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Economics of Farming Systems in Uttar Pradesh

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Abstract

Farming systems of households in the western Uttar Pradesh have been analyzed based on the primary data collected through a sample of 197 farmers in 2004-05. The sugarcane-based farming system has been found predominant in the study area. Livestock, vegetables, cereals and sugarcane have been observed to be the main sources of farm income. The study has indicated that cross-bred breeding programme has not become popular due to low demand for milk of cross-bred cows. Credit has significant impact on farm income and credit requirement of about 86 per cent farmers is met by the institutional sources. Fragmentations and sub-divisions of landholdings, scarcity of labour, low yield of crops, less reliable markets, scarcity of owned-fund, depleting natural resources, non-availability of good quality seeds and sheds for poultry, etc. have been identified as the major constraints to promote integrated farming system in this area.

Introduction

With rising population, declining land-man ratio and increasing mechanization in farm operations, agriculture alone is not able to provide adequate income and employment to households in India. Integration of farm enterprises provides better livelihood in terms of increased food production, higher net income, improved productivity, and reduced income imbalance between agricultural labourer and urban factory worker. Introduction of appropriate farming systems has been proposed as one of the approaches to achieve better growth in agriculture and livelihood (National Commission on Farmers, 2005). Increase in non-farm employment has also become essential for improving income and living standard of rural population (Chadha, 1993; and Kumar *et al.*, 2003). Sugarcane-wheat is the major cropping system, covering about 30 per cent

area in the western Uttar Pradesh. Other farming activities may comprise any one or combination of mono or multiple cropping; horticultural crops, agro-forestry, livestock poultry, fishery, goat/sheep-rearing, etc. In the present study, resource productivity of crop and non-crop enterprises in different farming systems has been analysed and constraints to higher returns in these farming systems have been identified.

Methodology

Since the productivity varies widely in the districts of western Uttar Pradesh, one district each representing low and high productivities was selected for providing the real average picture in the region. Bagpat as a high productivity and Gaziabad as a low productivity district were selected for the study in western plains of Uttar Pradesh. The data for the year 2004-2005 were collected from two blocks in each district and three villages from each block were identified using three-stage random sampling. For the selection of households, different strata were drawn based on the prevailing farm enterprises. About 10-15 per cent households covering marginal (63), small

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(66), medium (44), and large (24) farmers were selected randomly for the questionnaire-based interview for survey. Farming systems were identified based on the major contribution to income of farm enterprises.

Farm business income was computed by deducting from the gross returns the cost incurred on seeds, fertilizer, plant protection chemicals, hired human labour, farm machinery and implements, taxes, cess, water charges interest on working capital and expenditure on livestock maintenance such as feed and fodder, mineral mixture, medicine and depreciation of owned farm machinery, buildings and animals.

To analyze the resource productivities of different farming systems for improving the economic conditions of the farmers and to measure the contribution of specific factor in combination with other factors which are responsible for the change in the level of output, multiple regression analysis was used. The Cobb- Douglas production function in form of Equation (1) was fitted to the data:

$$Y_i = b_0 x_1^{b_1} x_2^{b_2} x_3^{b_3} x_4^{b_4} x_5^{b_5} x_6^{b_6} u_i \quad \dots(1)$$

where, Y = Gross farm income (Rs), X_1 = Area under sugarcane in ha (ASC), X_2 = Area under other crops in ha (AOTH), X_3 = No. of dairy animals/ farm (DA), X_4 = No. of mandays / year (EMP), X_5 = Household expenditure on fertilizer and chemicals in Rs (F&CH), X_6 = Household institutional credit availed in Rs (IC), $i = 1, 2, 3, \dots, n$ farms, b_0 = Constant and u_i = Random variable

The Cobb-Douglas type function was used in this study since the elasticity coefficients were free from the unit of measurement, computational ease and theoretical fitness to the agriculture data. The function was estimated using the ordinary least square method. In this study we measured gross income, expenditure on fertilizer and chemicals, off-farm income, institutional credit in monetary units, labour employed, number of dairy animals in physical units, and cropping intensity in percentage. Zero order correlation matrix for each case was computed to check the multicollinearity among the independent variables. Multicollinearity was

considered high if the value of 'r' was more than 0.8 (Heady and Dillon, 1961).

Constraints Analysis

For constraint analysis, each sample farmer was asked to assign a score to each constraint as per the order of importance on the scale of 0-10, which meant no constraint and most severe constraint, respectively.

Results and Discussion

Socio-economic Characteristics of Households

The study has revealed that 71 per cent farmers were following sugarcane-based farming systems, followed by livestock-based farming systems (19% percent farmers) (Table 1). Farmers were earning 51 per cent of their income from livestock in the livestock-based farming system, 36 per cent income from vegetables in vegetable-based farming system, 58 per cent income from cereals in cereal-based farming system and 58 per cent income from sugarcane in sugarcane-based farming system. The family composition indicated that family-size was largest (9.19) on sugarcane-based farming system, followed by cereal-based farming system (8.73). The occupational analysis has shown that about 55 per cent males and females were unpaid agricultural labourers, while about 32 per cent were dependents. No member in these households was found technically qualified, i.e. engineering, medical, law, computer or management graduate in the sample. Most of the family members had attained ordinary education. Educational index has been found lower in the vegetable-based farming system than in other systems. It was highest in the sugarcane-based farming system. The total operated area varied from 0.71 ha for marginal farmers to 4.80 ha for large farmers. The average size of holding was found to be 1.84 ha for all farmers.

As per survey data, livestock was the major component of the existing farming system. The livestock population varied from 1.66/ha in the sugarcane-based farming systems to 6.44/ha in the livestock-based farming system. Farming system-wise combination of dairy buffaloes varied from

Table 1. Socio- economic characters of sample farmers in western plains of Uttar Pradesh

Particulars	Livestock- based farming system	Vegetables- based farming system	Cereal- based farming system	Sugarcane- based farming system	All farming systems
Sample size	38 (19.29)	8 (4.06)	11 (5.58)	140 (71.07)	197 (100.0)
Gross income, %	51.12	36.83	57.55	58.01	100.00
Family size, No.	6.5	7.00	8.73	9.19	8.64
Educational index*	7.32	6.32	6.80	8.24	7.91
Family labour engaged in agriculture / farm, No.	3.47	3.50	3.27	5.69	4.76
Employment, mandays /year	243	572	299	477	404
Farm size, ha	0.75	2.08	1.33	2.16	1.84
Cropping intensity, %	180	218	183	163	168
Total agricultural credit availability, Rs/ ha	8561	9613	12215	9122	9207
Institutional credit, Rs/ ha	5875	9613	767	8372	7901
Non-institutional credit, Rs/ ha	2686	0.00	4545	750	1305
Kisan credit card, No.	4	2	2	30	38
Deshi cows, No. /ha	0.23	0.19	0.24	0.10	0.12
Cross-bred cows, No. /ha	1.10	0.45	0.80	0.19	0.29
Dairy buffaloes, No. /ha	2.77	1.91	1.37	0.68	0.91
Other animals **, No. /ha	2.33	1.53	1.04	0.69	0.85
Total animals, No. /ha	6.44	4.08	3.46	1.66	2.17
Off-farm income, Rs	40236	41187	46400	78186	69635

Notes: Figures within the parentheses are percentages to total, * Education index = $\sum w_i f_i / \sum f_i$, $i = 0, 1, 2, 3, \dots, 6$.

Education attained, i.e. Illiterate=0, Primary=1, Middle=2, Matric= 3, Twelfth = 4 Graduate=5, and Post-graduate=6, w_i = weights (0 to 6) and f_i = No. of family members

**Calves and draught animals

0.68/ha on sugarcane-based farming systems to 2.77/ha on livestock-based farming system As regards the combination of cross-bred cows in the farming system, it was found that cross-bred breeding programme has not made any marked headway in the area. The cropping intensity was highest in the vegetable-based farming systems (218 %) and lowest in the sugarcane-based farming system (163 %).

The farming system-wise analysis of agricultural credit has shown that the cereal-based farmers had borrowed the highest credit (Rs 12216/ ha), while the livestock-based farmers had borrowed the least (Rs 8561/ha) credit. The credit was mostly utilized towards crop cultivation, followed by purchase of agricultural machinery. Only about 19 per cent farmers were holders of Kishan Credit Cards

(KCCs), which should be a matter of serious concern to bankers and policymakers. The vegetable-based farming system provided the highest employment (572 mandays/year), followed by sugarcane-based farming system (447 mandays/ year). The employment was lowest in the livestock-based farming system (243 mandays/ year). On the average, a farmer household got employment only for 404 mandays/ year/farm.

Area under Different Crops across Farming Systems

Sugarcane-wheat has been found the major cropping system in the area. Sugarcane and wheat covered about 84 per cent of the cropped area in the western plains of U.P. (Table 2). It was also observed

Table 2. Farm-size-wise percentage area under different crops and cropping intensity under different farming systems

Name of crop	Farm size				All farms
	Marginal	Small	Medium	Large	
Livestock-based farming system					
Vegetables	3.59	7.89	0.34	0	3.63
Cereals	42.54	30.52	32.2	0	38.90
Fodder	33.22	28.94	17.45	0	29.71
Sugarcane	15.32	27.36	43.22	0	22.28
Others	5.14	5.25	6.77	0	5.47
Gross cropped area (ha)	1.14	1.90	2.36	0	1.35
Cropping intensity (%)	196.55	155.00	149.37	0	180.00
Vegetable-based farming system					
Vegetables	29.49	20.54	23.81	11.29	21.29
Cereals	42.10	34.96	23.81	24.19	34.47
Fodder	14.74	27.57	9.52	40.32	25.79
Sugarcane	13.68	15.14	42.86	16.13	16.25
Others	0.00	1.8	0.00	8.07	2.20
Gross cropped area (ha)	3.80	5.55	1.68	4.96	4.56
Cropping intensity (%)	275.36	256.94	195.35	112.73	218.99
Cereals-based farming system					
Cereals	74.24	75.06	0	0	75.55
Fodder	17.55	15.25	0	0	16.1
Sugarcane	0	4.69	0	0	2.98
Others	8.20	3.76	0	0	5.37
Gross cropped area (ha)	2.45	2.43	0	0	2.44
Cropping intensity (%)	196.08	1.77.69	0	0	183.49
Sugarcane-based farming system					
Vegetables	3.27	4.29	2.79	2.77	3.2
Cereals	31.19	27.41	26.32	27.6	27.42
Fodder	17.40	16.76	14.89	12.96	14.88
Sugarcane	48.15	50.28	53.89	54.23	52.66
Others	0	1.26	2.10	2.45	1.85
Gross cropped area (ha)	1.36	2.49	4.04	7.54	3.53
Cropping intensity (%)	186.71	169.14	161.48	156.49	163.53
All farming systems					
Vegetables	5.29	6.09	2.86	2.98	4.19
Cereals	41.33	33.31	26.63	27.51	30.92
Fodder	23.32	18.53	14.98	13.72	16.83
Sugarcane	27.17	40.31	53.18	53.17	45.74
Others	2.9	1.76	2.35	2.60	2.33
Gross cropped area (ha)	1.4	2.63	3.83	7.44	3.09
Cropping intensity (%)	197.5	177.77	160.96	154.9	168.00

Note: The sum of areas under vegetables, cereals, fodder, sugarcane and others is 100 per cent

that as farm-size increased, the area under wheat (cereals) decreased and area under sugarcane increased. It indicated that marginal and small farmers were more dependent on the wheat crop due to their food security. Medium and large farmers were

more interested in growing sugarcane, it being a cash crop.

As regards to the farming system, livestock-based farmers were putting their maximum (21 %) area under fodder crops, while cereal- and

sugarcane-based a farmers had about 11 per cent area under fodder. The analysis has indicated that farmers were growing need-based crops on their farms. A sugarcane plant crop and one ratoon was the most common practice. Most of the farmers were growing wheat after harvesting sugarcane ratoon crop, and after wheat they were growing sugarcane

The most common mixed cropping combination was wheat and mustard, practised by almost all the farmers of the area. These traditional practices provide oil, and meet the fodder/vegetable needs of the households in the form of bonus crops.

Farmers with medium and large holdings are more likely to grow sugarcane. Farmers with smallholdings put less proportion of area under sugarcane due to their food security. Sugarcane market in this part of Uttar Pradesh is well developed with 5 sugar mills and 5 *gur mandies*. The main reasons for its popularity are that sugarcane is a hardy

crop, it can tolerate more / less water and delay in harvesting and there is a lower risk from wild animals. There are no labour problems in its sowing and harvesting, as sugarcane crop is less labour-intensive.

Vegetable crops like *kheera*, green pea, cauliflower, onion, *bhindi*, pumpkin, radish, spinach, brinjal, luffa, and potato were found to be grown on 3.59 per cent area in the western plains. The government may encourage the farmers towards cultivation of these crops, which provide higher returns and employment. The cropping intensity analysis has indicated that as farm-size increased, the cropping intensity decreased.

Cost on Crop Production

In general, the average cost of production was found to be Rs 20122/ha (Table 3). It was highest (Rs 21259/ha) on sugarcane-based farming system,

Table 3. Annual input cost under different farming systems in western plains of U.P.

Particulars	(Rs/ ha)				
	Livestock-based farming system	Vegetable-based farming system	Cereal-based farming system	Sugarcane-based farming system	All farming systems
Cost on crop production					
Seed	2526	4251	1081	4286	3999
Fertilizer	2563	2025	1645	3547	3292
Plant protection	101	112	9	279	243
Irrigation charges	1567	1807	1310	1493	1509
Labour	3903	4228	3601	4085	4057
Machinery	3713	3682	2980	4117	4008
Transport/MC	1482	1214	213	3451	3014
Gross cost	15855	17320	10838	21259	20122
Gross income	37221	63678	30507	45911	45384
Livestock maintenance					
Concentrate	8573	4180	4078	1808	2482
Dry fodder	2101	1614	1101	591	763
Sugarcane top	1208	690	617	321	413
Green fodder	2839	2475	2319	778	1051
Mineral mixture	2193	1103	1483	297	510
Labour	5379	2924	2940	1379	1794
Medicine	907	644	727	238	321
Gross cost	23200	13631	13267	5413	7334
Gross income	29030	17983	14068	7131	9631
Overall cost	39055	30951	24105	26672	27456
Gross farm income	66251	81661	44575	53042	55015

followed by vegetable-based farming system. The labour cost was found highest in vegetable-based farming system (Rs 4228/ha), followed by sugarcane-based farming system (Rs 4085/ha). Expenditure on seed was highest on the sugarcane-based farming system (Rs 4286/ha), followed by vegetable-based farming system (Rs 4251/ha). Expenditure on machinery was also found the highest on the sugarcane-based farming system (Rs 4117/ha), followed by livestock based farming system (Rs 3903/ha).

The above analysis indicates that labour-use, machinery, seed, fertilizer and marketing cost were the major components of crop production and constituted about 92 per cent of total cost. It is worth mentioning that expenditure on crop protection was found negligible. It means that farmers of western U.P. were not applying insecticides / pesticides in their crops.

Cost of Livestock Maintenance

The per hectare cost of livestock maintenance was found maximum on the livestock-based farming system (Rs 23200/ha), followed by vegetable farming system (Rs 13630/ha). Expenditure on concentrate and labour components constituted about 60 per cent of the cost of livestock maintenance. Sugarcane top constituted only about 5 per cent of the cost of maintenance.

It was found that the vegetable-based farming system provided highest income (Rs 81661/ha) and the cereal-based farming system had the lowest income (Rs 44575/ha).

Source of Farm Family Income

The contribution of different sources towards farm-family income for different farming systems has been shown in Table 4. On an average, households in the region received Rs 170863/farm as farm-family income out of which 48.87 per cent was from crops, followed by non-farm income (salary and wages) (39.35%). Farming system-wise analysis has indicated that crops contributed a major share to farm-family income in vegetable- and sugarcane-based farming systems, while non-farm sources contributed the major income in livestock- and cereal-based farming systems. The share of livestock was recorded highest (24%) in livestock-based farming system and lowest (about 8 %) in sugarcane-based farming system. In the sugarcane-based farming system, the farmers were found earning lower income in absolute as well as percentage terms from livestock. On this basis, the hypothesis that farmers grow sugarcane for their fodder requirement for animals was rejected. The family labour was often surplus on marginal holdings, necessitating them to supplement their income by working out side the farms.

Table 4. Source of family income in different farming system in western U.P.

Farming system	(Rs / farm)			
	Crops	Livestock	Non-farm income*	Total
Livestock-based farming systems	27916 (31.04)	21773 (24.21)	40237 (44.75)	89926 (100)
Vegetable-based farming systems	132451 (62.76)	37406 (17.72)	41188 (19.51)	211045 (100)
Cereal-based farming systems	40575 (38.39)	18711 (17.70)	46400 (43.90)	105686 (100)
Sugarcane-based farming systems	99169 (50.69)	15403 (7.87)	81065 (41.43)	195637 (100)
All farming systems	83507 (48.87)	17722 (10.37)	69634 (40.76)	170863 (100)

Notes: The figures within the parentheses are percentages to total. * It included miscellaneous incomes like, sale of family assets, gift received in cash or kind, etc.

Table 5. Per capita and per earner farm business income and farm family income in different farming systems in western plains of U.P.

Farming systems	(Rs / year)			
	Farm-business income		Farm -family income	
	Per capita	Per earner engaged in agriculture	Per capita	Per earner
Livestock-based farming system	7644	14320	13835	19422
Vegetable-based farming system	24265	48531	30149	51100
Cereal-based farming system	6791	18130	12106	25840
Sugarcane-based farming system	12467	20136	21288	28436
All farming systems	11716	21267	19776	28911

Per Capita and Per Earner Total Family Income

A perusal of Table 5 revealed that in general an earner engaged in agriculture earned Rs 21266 as farm business income in the study zone. Farming system-wise analysis has shown that farm business income ranged from Rs 14319 for live stock-based to Rs 48530/- for vegetable-based farming systems. The farm business income analysis has indicated that a farmer of western U.P., which is known as the prosperous zone of U.P. state, was behind a Punjab farmer (Rs 74080) in the year 2002-03 (Joshi *et al.*, 2004). However, the per capita total family income in all the farming systems was found to be higher than the poverty estimates (Rs. $365.84 \times 12=4390$) (Economic Survey, 2004-05). But, the per capita income was not sufficient for livelihood security, which means secured ownership of, or access to, resources and income-earning activities, including resources and assets to offset risks, ease shocks and meet contingencies (Acharya, 2006).

Resource Productivities of Major Farming Systems

The OLS estimates of Cobb Douglas production function with respect to different farming systems have been presented in Table 6. The elasticity coefficient was found highly significant for area under sugarcane (ASC) for the livestock- and sugarcane-based farming systems. Area under other crops included area under cereals, pulses, oilseeds, vegetables, fruits and spices. The elasticity coefficients were found highly significant in all the systems. The elasticity of production indicated that one per cent increase in area under other crops

(AOTH) increased gross income ranging from 0.235 per cent, in the case of sugarcane-based farming system, to 0.331 per cent for the livestock-based farming system. Dairy animals included milch cow *desi* and crossbred, buffalo and other animals. The elasticity coefficients for the livestock- and sugarcane-based farming systems were found significant, indicating that 1 per cent increase in the dairy animals increased gross income by 0.428 per cent in the livestock- and 0.192 in the sugarcane-based farming systems. The negative and insignificant coefficient for human labour in the livestock-based farming system indicated that it did not contribute significantly to the output of this farming system. The regression coefficient of fertilizer and chemicals was insignificant in the sugarcane-based farming system, indicating little impact of this input. The elasticity coefficient for livestock-based farming system was positive, indicating that farmers practising this system were getting positive response for the input. The regression coefficient of institutional credit in the different farming systems was found significant, except for the livestock-based farming system.

Constraints to Higher Return in Farming Systems

A number of factors were found to influence the returns from farming systems in the study area. These included fragmentation and subdivision of landholdings, scarcity of family labour on medium and large farms, low yield of crops, less reliable markets, scarcity of owned-fund, dependence on depleting natural resources, global warming, non-

Table 6. Farming system-wise regression results for different farming systems in western plains of U.P.

Farming system	Sample size	Constant	Regression coefficient of					R ² -adj	
			Area under sugarcane	Area under other crops	Dairy animals	Labour employed	Fertilizer & chemicals		Institutional credit
Livestock	38	0.721 (13.05)	***0.100 (0.014)	***0.331 (0.046)	***0.428 (0.076)	-0.048 (0.123)	0.051 (0.058)	*0.196 (0.085)	0.94
Sugarcane	140	0.4 (27.01)	***0.550 (0.036)	***0.235 (0.019)	***0.192 (0.020)	**0.137 (0.042)	-0.056 (0.033)	0.039 (0.036)	0.97

Notes: Figures within the parentheses are standard errors of respective variables

*** Significant at .01 per cent level, ** Significant at one per cent level, and * Significant at five per cent level

Table 7. Constraints to higher returns in farming systems in western plains of U.P.

Particulars	Score out of 10 points				
	Livestock-based farming system	Vegetables-based farming system	Cereal-based farming system	Sugarcane-based farming system	All farming systems
Fragmentations and sub-divisions of landholdings	8	9	6	7	8
Scarcity of family labour	7	8	7	7	7
Low yield of local seed	8	7	6	6	7
Less reliable markets	6	6	5	5	7
Scarcity of owned-fund	8	9	8	8	7
Exogenous factors	6	6	5	5	7
Non-availability of good quality seeds	7	8	6	6	7
Lack of suitable poultry house/ cattle shed	9	5	5	5	6
Lack of transportation and marketing facilities	5	5	5	5	8
Lack of know-how	5	5	5	6	7
Lower risk-taking capacity	5	6	5	5	7

Note: Score out of 10 (10, most severe constraint, 0, no constraint)

availability of good quality seeds (variety and breeds), sheds for animals, poultry, etc. (Table7).

Conclusions and Policy Implications

The occupational analysis has shown that about 55 per cent males and females are the unpaid agricultural labourers. The educational index has been found highest for the sugarcane-based farming system but no one is professionally educated. The study has revealed that cows and buffaloes, irrespective of their breeds and productivity, are the integral parts of all the farming systems. Vegetables-based farming system provides the maximum employment. The cost analysis has indicated that

labour-use, machinery, seed, fertilizer and marketing cost are the major components of crop production. It has been observed from the farm business income analysis that a farmer of western U.P. is far behind his counterpart in Punjab.

The resource productivity analysis has indicated that area under sugarcane, area under other crops, number of dairy animals, and institutional credit are positively and significantly related with the gross income of sample households. The farmers have been found using excessive fertilizers and chemicals in the vegetable-, cereal- and sugarcane-based farming systems. Fragmentations and sub-divisions of landholdings, scarcity of labour, low yield of crops, less

reliable markets, scarcity of owned-fund, dependence on depleting natural resources, non-availability of good quality seeds (variety and breeds) and sheds for animals, poultry, etc. have been identified as the major constraints to higher returns to the farming systems. The wild animals like wild pig, blue bulls, insects and diseases are the major bio-physical constraints. Marketing is a major socio-economic constraint for diversification of farming system towards vegetables, fisheries, piggery, poultry, etc. A majority of farmers rear dairy animals to get milk for either home consumption or income enhancement. Generally, farmers are not able to avail agricultural credit facilities to diversify their farm business. There should be a higher emphasis on credit supply to the farmers for farm diversification.

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