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Characterization of Farming System and Determinants of Adoption of Horticultural Enterprises in Achham, Nepal

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Abstract

Nepal's rural agriculture is characterized by its diverse and interconnected system of farming. The Ghaghara/Karnali river system in the northwest of Nepal represents the typical rural farming system. A study was conducted in 2019 in the Mid-hill district of Achham, Nepal in the same river system with the aim of studying the farming system, its features, and different factors that influence the horticultural enterprise adoption by the farmers. A total of 130 respondents were selected from the Panchadewal Binayak Municipality of Achham district of Nepal using the multi-stage purposive random sampling approach. Beside the characteristics of Farming system; various factors that determine the horticultural enterprise adoption were examined using the binary logit regression model. The integrated or multi-enterprise farming system was found to be dominated by three primary enterprises: horticulture, livestock, and agronomy. The pattern of household participation in each enterprise under study was substantially the same, with almost three fourth of the household choosing main grain crops, and horticultural crops especially vegetables; around 85% adopting livestock in an integration system, and only about 13% fruit trees. The study demonstrated that among the many factors under inquiry, the gender of household head, size of the family and visit by the extension workers influences the farmer's decision on adoption of horticultural enterprise significantly.

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Though non-significant, age, level of education, farming experience, agriculture as primary occupation and credit facilities also positively plays the role in decision of horticultural enterprise adoption. Ethnicity, years of residence in same location, dependency ratio, total land size, training and visit to extension worker were negatively associated with farmers' decisions regarding horticulture enterprises. Thus, for the development of agriculture in rural areas with a higher adoption of horticultural enterprise which as higher potentialities in the rural agricultural system in Nepal, it is necessary to consider the role of various socioeconomic and personality variables in farmers decision to adopt the type of farm enterprise.

Keywords: Rural; Integrated Agriculture; Farming System; Enterprise; Horticulture.

1. Introduction

Nepal is a small country with a geophysical layout categorized into three primary regions; the plain Terai region in the south, mid hills and the elevated highlands in the north. The population distribution across these regions is uneven with 53.61% of the population residing in the Terai, 40.31% in the hills and 6.08% in the high mountains [1]. A significant portion of Nepal's Gross Domestic Product (GDP) is derived from the agricultural sector. Even if its share of GDP decreased to 33.1% by 2014–15 and to 25% in 2021, from 36.64% of GDP in 2005–06; it still represents the largest economic sector [2]. About 65.6% of the total population still engages in agriculture sector facing various challenges. In Nepal, farmers are basically small land holder representing diverse social, cultural, and ethnic backgrounds relying heavily on crops and tree cultivation, often alongside animal husbandry [3].

The rural and agricultural nature of Nepal's economy, coupled with the reduction in cultivable land, pose a significant challenge to sustainable and profitable farming [4]. This reduction in farm area without viable alternatives for income expansion results in decreased farm income and potential agrarian distress [5]. Despite recommendations for improved crop production technologies from agencies like Nepal Agriculture Research Council (NARC) and related agencies, only a few have been adopted on a commercial scale due to inadequate promotional techniques, unsuitability of the varieties or technology for specific location, or limited access to marketing opportunities [6]. Enhancing farmers' access to new technologies is seen as pivotal for increasing agricultural productivity and promotion of livelihood.

Social and economic factors significantly influence farmers' attitudes and aptitude towards adopting agricultural innovations and new farming practices [7, 8]. Understanding the interplay between socio-economic and biophysical dynamics aids small farmers in their decision-making [9, 10, 11]. Beside the socioeconomic and personal variables; farmers' willingness to adopt a farming component is also largely influenced by its perceived importance [12].

Achham district, a typical representation of mid hills of the country is endowed with the climate suitable for temperate and tropical fruits and vegetable in the river basin, too. The summer temperature is lower than that of terai and relatively higher than that of the hilly region. A good scope of vegetable and fruit production year around and its supply to both terai and high hills makes the district more fruitful for horticultural enterprises

[13]. The climate and geophysical diversity in the Achham district makes it suitable for most of the fruits and high value horticulture commodities that are suitable for mid hills like mandarin, sweet orange, lime, pomegranate, kiwi, coffee, tea, large cardamom, ginger, cut-flowers, vegetables and potatoes; alongside the scope of production of some tropical fruits like mango, banana, litchi, etc in the Karnali river basins. A practice of off season vegetable production could give better market price and export possibility to other districts. The nitche value and comparative advantage of producing these crops is different from that of neighboring countries too [14]. Nepal's comparative horticultural production is seen increased despite of its lower productivity; it has a higher perspective of horticultural enterprise. In this context, this study aims to analyze rural farming systems in Achham district of Nepal, with a specific focus on characterization of the farming system and assessment of factors influencing the adoption of horticultural enterprise among in the study area.

2. Methodology

2.1. Study area

The study was carried out in the Achham district which is among the most underdeveloped district in Sudhur Paschim Province of Nepal, it is situated along the Karnali river system originating from the Tibetan Plateau near Mansarovar Lake. The Karnali river passess through Nepal's most remote and rural areas and shares its western bank with Achham district bordering Karnali and Sudurpaschim province of Nepal [15]. The district spans a territory of 1692 square kilometers and is positioned between latitude 280°46' North to 290°23' North and Longitude: 810°32 East to 810°35' East. About 90% of the area in Achham is characterized as mid-hill, while the remaining 10% comprises high-hill terrain [16]. Achham is among the nine districts designated by Government of Nepal as backward area due to its remoteness. The local economy of the district is heavily reliant on agriculture and the seasonal migration of individuals to India [17]. At the same time; the district being remote, poor and a hilly district is still backward in commercialization of horticultural enterprises in the farmers' farming system, in spite of its great potentiality, the study could be a way to explore the major determinants of adoption of horticultural enterprise by the farmers.

2.2. Sampling procedure and data collection

To comprehend the study area, population and the general farming practice of the districts; a preliminary field survey was conducted. Among three major river systems in the country, the Karnali river basin serves as the water source for the entire western region of Nepal. Panchadewal Binayak municipality within Achham district was selected due to the presence of mid hill highway passing through it and its adjacency to Karnali river. A total of 130 sample households were selected. The study population comprised household engaged in the farming activities within the selected rural municipality. The selection of respondent farmers employed a multi stage random sampling technique with an aim to represent various geophysical regions adjacent to the Karnali River. Interview schedules were meticulously prepared, pretested and refined after the field observation in the study area. The primary information sources were respondents from the selected households, while the government and non-government publication, research articles and national census data constituted the major sources of secondary information.

2.3. Data analysis

The demographic data were analyzed using the descriptive statistical tools and interpreted with the quantitative attributes. Similarly, the relationship between several chosen factors and the type of dominating enterprise in the farming system was examined using a binary logit regression model. The decision to choose the type of enterprise was the dependent variable, and a variety of different variables, including demographic factors (Sex, Age, Family size and dependency ratio), socioeconomic and cultural factors (like ethnicity, credit facilities, education, farming experience, occupation, landholding / farm size, Residence in same location) and sources of agricultural information (Farm and Home visit by the Extension worker, visit to extension worker, training) were considered as independent variables in the study.

Let Yi, the farmer's binary reaction in the fundamental model, have one of two possible values: Y = 1 if the farming system's dominant enterprise is the horticulture and Y = 0 if not involved in that enterprise. Assumed that X is a vector of explanatory variables (x1, x2,..... xn) that influence the producer's decision to adopt the dominant enterprise type, and β a vector of slope parameters linked to X that gauges the impact of X's change on that likelihood.

Thus, the probability of the binary response can be defined as:

If $Y_i=1$; $P(Y_i = 1) = P_i$

$Y_i=0$; $P(Y_i = 0) = 1 - P_i$

Where $P_i = E(Y = \frac{1}{X})$ is the conditional mean of Y given values of X.

Now on the basis of [18], the probability of enterprise adoption can be expressed as follows:

$$P(Y_i = 1) = P_i = \frac{1}{1+\exp^{-z}}$$

Where, $Z = \alpha + \Sigma \beta_i X_i + \varepsilon_i$

The logit transformation of the probability of enterprise adoption decision, P (Yi = 1) can be exemplified as following [19]:

$$L_i = \ln[\frac{Pi}{1-Pi}] = Z_i = \alpha + \sum_{i=1}^{n} \beta_i X_i + \varepsilon_i$$

Where Y_i (type of enterprise) = Dichotomous dependent variable (i.e. 1 if the farmer has adopted the enterprise; and 0 if not)

X_i= vector of variables included in the logit model, (Table 1)

β_i = parameters to be estimated,

ε_i = error term of the model, exp (e) = base of natural logarithms, L_i= Logit and P_i / (1- P_i) = Odd ratios.

Thus the binary model used in the study is specified as:

$Y_i = f(x_1, x_2, \ldots..x_n)$

Table 1: Variables under study for the econometric analysis.

Variables	Description and values	Expected sign
Age	Age of the HH Head in years	+/-
Gender	Gender of the HH Head; 1= male; 0 otherwise	+/-
Ethnicity	1 for Brahmin/Chhetri; 0 for others	+/-
Education	Years of formal education	+
Experience in farming	Years of experience in Farming	+
Residence	Years of residence in same location	+
Family size	Number of People	+
Dependency ratio	The ratio of dependent population to economically productive population	+/-
Primary occupation	1 for Agriculture; 0 for Others	+
Visit by Govt. extension worker	Number of Farm and Home Visit by Government Extension Workers in a year	+
Visit to extension worker	Number of visit to extension office/worker by the farmer in a year	+
Training	1 for training received; 0 for Untrained farmers	+/-
Credit	1 for farmers with credit facilities and 0 for farmers without credit	+/-
Total land	Area of Land Owned and farmed (in Kattha)	+/-

3. Results

3.1. Demographic Characteristics

Table 2: Demographic characteristics of households in study area, 2019.

Characteristics	District mean	SE
Age	49.97	1.153
Education (years of schooling)	5.11	0.457
Farming experience (yr)	27.66	0.000
Experience in HH decision making (yr)	24.62	1.162
Years of residence in same location (yr)	42.43	1.174
Total family size	7.23	1.529
Dependency ratio	0.83	0.271
Family members under 15 years of age	2.54	0.050
Economically active members	4.22	0.135
Family members of age above 60	0.46	0.182
Share of off farm income in family (percentage)	13.84	0.064

The respondents' average age was 49.97 years, and they had relatively little schooling beyond the basic level (Table 2). The average number of years in spent farming was 27.66, the average number of years spent in making household decisions was 24.62, and most of them were discovered to have been born in the same place and had lived there permanently for more than 42 years. The dependency ratio was 0.83 and the average family size was 7.23. The family had a 4.22 average number of economically active members. The average number of

economically dependent people between the ages of 15 and 60 was 2.54 and 0.46, respectively. Farming was the primary source of family income for the farmers in the region with the off-farm income accounting for just 13.84% of total family income.

3.2. Landholding

Farmers possessed average land holdings of approximately 9.87 kattha (1 kattha equivalent to 338.63 sq. mt.) whereas the average irrigated land comprised nearly half of the total land (5.31 kattha) (Table 3). The primary cereal crops cultivated by the farmers were rice, maize and wheat, taking up an average of 4.74, 4.60 and 4.70 kattha per household, respectively. However, the harvest was inadequate to sustain the year round family food requirement.

Table 3: Mean landholding (in Kattha) and land use patterns by households in Achham district.

Characteristics	District mean	SE
Total Land	9.87	0.653
Irrigated land	5.31	0.457
Area under rice cultivation	4.74	0.359
Area under maize cultivation	4.60	0.322
Area under wheat cultivation	4.70	0.319
Food sufficiency for family (Months)	6.50	0.312

3.3. Extension Services

The average number of visits the farmers received from the extension workers is only 1.28 times, meaning less than two visits a year (table 4). On the other hand; the average number of visits by a farmer to an extension office or worker was even less than 1; i.e. most farmers only visiting once a year.

Table 4: Extension services obtained by households in study area, 2019.

Characteristics	**District mean**	**SE**
Number of farm and home visit	1.28	0.214
Number of visit to extension worker	0.73	0.154

3.4. Practices of Farm Enterprises

Farmers engaged in agronomical enterprises were about 74.62% (Table 5). Similarly, 84.62% of the farmers were involved in livestock enterprise. Among the total farmers; 77.69% were involved in the horticultural enterprise which include both vegetable and fruit trees cultivation.

However, only 13.08% had fruit trees in their own field. Major cereals like Rice, maize and wheat were widely cultivated along with minor cereals such as barley, buckwheat and millets. Soybean, lentil, pea, horse gram, cowpea and black gram constituted the major leguminous crops grown in the district. Seasonal vegetable and mango production were the major horticultural products in the farmers' field along the river basin. In terms of livestock enterprise, the primary animals reared by farmers were cows, buffaloes, goats and poultry.

Table 5: The pattern of farm enterprise of households in the Achham district, 2020.

Farm Enterprise	Frequency (N=130)	Percentage
Agronomy enterprise	97	74.62
Horticulture vegetable	101	77.69
Horticulture fruit trees	17	13.08
Livestock	110	84.62

The farming system in the study area typically represents the rural agriculture with farmers practicing the integrated farming. The irrigated and terraces in the region nearby to the Karnali river were used for rice cultivation; followed by a season of wheat and maize cultivation. Most of the household rear cow for milk production for household consumption; few with backyard poultry. A practice of kitchen gardening for seasonal vegetables especially potato, beans, cauliflower and radish was common especially in the rainy season with barren kitchen gardens in the winter and summer. Mango, litchi, banana, guava were the major fruit trees seen in the lower riverside areas which was also for household consumption and no commercial crop production system was seen in the district, especially in the study area due to lack of market nearby. A typical representation of rural midhill type of subsistence farming was seen in the study area.

3.5. Factors Associated with the Farm Enterprises

Achham, situated in the mid hills, is predominantly characterized by subsistence, and integrated type of farming encompassing agronomy, livestock and horticultural enterprises. Horticulture is one of the prominent enterprise with higher possibility of expansion and economic possibility in the district. The study explored different factors influencing the decision of adopting the horticulture enterprise using a binary logit regression model. Table 6 illustrates the determinants or the major factors involved in farmers' decision to adopt these enterprises. Among the different variables under study; gender, family size, dependency ratio, farm and home visit by the extension worker and extension visit by farmers were seen as significant factors influencing farmers' decision on adoption of horticultural enterprise.

Table 6: Determinants of horticultural enterprises adoption by the farmers in Achham district, 2020.

Variables	dy/dx	Coeff	P- value
Age	0.007	0.036	0.310
Gender	0.231**	1.300	0.043
Ethnicity	-0.088	-0.444	0.224
Education	0.011	0.0563	0.345
Experience in farming	0.003	0.016	0.594
Residence in same location	-0.003	-0.170	0.378
Family size	0.055**	0.278	0.017
Dependency ratio	-0.193**	-0.969	0.034
Primary occupation	0.089	0.421	0.573
Visit by extension worker	0.278**	1.489	0.036
Visit to extension worker	-0.566*	-2.573	0.002
Training	-0.55	-0.269	0.673
Credit	0.072	0.360	0.555
Total land	-0.002	-0.009	0.827
Log-likelihood	-51.983		
Prob>chi^2	0.000		
Pseudo R^2	0.256		

Note: coeff.-coefficient; Prob-probability; chi^2-chi square test

The gender of the HH head is positively and significantly associated with the farmers' adoption of the horticultural enterprise. The HH head being male increases the chance of involvement in the horticultural enterprise by almost one fourth than being a female HH head. Similarly family size is also associated with the adoption of the enterprise. The size of the family; farm and home visits from extension workers were positively and significantly associated with the adoption of horticulture. The family with one more member have five percentage more chance of adoption of the horticulture enterprise. The visit by the extension worker increases the chance of adoption of the type of enterprise by more than one fourth. An increase in the age of the farmers, level of education of the farmer, experience in farming, and agriculture being primary occupation led to a higher likelihood of adopting horticultural enterprise. Male farmers exhibited greater involvement in horticultural enterprises; possibly due to their engagement in vegetable production, which was often lacking in households where females were the heads. Regarding ethnicity, ethnic groups other than Brahmin and Chhetris were more inclined towards adopting horticulture enterprises, as Brahmins and Chhetri communities tend to pursue alternative professions rather than farming. Farmers with a longer history of settlement in the same location were found to be less likely to adopt horticultural enterprises. On the other hand, the dependency ratio, and farmer's visits to extension services negatively and significantly influenced the decision to adopt horticulture enterprise. Similarly, training and the total land holding had a negative impact on farmers' decision to adopt the enterprise. This might be the tendency of the trained farmers to leave the place and go to India mostly for the seasonal labor and other economic activities. Farmers who benefitted from credit facilities were more involved in horticulture enterprises.

4. Discussion

The Far Western province of Nepal faces multidimensional developmental challenges owing to its difficult topography, intricate socio-economic frameworks, and entrenched traditional systems linked to religion, culture and customs. Achham is among the nine districts in the far-western province designated by Government of Nepal as backward area [16]. The average family size of the district is 4.6, total population is 229,816 with total household 39375 in number. About 2 percentage of the total population of the district are supposed to stay mostly in abroad [1]. Agriculture is the primary livelihood in the district, however, the percentage of farming households with land and the average size of agricultural land holdings are diminishing. Achham is categorized as a district with a significant food deficit, leading many food insecure individuals to engage in seasonal migration to India for daily wage labour opportunities as a common strategy to cope [20]. Paddy, wheat, maize, winter potato, garlic, mustard, and both winter and summer vegetables are the main crops cultivated in the region. Agriculture significantly contributes to household income, with primary employment sources including wage labor, agricultural labor and self-employment through farming. Key challenges in the agriculture sector encompass traditional agricultural methods, land fragmentation, limited land holdings, unfavorable climate conditions for production, and inadequate technical support to farmers. The district is characterized by a low level of education and majority of household engage in diverse agricultural enterprises. The demographic setting of households in this study area aligns the similar studies previously done [21, 22] which described the typical Asian small scale farmer as residing in a six-membered household relying on family labor working under

various of tenure arrangements, with an average farm size of 1.5 ha. These farmers follow a mixed farming system predominantly focused on rice cultivation and involve a couple of draft animals and a small mixed poultry flock.

Farmers in this district are involved in adopting various agricultural practices composing agronomical, horticultural, and livestock enterprises. Behera and France explain that farming systems encompass multiple crops and diverse enterprises on a single farm which is the result of intricate interactions among different components that rely on land, labor, capital and management [23]. According to Fresco and Westphal; a farming system as a decision-making entity comprising the farm household, cropping pattern, and animal management [24].

In Achham district livestock and horticultural (vegetable) enterprises are prominent than agronomical enterprises; this is because of the lack of vegetable market nearby and the vegetable they grow is for their home consumption; which slightly differs from Ray and colleagues where the gross cropped area was mostly allocated for cereals (57.79%), followed by vegetable (22.15%) [21]. However, Crop production, livestock and forestry have been closely integrated and interlinked in the farming system, each supporting the other [25]. Similarly crop cultivation takes precedence in Asian farming with less emphasis on livestock raising [26]. Nevertheless, in Achham, Livestock remained a vital component of the agriculture system. A study shows that, lack of irrigation pose a common challenge for farmers, with 84% relying on rainfed farming in Nepal, a scenario not distinct for the farmers in Achham district [27].

Farming experience have shaped the existing farming system in Achham, which is also in agreement with observations by different researches [25, 28, 29], that specific agricultural systems evolve over generations of farmers' practices. Non-significant but negative role of the years of residence in the same location is because of the tendency of the household members to visit or going India for seasonal migration and lack of market nearby for selling of the crops produced. In rural Nepal, Farmers receive only one visit from extension workers in rural Nepal which is also a common situation in Nepalese agricultural extension service [30]. According to Devendra, from different researches he found that the asian agriculture is characterized by small and poor farmers managing diverse farm enterprises involving a variety of crops and animals [27, 31]. Similarly, a majority of households possess limited arable land and engage in multiple enterprises, incorporating both agronomical and horticultural crops along with livestock in the study area. This reflects the subsistence-type farming systems found in rural areas of India and the Indian subcontinent where livestock play multiple roles such as supporting agriculture, transportation, providing food, and supplying manure [32]. The similar subsistence farming approach also prevails commonly in the mid-hills of Nepal including study district.

4.1. Determinants of the horticulture enterprises

Achham, being a backward district with subsistence-oriented farming, adoption of any type of agricultural enterprise depends upon factors variables such as gender of the HH head, family size, dependency ratio, and technical support. [6] highlighted that the adoption of modern farming technologies among farmers is influenced by range of factors encompassing personal, social, and environmental aspects. Gender played a significant role

in adoption decision of horticulture enterprises. Different similar studies on adoption of farm practices indicated that the gender plays an important role in adoption of recommended technology [33, 34, 35]. Conversely, ethnicity exhibited a negative association with adoption process. Joshi and Piya reported that individuals from the Hills/Mountain region, specifically Brahmin/Chhetri were less likely to adopt commercial vegetable production in comparison to non-Brahmin communities [36]. Ethnicity was also found to be serving as a socioeconomic factor that impacts on individual's behavior, perception, adoption, and continuation of a specific technology [37]. Residing in the same location was associated with reduced adoption of horticulture enterprises. Due to the remote location of Achham, limited market opportunities, and diminished off-farm income, farmers who have lived in the same location for extended periods are reluctant to adopt new technologies; on the other hand the new immigrants in any place want to go through new experiences and are willing to adopt new innovations in the initial years. Geographical location was also identified as a significant factor affecting technology adoption in different studies [36, 38].

Family size is an indicator of available labor on the farm. It can be anticipated that households with larger family sizes possess the capability to mitigate any labor constraints in farming [36]. Additionally, Nepal is struggling with a severe shortage of agricultural labor due to significant youth migration for foreign employment [36] underscoring the crucial role of household labor in agriculture. The larger size of family was found to have adopted the horticultural enterprise in the study too. The district currently faces a lack of adequate extension visits to farmers. The visit by the extension worker significantly affects the adoption decision.

This situation resembles the previous findings [10, 34, 39] which emphasized the positive impact of such visits on technology adoption, fostering a favorable attitude toward it. Familiarity with farming had a beneficial influence on the adoption of horticulture enterprises. Ainembabazi and Mugisha also concluded that farming experience plays a role in the early stages of adopting agricultural technology for certain crops, when farmers are in the process of assessing its potential benefits [40]. Moreover, the dependency ratio exhibited a significant but negative effect on the adoption of new technology. This finding aligns with the findings where households with higher dependency ratio were less likely to participate in adoption of agricultural technology [41].

Farmers who have received training and visit extension workers appear to be more motivated to adopt off-farm jobs and seek for other opportunities rather than sticking to agriculture. This tendency might arise from trained farmers relocating to urban areas to explore farming prospects, or it could be attributed to the fact that the training or technical guidance they receive does not align with their specific requirements. It is also because of the less commercial activities in the area of study which is almost similar for all the rural regions of the nation.

Even when these farmers receive pertinent training or technical support, they might encounter obstacles in integrating the acquired knowledge into their farming practices, possibly due to social or economic constraints. Additionally, after undergoing training, farmers might not perceive a substantial impact on their lives and therefore struggle to elevate their economic standing. However, it is worth noting that training and awareness increased initiatives augmented the likelihood of adopting Integrated Pest Management in vegetable cultivation [42].

5. Conclusion

The integrated and subsistence type of farming system is prominent in the study area. Thus, extension efforts should focus on the efforts for commercialization of agriculture. The factors associated with the farmers' decision are the key areas to be stressed for the technology dissemination and also for promotion of the extension efforts for higher expansion of farmers' involvement in the horticultural enterprise. Gender, size of the family, number of youths in the household and extension visits to the rural farmers are the key factors responsible for adopting horticultural enterprise by farmers and thus should be prioritized in program and plan formulation.

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