversification became the major impact factors over technology adoption and farming perception under IFS in this region (Table 8).

Return from fibre crops followed by cereals have shown the highest component scores (0.477 and 0.461 respectively) in PC 1. However, Education, CDI, Gross return from Orchard, Floriculture, Livestock, Consumption Expenditure and also Non-Farm Income have shown significant negative impact in PC 1. Non-Farm income per annum has shown highest positive score in PC 2 followed by Gross return from fibre crops and oilseeds (0.729, 0.393 and 0.392 respectively), however return from Cereals (-0.212) has shown significant negative impact on PC 2. Return from Livestock has shown highest impact score on PC 3 followed by return from pulses and orchard (0.843, 0.319 and 0.218 respectively). Return from pulses (-0.629) has shown the highest significant negative impact in PC 4 while return from poultry (0.593) has shown highest significant positive impact. Return from orchard (0.452) has become the highest positive score for PC 5 followed by oilseeds and floriculture (0.391 and 0.390) while Non-farm income per annum (-0.497) followed by return from dairy livestock (-0.356) has exerted significant negative score in PC 5 (Table 9).

CONCLUSION

The study's overall goal was to look at the influence of integrated farming system on a group of farm households in our mentioned study area. Crop along with livestock, poultry, goatery have exhibited sufficient income enhancement to the farm-family under IFS, whereas the non-IFS farms have shown traditional way of cultivation practices over the years with less return as the cost of cultivation for crops are rising day by day. Improper use of farm inputs, machineries followed by lack of education and knowledge gaining could be the major obstacles behind the adoption of technology while integrated farming systems has shown the better opportunity to enhance and upgrade the overall livelihood of the farming sector. The results have shown 14.97% increase in system productivity whereas the estimated productivity change was recorded as 13.95%. Technology difference between IFS and non-IFS farms has played the major role while the difference responsible for the change in input use has shown significantly negative impact on overall productivity change. So, the improved way of crop cultivation and animal rearing would be the prime factor behind the overall gain in productivity in this region as well.

REFERENCES

Bisaliah, S. 1977. Decomposition analysis of output change under new production technology in wheat farming: Some implications to returns to investment. *Indian J. Agric. Eco.,* **32**(3): 193-201.

CARDI- A Manual on Integrated Farming System. 2010. Caribbean Agricultural Research and Development Institute, (Ministry of Economic Development, Belize). pp 1- 58.

Cirera, X. and Masset, E. 2010. Income distribution trends and future food demand. *Philosophical Transactions of the Royal Society B: Biological Sciences,* **365**(1554): 2821- 2834.

Edwards, C. A. 1989. The importance of integration in sustainable agricultural systems. *Agric., Ecosys. Environ.,* **27**(1-4): 25-35.

Food and Agriculture Organization. 1977. China: Recycling of Organic Wastes in Agriculture. FAO Soils Bulletin 40. FAO. United Nations. Rome. pp 107.

Feder, G. and O' Mara, G. T. 1981. Farm size and the diffusion of green revolution technology. *Eco. Dev.Cultural Change,* **30**(1):59-76.

Pretty, J. 1997. The sustainable intensification of agriculture. *Natural Resources Forum*, **21**(4):247-256.

Prein, M. and Ahmed, M. 2000. Integration of aquaculture into smallholder farming systems for improved food security and household nutrition. *Food Nutri. Bull.*, **21**(4): 466-471.

The Royal Society. 2009. Reaping the Benefits: Science and the Sustainable Intensification of Global Agriculture. The Royal Society, London.

Tipraqsa, P., Craswell, E. T., Noble, A. D. and Schmidt-Vogt, D. 2007. Resource integration for multiple benefits: multifunctionality of integrated farming systems in Northeast Thailand. *Agric. Systems*, **94**(3): 694-703.