SUBJECT II
SOCIO-ECOLOGICAL TRANSITIONS IN THE ADIVASI LANDSCAPE

Economic Analysis of Farming System of Apatani Farming Community in Arunachal Pradesh - A Way Forward for Sustainability

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ABSTRACT

Farming system has immense potential for the improvement of rural economy. Farming system approach is essential to achieve better growth in agriculture and livelihood. An attempt has been made to study the economic aspects of farming systems, along with resource productivity analysis of different farming systems and its constraints in Apatani farming community of Arunachal Pradesh. For the purpose a total sample of 120 Apatani farmers from four villages namely; Hari, Hija, Hong and Bulla of Ziro valley of Lower Subansiri district of Arunachal Pradesh were selected through purposive and random sampling methods using well-structured interview schedule. It was observed that the elasticity of coefficient of manures, fertilisers and agro chemicals was negative and insignificant in fishery based FS. The study revealed that the value of adjusted coefficient of multiple determination (R^2) is very high explaining 96 per cent of the variations in cereal based FS by the explanatory variables included in the regression analysis. Efforts should be made towards appraising the Apatani farmers of appropriate techniques and application of modern inputs for better production in different farming systems. There is a need of strong policy support for promoting farming system with easier credit flow, subsidy and agricultural insurance, market linkage with establishments of village cluster development programme in the study area.

Keywords: Farming system, Resource productivity, Apatani farming community, Arunachal Pradesh

JEL: Q13, Q16, Q22, Q23

I

INTRODUCTION

Farming system approach is essential to achieve better growth in agriculture and livelihood. Integration of farm enterprises provides better livelihood in terms of increased food production, higher net income and improved productivity (Singh *et. al.*, 2009). Farming system emphasised on rational utilisation of land, water, biodiversity, genotypes along with social and human resources combined with best available technologies and ecological management practices for sustaining farming for improving livelihood security of Apatanis in Arunachal Pradesh. It represents the integration of agricultural enterprises such as cropping systems, livestock, aquaculture, agroforestry, agri-horticulture and apiary in an optimum combination. This system has immense potential for improvement of rural economy due to intensification and integration of crop and allied enterprises. Declining the size of land holding and diversion of agricultural lands for other uses poses a serious

challenge to Indian agriculture in terms of food and livelihood. With this continued trend the average size of holdings is expected to further decline to 0.32 ha by 2030 (Government of India, 2014). With the limited scope for horizontal expansion, vertical expansion of agriculture is the ultimate way for ensuring food and livelihood security (Nayak *et al.,* 2020). However, the per capita income was not sufficient for livelihood security, which means secured ownership of or acees to resources and income earning activities (Acharya, 2006). In this context, adoption of farming system approach is one of the important solutions for steady growth in output and sustainable development through undertaking different enterprises based on the available resources and location-specific systems (Torane *et al*., 2011).

Farming system is defined as a complex inter-related matrix of soil, plants, animals, implements, power, labour capital and other inputs controlled in part by the farming families and influenced to varying degrees by political, economic, institutional and social forces that operate at many levels. The farming system therefore, refers to the farm as an entity of inter-dependent farming enterprises carried out on the farm. Thus basically it is an integrated set of activities that farmers perform in their farms under their resources and circumstances to maximize the productivity and net farm income on a sustainable basis (Singh and Ratan, 2009). The farming system takes into account the components of soil, water, crops, livestock, labour, capital, energy and other resources, with the farm family at the centre managing agriculture and related activities (Behera and France, 2016). Farming system is built on the principles of productivity, profitability, stability and sustainability. All the components are complimentary and supplementary to each other and the development process involves the participation of rural communities (Apatanis). The farming system assumes great importance for the sound management of farm resources to enhance farm productivity, reduce the degradation of environmental quality and improve the quality of life of farmers and above all to maintain sustainability in farm production and productivity.

Apatani is one of the most primitive tribes of Arunachal Pradesh, concentrated in a hilly plateau of Lower Subansiri district called 'Apatani Plateau' located at 27º30´-27º40´N latitude and 93º57´ and 94º12´E longitude and mean sea level of 5000 ft . Rice being the staple food of Apatanis, paddy cultivation of settled type agriculture is practiced, in which fish and finger millets are integrated for higher economic return and judicious utilisation of land pattern system. (Tayo *et al.,* 2017). Among all tribes, Apatani tribe is widely popular for its unique land use pattern and natural resource management practices. There are 35 villages with a population of around 80,000 in Ziro valley (Government of India, 2014). The Apatanis, one of the major ethnic groups of the eastern Himalayas, practise a distinctive form of agriculture where rice and fish are grown together. These farmers have been practising integrated rice-fish farming in their mountain terraces of Arunachal Pradesh since the 1960s. The potential areas of rice-fish culture in the Apatani plateau are Napping, Yachuli, Ziro-II, Palin and Koloriang. Apatanis principally use

three rice varieties: Emeo, Pyape and Mypia. The total area of the Apatani Plateau is 10,135 square kilometres, where rice-fish culture is undertaken approximately in 592.0 hectares (ha) of irrigated rice land out of 715.7 ha. Apatani Plateau is a land of diverse cultures. The major festivals of Apatanis are the Myoko, Dree, Yapung and Murung. People here believe that these traditional festivals ensure better productivity and well-being. The study area has a climate ranging from humid sub-tropical to temperate. So, this plateau receives adequate rainfall during the summer season. The permeability and water-retention capacity of the clayey, loamy soil favour this unique farming technique. The Apatanis have a distinct socio-cultural fabric with systematic land-use practices and rich traditional ecological knowledge of natural resources management and conservation. The Apatanis with a highly developed valley cultivation of rice perfected over centuries has often been suggested to be one of the relatively advanced tribal societies in the north-eastern region of India. Apatani village ecosystem is a good example of economic self-sufficiency of a traditional agricultural society that practices ecologically sound sedentary agriculture in the north-eastern hill region of India. Indigenous farming system of Apatani community provides high economic returns of hill agro-ecosystem (Rai, 2005).

The Apatani communities are known for their judicious utilisation of limited land area that evolved over century old experimentation. There are separate areas for human settlement, wet land rice-fish cultivation, dry cultivation, community burial grounds, pine and bamboo gardens, private plantations and community forests (Amarendra *et.al,* 2017). The Apatanis, one of the major ethnic groups of eastern Himalayas, have a distinct civilisation with systematic land use practices and rich traditional ecological knowledge of natural resources management and conservation, acquired over the centuries through informal experimentation. The tribe is known for their colorful culture with various festivals, intricate handloom designs, skills in cane and bamboo crafts, and vibrant traditional village councils (UNESCO,2014)**.** These tribes practiced different farming system that evolved major socio-economic issues to meet food demand, food security, utilisation of resources and its management, water management, community participation and sustainability. Practices of agro-forestry in Ziro valley with definite areas as grazing ground, sacred groves, plantations areas, etc. have helped in optimal utilisation of limited land to produce various resources while sustaining agriculture with improved yields. Such traditional ecological knowledge has special value in today's world. The method of agriculture of the Apatani is scientific and systematic. The water for paddy fields is supplied by the construction of a canal system connecting from the Kiile (River). In case of the distant paddy fields from the canal system, water is supplied from the attached fields which are connected to other fields through Siicho (draining pipe) which drained water during the fishing or drying up of the field, to supply water to next field and also when there is an overflow of water. There is a common canal system which is

connected from forest water, these canals are maintained yearly by all the paddy field owners annually in each village or location (Hana, 2019).

Land is inherited or purchased but most of them do not have formal documentation. The land within the Apatani tribal territory can be divided into three categories: individual owned land, clan land and common village land. The first category comprises practically all cultivated land, i.e., irrigated rice fields, gardens, groves as well as house sites for granaries. Clan lands consist of the sites for public assembly platforms (Lapang) inside the village, meadow land used for pasture and burial grounds as well as tracts for forest, where members of the owner clan have the right to hunt and trap. Common village land, on the other hand, is confined to a few rather insignificant stretches of pasture inside the valley and to forest tracts on the periphery of the Apatani (Mossang and Yomso, 2022).

Reduction in risk with the monoculture activities and promoting enterprise diversification, value addition and development of alternative income sources with efficient utilisation of farm resource helps in bringing about enterprise diversification for sustainability and additional benefits, better management of important farm resources like land, labour and capital etc. Productivity of farming system is less but sustainable which has resulted in low income and limted scope for multi-cropping. Apatanis sell their produce in weekly local market and zero town, Usually, the most prevalent marketing channel is producer to consumer (Direct marketing). The farming system will thus promote ecological security, economic efficiency and social equity.

Farming system would definitely provide extra economic return per unit area of cultivable land and improve the present integrated farming land escape scenario of Apatani valley. Adoption of modern farming system approach helps the apatani farmers to understand the interaction and linkage of different farm resources which helps in resource recycling and ultimately leads to reduction of input cost and enhancement of productivity and profitability of the system. Keeping in view the above, the paper has studied the economic aspects of farming systems, along with resource productivity analysis of different farming systems and its constraints in Apatani farming community of Arunachal Pradesh.

II

RESEARCH METHODOLOGY

The study was conducted in Ziro circle of Lower Subansiri district of Arunachal Pradesh pertaining to the agricultural year 2021-22. The Lower Subansiri district of Arunachal Pradesh was selected purposively due to concentration of apatani farming community in this district as compared to the other district. The data were collected from the sample Apatani farmers through personal interview method with the help of a specially designed schedule covering all aspects. It is based on the primary as well as secondary data. The present study was undertaken with a sample

of 120 Apatani farmers from four villages namely; Hari, Hija, Hong and Bulla of Ziro valley of Lower Subansiri district of Arunachal Pradesh through purposive and random sampling methods with well-structured interview schedule. Farming systems were identified based on the major contributions to income of farm enterprise ofapatani community. Farm business income was estimated by deducting from the gross returns the cost incurred on seed, planting materials, manures, fertilisers, plant protection chemicals, hired human labour, farm machinery, interest on working capital etc and expenditure on livestock maintenance, fishery and Orchard such as feed, fodder, medicines, bamboo, depreciation of owned farm implements etc. Multiple regression analysis was employed to analyse the resource productivities of different farming systems for improving the economic conditions of the apatani farmers and to measure the contributions of specific input variable in combination with other factors which are responsible for the change in the level of output. The Cobb- Douglas production function in form of equation (i) was fitted to the data of different farming system.

$$Y_i = b_o \, X_1^{b1} \, X_2^{b2} \, X_3^{b3} \, X_4^{b4} \, X_5^{b5} \, X_6^{b6} U_i \ldots \ldots \qquad \ldots (1)$$

Where, Y= Gross farm income (Rs) (GFI), X_1= Area under cereals in ha (AUC), X_2= Area under other crops in ha (AOTH), X_3= Fish production (kg), X_4 = No. of livestock animals (LA), X_5 = Number of man-days per year (EMP), X_6 = Household expenditure on manures, fertilisers and agrochemicals (MFA), i = 1, 2, 3. ……., n farms. b_o = Constant, U_i = Random variable.

For constraint analysis, each apatani 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.

III

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Apatani Farmers

The findings of the study in Table 1 revealed that 46.6 per cent apatani farmers were practicing cereal based farming system (FS), followed by fishery based (26.6 per cent) and horti-based farming system (15 per cent). These farmers earned 62 per cent of their income from cereal based farming system, 58 per cent from fish based, 52 per cent from horti based farming system. It was observed that gross income from livestock based and forestry based farming system were 36 per cent and 27 per cent respectively. The family size was the largest (5.17) on cereal based FS followed by fishery based FS (4.75). The farm size for cereal based FS is 2.69 ha followed by horti based FS (2.08 ha). The average farm size was found to be 1.45 ha for all farming system in the study area. The cropping intensity was highest in the horti based FS (188 per cent) and lowest in fishery based FS (133 per cent). As per survey data, on an average 3.85 number of family labourers were engaged in agriculture/farm operations among all farming system. In terms of credit availability

to these farmers the cereal based FS had borrowed highest credit (Rs. 27215/ ha), while forestry based farmers borrowed the lowest (Rs. 17596/ ha). The livestock population varied from 0.67 / ha in the fishery based FS to 4.24/ ha in the livestock based FS. Educational index has been found highest in cereal based FS (5.80) and lowest in case of forestry based FS (3.82). the average Education Index was 4.52 for the all farming systems. The horti based FS provided the highest employment (377 man-days per year), followed by cereal based FS (265 man-days/year). On an average, a farmer household got employment for 230 man-days/year in all the farming systems.

TABLE 1. SOCIO-ECONOMIC CHARACTERISTICS OF APATANI FARMERS IN LOWER SUBANSIRI DISTRICT OF ARUNACHAL PRADESH

Particulars	Farming System					
	Cereal based	Fishery based	Horti based	Livestock based	Forestry based	verall farming systems
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample size of Apatani farmers	56 (46.66)	32 (26.67)	18 (15.00)	9 (7.50)	5 (4.16)	120 (100.00)
Gross income (per cent)	62.05	58.11	52.67	36.81	27.08	100.00
Family Size (No.)	5.17	4.75	3.78	3.00	2.60	3.82
Farm size (ha.)	2.69	0.65	2.08	0.20	1.16	1.45
Cropping intensity (per cent)	153	132	188	150	144	138
Family labour engaged i agriculture/farm (No.)	4.68	3.60	3.25	3.07	2.15	3.85
Total agricultural credit availability (Rs./ha)	27215	25122	24613	20561	17596	22072
Total livestock (No./ha)	3.96	0.67	2.68	4.24	3.16	2.43
Educational Index[#]	5.80	4.32	4.15	5.06	3.82	4.52
Employment(man-days/year)	265	208	377	184	169	230

Notes- Figures in the parentheses are percentage to total.

Education Index = $\sum_{i=1}^{n} w_i f_i / \sum f_i$ where, i=0,1,2,3….6.; Education attained: Illiterate =0, Primary-1, Middle=2, Matric=3, Twelfth=4. Graduate= 5, Post Graduate=6, w_i= weights (0 to 6) and f_i = No. of family members.

Farm Size of Different Farming System of Apatani Farmers

Cereal and fishery based FS are found the major cropping system in the study area. Cereal covered about 76 per cent of the crop area under cereal based FS and 54.7 per cent under fishery based FS (Table 2). It was observed that farmers were

TABLE 2. FARM SIZE OF DIFFERENT FARMING SYSTEM OF APATANI FARMERS IN ARUNACHAL PRADESH

Name of farming system	Crop area (per cent)				Gross Cropped Area (ha)	Cropping intensity(per cent)
	Cereals	Vegetables	Fruit	Spices		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cereal based FS	76.34	4.22	15.65	3.79	2.69	153
Fishery based FS	54.70	15.88	24.10	5.32	0.65	132
Horti based FS	19.03	25.76	51.26	3.95	2.08	188
Livestock based FS	42.45	24,75	28.02	4.78	0.20	150
Forestry based FS	30.96	22.35	38.68	8.01	1.16	144

Note: The sum of areas under cereals, vegetables, fruits, spices is 100 per cent.

more dependent on rice based farming due to their food security. The gross cropped area under cereal based FS is 2.69ha, followed by horti based FS (2.08ha). more than 51 per cent fruit cropped area and 25 per cent vegetables covered under horti-based FS. Most common rice–fish based farming system was found among Apatani farmers. About 42.45 per cent of cereal crop area covered under livestock based FS. The cropping intensity is 188 per cent under horti based FS, followed by 153 per cent in cereal based FS in the study area.

Economics of Different Farming System of Apatani Farmers

It was revealed that the average cost of production is Rs. 34615/ ha (Table 3). It was highest (Rs. 48972/ ha) on horti-based FS, followed by fishery based FS (Rs 40951/ha). The labour cost was found highest in horti based FS (Rs. 14655/ha), followed by Fishery based FS (Rs. 12742/ ha). It was observed that on an average cost of manures, fertilisers and plant protection chemicals are Rs.7800/ ha for all farming system. It indicates that seed, labour cost, farm machinery, manures and

Table 3. Costs and Returns of Different Farming System of Apatani Farming Community in Arunachal Pradesh

(Rs./ha)

Particulars	Farming System					
	Cereal based	Fishery based	Horti based	Livestock based	Forestry based	Overall Farming Systems
(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Cost on Crop Production						
Seed / planting material/ fingerlings	8526	15422	14768	10260	9617	11715
Manures / FYM	5023	4045	8201	1005	2458	4068
Fertilisers	2567	2298	3275	2086	2103	2372
Plant protection	1205	1176	1648	1310	1475	1360
Labour	9278	12742	14655	10762	8087	10105
Farm Machinery	1192	1590	2298	2479	1652	1745
Marketing Cost	2485	3678	4127	3525	2208	3250
Gross Cost	30276	40951	48972	31427	27600	34615
Gross Returns	62405	97612	89360	74082	58925	75485
B. Maintenance of Livestock, Fishery and Orchard						
Feed	8078	10246	11668	14205	5122	9768
Dry and Green Fodder	1735	6076	3521	8807	1568	4521
Labour	4290	5679	7804	6422	4176	5780
Medicine	0	0	0	1648	0	1650
Bamboo	2840	2275	4587	3280	1762	2845
Gross Cost	16943	24276	27580	34362	12628	24564
Gross Returns	54348	76870	75112	51347	45665	60258
Overall Costs	47219	65227	76552	65789	40228	59179
Gross Farm Income	116753	174482	164472	125429	104590	135743

marketing costs were the major factors of crop production. The expenditure on plant protection is very negligible. The per hectare cost of livestock maintenance was found maximum on the livestock based farming system (Rs.34362/ha) followed by horti-based FS (Rs. 27580/ha). The overall cost for horti-based FS was highest (Rs.

76552/ha), followed by livestock based (Rs. 65227/ha). It was observed that the gross farm income from fishery based FS, horti based FS and livestock based FS were Rs. 174482/ha, Rs.164472/ha and Rs. 125429/ha respectively. The overall cost was Rs. 59179/ha and the gross farm income was Rs. 135743/ha for all farming systems in Ziro valley of Lower Subansiri district of Arunachal Pradesh.

Sources of Farm Income of Apatani Farming Community

The contribution of different sources towards farm income for different farming systems has been estimated in Table 4. On an average, apatani farm households received Rs. 90410/farm as farm income out of which 34.68 per cent was from crops, followed by 34.49 per cent from fish and 30.82 per cent from livestock. The farming system wise analysis has indicated that crops contributed major share in cereal based FS and horti-based FS. The share of fish recorded highest (53.02 per cent) in fishery based FS and lowest (25.90 per cent) in livestock based FS. The farmers earned higher income from livestock (45.38 per cent) and lower income from fish (25.9 per cent) in livestock based farming system.

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TABLE.4. SOURCES OF FARM INCOME OF APATANI FARMING COMMUNITY IN ARUNACHAL PRADESH

(Rs./farm)

Name of Farming System	Crops	Fish	Livestock	Total
(1)	(2)	(3)	(4)	(5)
Cereal based FS	32129	24867	23037	80033
	(40.14)	(31.07)	(28.78)	(100.00)
Fishery based FS	25941	56665	24278	106884
	(24.27)	(53.02)	(22.71)	(100.00)
Horti based FS	40388	27110	22628	90126
	(44.81)	(30.08)	(25.10)	(100.00)
Livestock based FS	26985	24346	42655	93986
	(28.71)	(25.90)	(45.38)	(100.00)
Forestry based FS	31325	22942	26760	81027
	(38.65)	(28.31)	(33.02)	(100.00)
Overall Farming Systems	31354	31186	27871	90410
	(34.68)	(34.49)	(30.82)	(100.00)

Note: Figures in parentheses are percentage to total.

Per Capita Farm Business Income and Farm Family Income of
Different Farming Systems

The per capita farm business income and farm family income of different farming systems are given in Table 5. It was revealed that on an average per capita farm business income is Rs. 16982 and per capita farm family income is Rs.22845 from all farming systems of the region. Farm business income was highest (Rs. 26790) in fishery based FS, followed by livestock based FS (Rs.20154). it was observed that per capita farm family income ranged from Rs. 12864 for forestry based FS to Rs. 32608 for fishery based farming system.

TABLE.5. PER CAPITA FARM BUSINESS INCOME AND FARM FAMILY INCOME OF APATANI
FARMING COMMUNITY IN ARUNACHAL PRADESH

(Rs./year)

Name of Farming System (1)	Per capita Farm business income (2)	Per capita farm family income (3)
Cereal based FS	10165	16457
Fishery based FS	26790	32608
Horti based FS	18137	24766
Livestock based FS	20154	27115
Forestry based FS	8742	12864
Overall Farming Systems	16982	22845

Resource Productivity of Major Farming System

The Cobb- Douglas production function with respect to resource productivity of different farming system is given in Table 6. The elasticity of coefficient was found highly significant for areas under cereal (AUC) for fishery based and cereal based farming systems. Area under other crops (AOTH) included fruits, vegetable and spices. The elasticity of production indicated that one per cent increase in area under cereal increased the gross income ranging from 0.1 per cent in the case of fishery based FS to 0.541 per cent for cereal based farming system. It was observed that the elasticity of coefficient was found highly significant in all the farming systems. Similarly, one per cent increase in area under AOTH increased the gross income of 0.337 per cent for fishery based FS and 0.265 per cent for cereal based FS.

TABLE. 6. RESOURCE PRODUCTIVITY OF MAJOR FARMING SYSTEM OF APATANI FARMING
COMMUNITY IN ARUNACHAL PRADESH

Particulars	Farming System	
	Cereal based	Fishery based
(1)	(2)	(3)
Sample Size	56	32
Constant	0.451	0.724
	(26.72)	(14.01)
Regression Coefficients		
• Area under cereals	***0.541	***0.100
	(0.037)	(0.012)
• Area under other crops	***0.265	***0.337
	(0.027)	(0.047)
• Fish production	***0.256	***0.324
	(0.018)	(0.044)
• Livestock animals	***0.193	***0.437
	(0.022)	(0.075)
• Labour employed	**0.138	-0.049
	(0.046)	(0.122)
• Manures, Fertilisers and Agro chemicals	0.055	-0.042
	(0.034)	(0.047)
R^2adj	0.97	0.94

Note-*** , ** and * Significant at .01, 5 and 1 per cent level, respectively. Figures in the parentheses are standard errors of respective variables.

The elasticity of coefficient for the cereal and fishery based FS were found significant, indicating that one per cent increase in the fish production increased the gross income by 0.324 per cent in the fishery based and 0.256 per cent in cereal based farming systems. It was estimated that the elasticity of coefficient was found highly significant as 1 per cent increase in animals increased the gross income by 0.437 per cent in fishery based FS. The negative and insignificant coefficient for labour employed in the fishery based FS indicated that it did not contribute significantly to the output of this farming system. It was observed that the elasticity of coefficient of manures, fertilisers and agro chemicals was negative and insignificant in fishery based FS. It revealed that the value of adjusted coefficient of multiple determination (R^2) is very high explaining97 per cent of the variations in cereal based FS by the explanatory variables included in the regression analysis.For fishery based farming system, the value of adjusted coefficient of multiple determination (R^2) suggest that 94 per cent of the variations in the value productivity of farming system could be explained by the independent variables included in regression model.

Constraints in Farming System

The problems faced by the apatani farmers in different farming system are indicated in Table 7. A number of factors were found to influence the returns from farming system in Ziro valley of Arunachal Pradesh. These included lack of

TABLE. 7. CONSTRAINTS FACED BY APATANI FARMERS IN FARMING SYSTEM IN ARUNACHAL PRADESH

Particulars	Scores (10 point scale)					
	Cereal based FS	Fishery based FS	Horti based FS	Livestock based FS	Forestry based FS	Overall Farming Systems
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lack of remunerative prices for farm produce	9	8	8	7	6	7
High price fluctuations	7	6	8	7	7	7
Non-availability of good quality seed / planting materials	8	7	9	6	5	7
Low productivity	9	7	8	8	5	8
High cost of farm inputs	8	8	7	8	6	7
High infestation of diseases and pests	8	7	8	6	5	7
Lack of marketing facilities and exploitation by middlemen	7	7	8	7	6	7
Scarcity and high cost of labour	8	7	8	6	5	7
Scarcity of owned fund	7	8	7	9	6	7
Monsoon fluctuations affecting production levels.	8	8	8	7	7	7
Lower risk bearing ability	5	6	5	6	5	6
Lack of proper access to information and extension services	7	8	7	8	6	7
Management of subsidiary enterprises	6	6	7	7	5	6
Less involvement of youth in farming	7	5	7	6	7	6
Lack of knowledge of scientific package and practices	8	9	8	9	7	8

Note: Score out of 10 (10- most sever constraint, 0- no constraints)

remunerative prices for farm produce, high price fluctuations, low productivity, high cost of farm inputs, high infestation of diseases and pests, lack of proper access to information and extension services, less involvement of youth in farming and Lack of knowledge of scientific package and practices etc. The apatani farmers facing problems of low productivity and lacking knowledge on scientific package and practices with scores 8 on severity out of 10 pointer scale was evident in all farming systems.

<div align="center">IV</div>

<div align="center">CONCLUSIONS AND POLICY IMPLICATIONS</div>

The study concluded that majority of the apatani farmers were following cereal based Farming System (FS), followed by fishery based and horti based farming system. The most common farming system was found to be rice–fish based among Apatani farmers and these farmers were more dependent on rice based farming due to food security. The average cost of production was the highest on horti-based FS, followed by fishery based FS. The labour cost was found to be the highest in horti based FS followed by fishery based FS. It was indicated that seed, labour cost, farm machinery, manures and marketing costs were the major factors of crop production. The expenditure on plant protection is very negligible. On an average, apatani farm households received majority of farm income from crops, followed by fish and livestock. Farm business income was highest in fishery based FS, followed by livestock based FS. The elasticity of coefficient was found highly significant for areas under cereal for fishery based and cereal based farming systems. It was observed that the elasticity of coefficient of manures, fertilisers and agro chemicals was negative and insignificant in fishery based FS. Lack of remunerative prices for farm produce, high price fluctuations, low productivity, high cost of farm inputs, high infestation of diseases and pests, lack of proper access to information and extension services, less involvement of youth in farming and lack of knowledge of scientific package and practices were found to influence the returns from farming system in Ziro valley of Arunachal Pradesh.

On the basis of the above findings and discussions of the study, the following can be suggested for multiple benefits, making a win-win proposition as a promising farming system for apatani farmers of Ziro valley in Arunachal Pradesh;

- Efforts should be made towards appraising the Apatani farmers of appropriate techniques and application of modern inputs for better production in different farming systems.
- Input delivery system should be based on the single window approach which encourages in the study area for timely, easy and convenient availability of inputs to apatani farmers.
- Apatanis farming system approach would definitely provide extra economic return per unit area of cultivable land and improve the present integrated farming landscape scenario of Zero valley.

- There is enormous need for a linkage and full co-operation between the state government, financial institutions, researchers, scientists, extension workers and Apatani farmers on different advanced technological aspects of better farm production, effective marketing which help the farmers to get remunerative prices from their farm produces.
- There is a need for strong policy support for farming system backed up with easier credit flow, subsidy and agricultural insurance, market linkage with establishments of village cluster development programme in the study area.

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