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An Economic Analysis of Major Farming Components in the Mid-Hills of Nepal

Cases of Nuwakot, Kavre and Lalitpur Districts*

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Summary : Three ecological regions, mountain, hill and terai, are characterized by different land structure, climate and socio economic conditions, resulting in varying farming systems in Nepal. This paper focuses on the traditional mid hill farming system performed on slope and terrace, which is a location-specific and environment-adaptive system. The traditional subsistence farming has been changing toward obtaining higher productivity in recent years, in order to meet the increasing demand for food due to expanding upland population. It has the distinctive characteristics of three major components : crops, livestock and forestry interacting with each other. Crops provide feed and fodder, while in return animals supply draught power and manure, and forest gives nutrients and support lands. In this paper, the performance of the mid-hill farming system is assessed and the merits of interaction in terms of physical and economic value are analyzed with a focus on the role of the three farm components.

Key words : farming system, crops, livestock, forest, interactions, farm income, regression analysis

Introduction

In Nepal poverty reduction is the central theme in the implementation of development strategies. It is necessary to increase the living standard of the farmers by increasing agricultural productivity and farm income. Nearly 80% of the total population is engaged in the agricultural sector. The challenge is to increase agricultural performance in order to keep pace with the 2.2% per annum growth in population. In the 1970 s and 80s the growth rate of agriculture GDP was lower than the population growth and recorded a negative during 1990-98[8].

From the multidimensional perspective, people are poor when their level of income does not allow them to buy the minimum amount of food required to carry out daily duties and tasks, nor to obtain a minimum level of education or medical attention when necessary, that is, when they are not able to satisfy their basic needs[26].

In the mid hills farmers cultivate crops, raise livestock and plant trees on the farms (agroforestry) or utilize community forestry to cope with the problem of shortage of basic needs caused by their very small landholdings. The three components are the key factor of livelihood of the rural poor. Hence, this paper tries to identify the nature of interaction among these components and their economic role in the determination process of the total farm income in the mid hill farming system in Nepal.

Figure 1 shows a model for interaction among the three components. Crops, animal husbandry and forestry are closely and inseparably integrated. Although the farmers in the region have always understood these linkages, the interrelationships have only recent ly begun to be understood and appreciated by researchers[14]. For example, a study conducted by the International Centre for Integrated Mountain Development (ICIMOD) in 1992 quantified the contribution of

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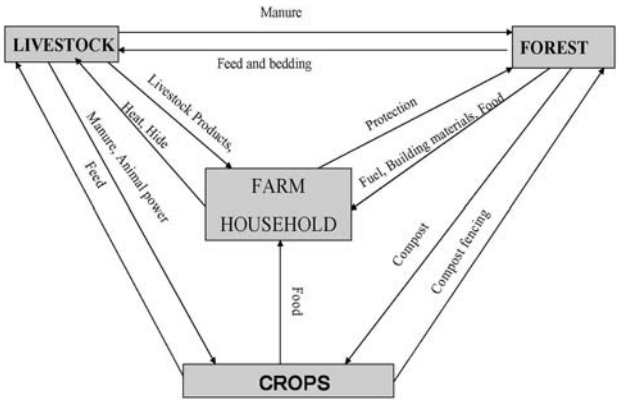

Fig. 1 Integrated farming practice in the Mid-hills of Nepal

Fig. 2 Map of Nepal and study areas

each of these components of the farming system[25]. DOUGILL, *et al.* (2001) found that community forestry has not yet had a major impact (either positive or negative) on farming systems, but recognized some opportunities that could increase the quantity and quality of compost supply, leading to higher crop yields[6]. RASAILY (2006) revealed that poor households relied more on the community forest than the rich households for crop production and livestock rearing. He further recommended that research should be oriented towards a clearer understanding of the inter- linkages among the various components of the existing hill farming system and land use systems which are capable of reducing environmental deterioration while meeting the basic needs of the local people on a sustainable basis[21].

Another study by the department for International Development (DFID) entitled "A socio-economic factor in agroforestry" emphasized the importance of an understanding of the existing and potential interactions between crops, forest species and livestock, and identified eight priorities for future research, one of which was tree-crop interaction[3]. TANIGUCHI and MALTSOGLOU (2004) showed that livestock contributed significantly to agricultural income both in the form of home consumption and cash income[12]. THAPA and WEBER (1994) concluded that forestry based farming would be an economically efficient form of land use, if its economic and environmental benefits are accounted on the hill slopes[24].

It is therefore necessary to evaluate the management and economic performance of existing farming systems, but no study has been made to identify the economic value of existing farming system (inter linkage among three components) in the mid-hills especially in relation to the role of each component in the determination of total farm income. In order to fill this gap, this paper attempts to (i) clarify quantitatively the degree of interactions among the three components, (ii) examine the strength and weakness of the interactions, and (iii) analyze the economic contribution of each component to total farm income. Data on three mid-hills villages were obtained by a questionnaire survey, conducted at two different periods, December 2007-February 2008, in two villages, Kaule and Khalchowk and October-November 2008 in the remaining one village. The analytical method includes both descriptive statistics and econometric methods.

The structure of the paper is as follows. Following this introduction, characteristics of the study areas and farmers will be discussed in Section Two. Section Three clarifies the structure of crops, livestock and forestry productions. Section Four will be devoted to a discussion on strength and weakness of the interaction between the three components, while Section Five presents the formation of total farm income. Conclusion and recommendation of this study will be presented in Section Six.

Characteristics of the Areas and Farmers Studied

All three villages studied are typical hill farming villages in Nuwakot, Kavre and Lalitpur Districts, located on steep slopes out of Kathamndu Valley. Kaule village is located in Okharpauwa VDC, Nuwakot District, about 25 km northwest of Kathmandu. The second village, Khalchowk is at the western edge of Nashikasthan VDC, Kavre District, about 22 km east of Kathmandu. The third village, Bistagaun is in Chapagaun VDC, Lalitpur District, about 10 km from Patan city. Figure 1 shows the location of the study villages. These villages were first studied in 2003–2004 by a collaborative project of Tokyo University of Agriculture (TUA)-Nepal Agriculture Research Council (NARC)[9–11] and next in the year 2006–07[9,18].

Most villagers in the first two villages belonged to the Tamang caste and were Buddhists, whereas villagers of Bistagaun were Hindus and belonged to the

Table 1 Profile of farmers and study areas

	Kaule	Khalchowk	Bistagaun
No of Hhs	60	64	61
No. of Hh studied	52	41	50
Total population	306	262	259
Male	161	167	113
Female	145	95	146
Caste	Tamang	Tamang	Bhraman
Religion	Buddhism	Buddhism	Hindu
Altitude(m)	1,300-2,100	1,480-1,850	1,000-1,400
Average age of HH	49	55	52
Average Family size	5.9	6.3	5.2
Level of Education of HH (%)			
Illiterate	67	63	44
Primary education (1-5yrs)	29	34	14
Secondary (6-10yrs)	4	0	26
Higher (11-16yrs)	0	2	16

Source: Field Survey 2007/08

Table 2 Occupation of the household head in percent

Occupation	Kaule (N=52)		Khalchowk(N=41)		Bistagaun(N=50)	
	Main job	Secondary Job	Main job	Secondary Job	Main job	Secondary Job
Own farming	62	21	78	17	70	40
Ag wage labor	8	8	2	2	4	8
Non ag. labor	23	14	5	0	4	0
Government services	4	0	12	5	14	0
Business/trading	4	4	2	7	8	0
No secondary job		54		68		52

Source: Field Survey 2007/08

Bhraman caste. Tamang are believed to be a lower caste with low socio-economic status whereas Bhraman are a higher caste with better socio-economic status[4]. Table 1 gives a general profile of farmers and the area studied. In the agricultural sector, the higher the education level, the greater is the exposure to modern technology, leading to higher agricultural productivity and income[9]. However, more than half of the farmers had no schooling in the first two villages, Kaule and Khalchowk. Only 27% and 34% farmers had primary and very few, 6% and 2%, had secondary education in Kaule and Khalchowk respectively. In contrast more than half of the Bistagaun farmers attended school : 14% primary, 26% secondary and 16% higher education.

Table 2 shows the occupation of household heads in the three villages, where 62%, 78% and 70% of farmers were engaged in agriculture as the main job and 21%, 17% and 40% as the secondary job respectively. Villagers who owned very small farm land, worked for other farms as laborers. There were 8%, 2% and 4% of farmers whose main occupation was agricultural labor. A small number of farmers were involved in other activities such as business or government service : the number was comparatively higher in Bistagaun than Kaule and Khalchowk.

Structure of Major Farming System

This section looks into the physical structure of the major farming system in the study villages which consists of three components, cropping, animal raising and forestry. Crop production is highly diversified with a predominance of cereals which are the staple food of the villagers and thus constitute the most important component in the farming system, while the two other components play an important role to support food production and livelihood of the villagers.

Table 3 shows that crops were planted on two different types of land ; lowland and upland. The former is irrigated area, and the later rain fed. Obviously the irrigated land is more productive than the rain fed land. As all villages are located on the hill, total area of upland is larger than low land fields. Type of land largely determined the crops planted, in that rice and wheat are major crops in lowland and maize, mustard and vegetables predominate in upland.

Animals, the second component, are kept in a small hut or sheds near or next to the residential house. Some farmers raised livestock in the lower part of the house, while farmers lived at the upper part. As seen in Table 3, livestock could be categorized into two types ; big ruminants (cattle and buffalo) and small ruminants (sheep and goat). This is because the role of small and big ruminants varies greatly in this farming system. The average number of big ruminants per household was 1.3, 1.5 and 1.3 heads in Kaule, Khalchowk and Bistagaun respectively, raised by 76%, 77% and 78% of the households. These figures are lower than the national average, cattle, buffalo and goat-sheep being 3.1, 2.1 and 4.5 respectively[17]. Number and owner of ruminants were larger in Khalchowk than the two other villages. The number of livestock raised by farmers determined the amount of compost they could produce for crop production. CARSON (1992) found that Nepalese hill farmers used an average of 10–20 tons of compost manure per hectare in rain fed Bari land, which delivered nutrients to the crop fields from forest and grasslands via livestock[1].

Forestry is the third component of this farming system. It generally allows farmers in many ways to sustain hill farming system, particularly through animal production and nutrient recycling. Forestry meets 78% of energy and 62% of fodder needs of the country[14].

Table 3 shows the existence of two kinds of forest, community forest and private forest in the study area. Community forest is administered by user groups and monitored by the District Forest Office. Villagers are

Table 3 Major components of farming system in three study villages

Component	Kaule				Khalchowk				Bistagaun			
	HH		Ave	Area	HH		Ave	Area	HH		Ave	Area
	No.	%	ha /hh	(ha)	No.	%	ha /hh	(ha)	No.	%	ha /hh	(ha)
Crop												
Low land	48	92	0.37	18.90	26	63	0.12	4.90	40	80	0.15	8.18
Up land	52	100	0.39	21.40	41	100	0.51	21.00	49	98	0.20	9.66
Total average size	-	-	0.75	40.30	-	-	0.63	25.90	-	-	0.35	17.84
Livestock (No/HH)												
Big Animals	40	76	1.30	-	31	77	1.50	-	39	78	1.30	-
Small Animals	45	95	3.70	-	39	87	4.40	-	35	70	2.60	-
Forestry or Trees												
Community forest	52	100		243.00	41	100		269.00	50	100		102.00
Private forest	12	23	0.04	2.50	24	59	0.36	14.62	22	44	0.06	2.94
No. of trees on yard	36	69	13	-	10	24	5.54	-	50	100	26	-

Note One ropani = 0.05 ha
Source: Field Survey 2007/08

allowed to use it, subject to their abiding by the strict regulations[10]. Community forest in the vicinity of study villages was allowed to be used for two months in the dry season (April and March). They could collect grass fodder, litter, thatching material and firewood in these two months. But the distance of community forest accessible to farmers and family labor available determine the degree of use. As the use of community forest is limited due to many physical and environmental reasons, farmers depended on privately owned forest, or growing trees in their farm yard. Because a very small number of farmers had private forest, trees planted in farm yard appeared to be very important. The largest number of trees was owned by Bistagaun farmers, followed by Kaule and Khalchowk, similarly the largest area of private forest was owned by Khalchowk farmers, followed by Bistagaun and then Kaule. The availability of trees or forest was a determinant of the number of animals which could be raised by the farmers.

Interaction among Three Components

This section explains the nature of interactions that took place among crops, livestock and forestry in order to maintain farm productivity and sustain the farming system. The synergistic interactions of the components of this system appeared to have a significant and positive total effect that is greater than their individual effects[7]. The crops and livestock integration has been sustained from ancient periods of time and built into Hindu culture. It is not uncommon to hear farmers state that, without livestock, there could be no crop production[19]. Das and Shivakoti (2006) evaluated the livestock carrying capacity of land resources and formulated the optimum herd size at a suggested 3 LU buffaloes and 4 LU goats, 2 LU buffaloes and 4 LU goats and 1 LU buffaloes and 4.4 LU goats, per hectare to gain the maximum return to the farm family without exerting pressure on natural resources[2].

Similarly the trees play a crucial role in sustaining livestock production. Animals are the back bone of hill farming as they provide compost and animal power to crops. Crops provide food to both household and animals. Besides, trees provide raw materials in the form of forage and fodder to feed animals, leaf litter for both animal bedding and composting with dung to provide manure, fuel and timber for the household for heating, cooking and construction. Figure 1 shows a model for interaction among the three components.

In this section, interactions among the three components are quantified and the strength and weakness of the interaction are identified and analyzed. Major interactions identified are crops to livestock, forest to livestock and vice versa. However, inter-linkage among forest to household and vice versa has been taken into consideration as forest products are a significant source of income for the farmers. Therefore, the following interactions are considered ; (i) Crops to livestock, (ii) Livestock to crops, (iii) Forest to livestock, (iv) Forest to crops, (v) Forest to household and, (vi) Household to forest

Crops to Livestock

The interaction between crops and livestock existed as a complementary. Neither could be produced without the existence of the other. Of the two major livestock feed, roughages and concentrates, the latter mostly come from farm products. Crop residues as dry matter roughage were also fed to animals. Overall, about three million tons of crop residues are produced annually in the mid-hills of Nepal and contributed 32% of total feed supply for livestock[22]. In the study villages, major crop residue species were rice and wheat straws, maize stalk, maize grain, and wheat husks. Table 4 indicates the number of farmers, and the amount and variety of crop residues fed to livestock in the three villages. It is noticeable that the amount was small compared to green fodder, though these residues play an important role in the dry season. The variety of residue used depended on the amount of crops produced. For example, in Kaule and Bistagaun there was a large amount of rice straw feed since rice was planted in a larger area, while in Khalchowk maize stalk and by-products of maize and wheat were larger as the area planted and production were large.

Livestock to Crops

Livestock provide draft power and manure as compost. Cultivation of land by using animal power and maintenance of soil fertility through the use of farmyard manure (animal dung) are ancient practices which have continued in Nepal until today. But the amount

of dung produced per animal per day depends upon the amount of forage fed to the animals. As is shown in Table 4, average manure (fresh dung) supplied by animals to produce compost was 9,713 kg, 12,556 kg and 10,457 kg per household per year in Kaule, Khalchowk and Bistaguan respectively. The animal power used for crop production was 6, 5 and 3 animal days per household in Kaule, Khachowk and Bistagaun respectively. In terms of quantity, the link between livestock and crops looked stronger in Khalchowk than in Kaule and Bistagaun as a greater amount of manure and animal power was available for crops. This could be due to the ownership of a larger number of ruminants by Khalchowk farmers.

Forest to Livestock

Strong linkage has been observed between forest and livestock. Forest is a major source of feed and energy. In the hills and mountain areas, the number of livestock per household is determined by the available area of forest or number of trees[23]. One major feed for livestock is roughage which consisted of bulky feed, containing relatively large amounts of less digestible material and more than 18% fiber[12]. The source of bulky feed is green fodder and forage provided by tree or forest. Forest grass land in the vicinity provided 30% of the fodder requirements and 70% of the firewood needs of the mid hill villages[20]

In our study villages, those farmers who reared livestock necessarily collected grass fodder and litter to feed them. The Bistagaun farmers collected the largest amount of 25,621 kg/year, followed by 22,170 kg/year and 21,538 kg/year by Khalchowk and Kaule farmers. Of the total amount collected, 83% was used to feed animals in the first two villages, 80% in Bistagaun and the rest was made into compost. Ruminants also require a large amount of dry matter, one third of which must be supplied through green stuff. NEUOPANE, *et al.* (1990) estimated that 25 kg fresh material was fed to a buffalo per day[16], although DELOBEL (1986) estimated between 8–36 kg fresh weight per day depending on season and lactation[5]. Another survey conducted in eastern Nepal estimated that buffalo, cow, ox and goat were fed with 30, 21, 12.5 and 3 kg fresh materials per day, respectively[19]. In our study villages, an average of 41, 43 and 42.5 kg per day of fresh material was fed per animal unit respectively in Kaule, Khalchowk and Bistagaun.

Forest to Crops

According to farmers, some amount of raw materials collected either from forest or trees were used to produce compost. In our study villages every household produced and used compost in crop production. Of the total amount of raw materials collected, 17% in Kaule and Khalchowk and 20% in Bistagaun were used for producing compost. It was reported that 10% and 30% respectively of feed given to large ruminants (buffalo, ox and cow) and goat were actually refused[19]. Our study confirmed that 18% of feeds was refused and eventually ended up as compost.

Another benefit provided by forest or trees is the protection of slope fields from soil erosion. Several studies indicated that farmland on hill slopes of Nepal were losing soil at the rate of 8–12 tons/ha/year due to erosion[1]. Table 4 shows that 67% of Khalchowk and 37% of Kaule and 64% of Bistagaun farmers reported trees would conserve the farm land so they planted trees or refrained from cutting trees grown on the edges of terrace farm.

Forest to Household

Another strong linkage identified is between forest or tree products and households. In Nepal, 84% of households used firewood for cooking fuel and 88% of these user households collected them in forests[17]. All farmers of Kaule and Khalchowk collected firewood, whereas 88% of Bistagaun farmers did so. Collected firewood is used as a source of energy for cooking in all three villages. Timber was also an important product of the forest, the use of which varied from year to year. In 2007/08, 10% of Kaule farmers, 20% of Khalchowk farmers and 22% of Bistagaun farmers actually collected and sold timber. In addition, Kaule farmers collected wild flowers and fruits from the forest for sale in the market, while Khalchowk farmers collected wild fruits and food for home consumption. Bistagaun farmers collected some wild fruits for sale in markets and other fruits and food for home consumption.

Household to Forest

Nepal has been known as a leading country of community forest management[23]. The interaction between household and forest does not seem very strong as quantified by numbers but most farmers understood the importance of forestry and conserved the forest. Some farmers also participated in tree plantation programmes organized by Village Development Committee (VDC) or the forestry office. The number of farmers who reported participation was 39% in Kaule and 20% in Khalchowk and 40% in Bistagaun. Most of the farmers also prevented cutting of young trees on their farm land.

Table 4 Interactions between three components in three villages

Interactions	Kaule		Khalchowk		Bistagaun	
	HH %	Ave kg/year/hh	HH %	Ave kg/year/hh	HH %	Ave kg/year/hh
Livestock to Crops						
Animal dung for manure production	88	9,713	100	12,556	90	10,457
Draught power (animal days/ year/hh)	-	6	-	5	-	3
Forest to Livestock						
Grass fodder + litter	100	21,538	100	22,170	90	25,621
Thatching material	15	19	10	205	-	-
Bedding material	-	6,377	-	-	50	6,401
Grazing	-	-	-	-	16	13
Crops to Livestock						
Straw (rice)	89	1,046	71	812	84	1,278
Stalk feeding+ bedding (wheat+maize)	85	732	61	864	90	311
Grains (maize)	100	371	100	459	90	450
Stalk for roofing (wheat + maize)	13	235	5	73	-	-
Husk (wheat)	44	132	39	216	80	207
Forest to Crops						
Grass fodder + litter used for manure	100	3,661	100	3,769	90	6,404
Conserve soil	37	-	67	-	64	-
Forest to Household						
Firewood	100	4,140	100	6,094	88	3,056
Timber (cu.ft)	10	13	20	55	22	3trees/year
Household to Forest						
Plant trees	39	-	20	-	40	-

Source: Field Survey 2007/08

Table 5 Matrix of correlation coefficient among three components

Indicators	Kaule		Khalchowk		Bistagaun	
	No of Big animals	No of Small animals	No of Big animals	No of Small animals	No of Big animals	No of Small animals
Area of private forest	0.489 *	0.201	0.533 **	0.075	0.533 **	0.211
No of trees in farms	0.666 **	0.18	0.345 *	0.122	0.311 *	0.041
Amount of cattle compost used in crops	0.522 **	0.046	0.241 *	0.222	0.370 **	0.205
Planted area for crops	0.479 **	-0.131	0.398 **	-0.123	0.493 **	0.303

Source: Field Survey 2007/08

Correlation Analysis

A statistical analysis was conducted to clarify the level of strength between three components. Indicators taken in consideration to represent three variables are ; area of private forest, number of trees in the farm yard, amount of cattle compost used in crops and planted area of crops. These indicators were correlated with the number of small and big animals separately in order to examine the strength of interaction. The matrix of correlation coefficients of the three villages is shown in Table 5.

The following relationship should be noted ; Firstly there existed a positive correlation between the number of big animals with area of private forest in all three villages. The correlation coefficients are statistically significant at the 10% level in Kaule and at the 5% level in Khalchowk and Bistagaun, indicating that the larger the area of forest, the larger the number of big animals. Similarly, the correlation coefficient between small animals and area of forest was also positive but not statistically significant, indicating that private forest played greater role for big animals.

Second, the correlation coefficient between number of trees on farms and livestock was positive and big animals were significant at the 5% level in Kaule whereas at the 10% in Khalchowk and Bistagaun. This indicated Kaule farmers relied more on trees on farms to feed animals compared to the other two villages.

Third, the correlation between the amount of cattle compost used for crops and the number of big animals was positive in three villages. The larger the number of big animals, the higher was the amount of compost for crops production. The coefficient was statistically significant at the 5% level in Kaule and Bistgaun whereas in Khalchowk it was positive but not significant.

Fourth, the area planted for crops and the numbers of big animals were also found to be positively correlated and statistically significant at the 5% level in all three villages. The farmers with big farms owned a greater number of big animals but the small animals showed a negative relationship with farm size in two villages, Kaule and Khalchowk, in Bistagaun was positive but not significant. Therefore, it is revealed that interacting behavior among big animal and crops is strong but among small animal and crops were not. Small animals were not playing significant roles in crop production, however they were an important source of income to the farmers. Overall, based on the value and significance level of the correlation coefficients, it may be said that there existed the strongest relationship between the number of trees on farm and livestock raised in Kaule. This was supported by the positive interaction between area of private forest and number of livestock in Kaule and Bistagaun. The amount of cattle compost used in crops and the number of animals were also positively correlated in Kaule, leading to the strong positive relationship between the area planted for crops and livestock in the study villages.

Formation of Total Farm Income

This section gives a full description of the actual roles played by the three components in the formation of total farm income under this integrated farming system in the hill region. For this, it is first necessary to analyze input and output. Table 6 shows inputs used per ropani (one ropani＝500sq.m) for crop production. Major inputs were labor, chemical fertilizer, manure, seeds and pesticides in the three villages. Table 7 shows inputs for livestock per animal unit and input for forestry as an average per household per year. Major inputs for livestock were grains, by-products of crops, and labor, while for forestry or tree products the only input was labor. Compared to crops and livestock, forestry required less input, resulting in lower cost. The Khalchowk farmers were applying larger amount

Table 6 Inputs used for all planted crops

Major inputs	Kaule		Khalchowk		Bistagaun	
	HH %	Ave/ Ropani	HH %	Ave/ Ropani	HH %	Ave/ Ropani
Average area planted (Ropani)	100	24	100	18	100	15
Seed (Kg)	79	3	100	5	100	9
Seedling (No.)	40	53	0	0	80	371
Fertilizer (Kg)						
Chemical						
Urea	92	4	71	5	98	8
DAP	96	7	85	6	80	2
MOP	37	0.4	5	0.2	48	0.7
Manure (Kg)						
Cattle manure	100	176	100	350	100	337
Chicken manure	37	7	37	6	70	24
Pesticide (ml.)	48	42	41	8	76	84
Labor Input (Mandays)						
Hired labor	98	4	76	1	90	5
Family labor	100	10	100	11	98	10
Bullock use (Animal days)	96	0.5	76	0.26	20	0.03
Tractor use (Hrs.)	0	0	17	0.05	30	0.28

Note: One ropani= 0.05 ha
Source: Field Survey 2007/08

Table 7 Inputs used for livestock and forestry

	Kaule		Khalchowk		Bistagaun	
	HH %	Ave/ Animal unit	HH %	Ave/ Animal unit	HH %	Ave/ Animal unit
Major inputs for Livestock						
Material Inputs(Kg)						
Grains	90	204	40	368	90	792
Straw	94	1,216	29	590	84	1,129
Husk	46	64	15	94	80	135
Stalk	92	655	6	588	90	221
Fodder	100	13,411	41	14,437	90	14,617
Litter	75	10,148	30	5,948	54	5,051
Thatching material	25	220	6	334	10	57
Grazing(Days/year)	0	0	0	0	16	16.8
Labor Input (Mandays)						
Family labor	98	113	100	162	90	131
Major input for Foresty						
Labor Input (Mandays)	92	43	100	50	90	11

Source: Field Survey 2007/08

Table 8 Value of inputs and output by farming components

Unit : Rs/HH

Villages	Crops	Livestock	Foresty	Total
Kaule				
Total material cost (a)	16,519	5,123	0	21,642
Total labor cost (b)	32,097	10,615	5,811	48,523
Total cash cost (c)	21,142	0	0	21,142
Total cost (A=a+b)	48,616	15,738	5,811	70,165
Gross income (B)	65,628	26,385	20,701	112,715
Net income (C=B-c)	46,017	26,385	20,701	93,104
Net revenue (D=B-A)	17,012	10,647	14,890	42,550
Khalchowk				
Total material cost (a)	10,122	8,567	0	18,110
Total labor cost (b)	16,702	18,117	7,434	42,253
Total cash cost (c)	6,816	0	0	6,816
Total cost (A=a+b)	26,823	26,519	7,434	60,363
Gross income (B)	25,411	34,210	29,691	89,312
Net income (C=B-c)	16,693	34,210	29,691	80,594
Net revenue (D=B-A)	-1,412	7,525	22,257	28,370
Bistagaun				
Total material cost (a)	29,518	8,472	29	38,323
Total labor cost (b)	32,665	15,932	3,629	52,716
Total cash cost (c)	20,023	0	0	20,023
Total cost (A=a+b)	62,184	24,404	3,659	91,039
Gross income (B)	74,628	42,844	10,809	130,005
Net income (C=B-c)	54,861	42,584	10,809	109,983
Net revenue (D=B-A)	12,444	16,659	7,150	38,966

Source: Field Survey 2007/08
One ropani = 0.05 ha

of inputs to livestock and forestry than those of Kaule and Bistagaun. This might be due to the ownership of a larger number of livestock and higher tendency of using forest by Khalchowk farmers.

Table 8 shows value of inputs and output by farming components and the profitability of three major components. Input cost of all produced crop, livestock and forestry/trees has been calculated in average rupees per household per year. Total cost has been categorized in material cost and labor input cost ; the first one includes cost of seed, chemical fertilizer, manure and pesticide for crop production and for livestock it includes cost of feeds like grass fodder, litter, grains, husk, and straw, however there was no material input cost for forest and tree products except in Bistagaun. The total labor input cost comprises family, hired and exchange labor for crop production, but only family labor for livestock and forestry as these two components were operated by family members only. The value of labor input cost was obtained by multiplying the total labor input by the wage rate per man-day in three villages.

Gross income of crop component is calculated by multiplying the volume of produced crops and crop residue (by-products) by average selling price per kilogram. The gross income for livestock was obtained by multiplying the total animal and animal products produced by per unit price of animal and per kilogram price of animal products. The gross income from forestry was obtained by multiplying the total amount of forest or tree products collected by per kilogram market price of each item. However the items like grass fodder and litter were not marketable, therefore gross income was calculated as the cost of labor investment to collect them. Net revenue is obtained by deducting the total expenditure from gross income, and net income by deducting the total cash expenses from gross income.

Among three components, the value of material input was largest for crops followed by livestock in three villages. There was no material expense for forestry. Value of labor input was also largest for crops followed by livestock and forestry respectively which resulted in a similar trend for total expenses in the three villages. But the value of cash expenses was zero for livestock and forestry in all three villages, resulting in quite satisfactory net revenue compared to crop production which required a larger investment.

Among three components, crop production was giving the largest incomes (gross, net and revenue) to Bistagaun and Kaule farmers respectively but this was not true for Khalchowk farmers. Crops failed to give them the largest gross and net income along with negative net revenue though input used on it was the largest among three components. In contrast, the gross and net incomes were largest from livestock followed by forestry or tree products. The reason for this could be a cultivation of profitable crops like strawberry and

Table 9 Shares of three components in net income and net revenue

Unit : %

Components	Kaule		Khalchowk		Bistagaun	
	Net income	Net revenue	Net income	Net revenue	Net income	Net revenue
Crops	49	40	21	-5	51	35
Livestocks	28	25	42	27	39	47
Forestry	22	35	37	78	10	18

Source: Field Survey 2007/08

vegetable in larger area by Bistagaun and Kaule farmers. However, Khalchowk farmers were putting more effort into obtaining larger income from livestock and forestry as the land suitable for growing profitable crops was small in area.

Table 9 shows the share of each component in net revenue and net income. The share of crops, livestock and forestry constituted 49%, 28% and 22% respectively of total net income among Kaule farmers whereas 21%, 42% and 37% to Khalchowk farmers and 51%, 39% and 10% to Bistagaun farmers. The shares in net revenue were 40%, 25% and 35% in Kaule −5%, 27% and 78% in Khalchowk and 35%, 47% and 18% in Bistagaun village respectively. In Kaule, cropping contributed the largest share to both net income and revenue. In Bistagaun too it constituted the largest share of net income but in Khalchowk the largest net revenue was obtained from forestry followed by livestock. Crops failed to give any net revenue and instead forestry was providing the largest revenue due to timber production on their private forest. Therefore, trees and tree products were the most profitable components for Khalchowk farmers, whereas crops and crop products for Kaule farmers, and crops and livestock for Bistagaun farmers in this integrated farming system.

In order to identify the impact of farm and farmers characteristics on total farm income a student t-test and ANOVA was conducted. ANOVA was utilized for the category of three groups and t-test for two groups. Multiple comparisons among the three groups were obtained by Tukey's HSD test. Major farm and farmers characteristics contributing to make the difference in total farm income were size of farm, level of education, age, size of animal herd and ownership of private forest in three villages. Tables 10, 11 and 12 show the differences in the three villages. In Kaule and Bistagaun small farms are those which operated farms less than the average size and big farms are those operated larger than the average size. However, in Kaule as farmers owned larger farms compared to other two villages, sizes were categorized in three groups ; small, medium and large. The differences in farm size, education, tenural status and area of forest privately owned played a significant role in gross income, net income

Table 10 Comparison of incomes and net revenue per ropani in Kaule

Dependent Variables	No of farmers	Ave. gross income	F value	Ave. net revenu	F value	Ave. net income	F value
Farm Size							
Small farms (Less than 5 ropani)	12	11,593 a	3.153*	4,488 a	0.58^{ns}	10,659 a	3.83*
Medium farms (5 -15 ropani)	20	5,081 ab		1,385 a		4,248 ab	
Big farms (Above 15 ropani)	20	3,995 b		2,206 a		3,659 b	
Education							
Not attended school	35	1,541 a		-1,381 a		415 a	
Attended school (1-10years)	17	7,372 b		5,011 b		6,512 b	
Age							
Young (Below 50 years)	18	2,260 a		-723 a		1,095 a	
Old (Above 50 years)	34	4,076 a		1,466 a		3,103 a	
Tenurial Status							
Owner farmers	49	3,011 a		210 a		1,963 a	
Owner-tenant farmers	3	10,576 b		8,847 b		9,683 b	
Size of Livestock Herd (Animal unit)							
Small size (Below 2 au)	28	2,500 a		-3 a		1,530 a	
Big size (Above 2 au)	24	4,552 a		1,538 a		3,433 b	
Area of Private Forest							
No Private forest	40	1,922 a	6.82***	-703 a	6.02***	949 a	6.14***
Small (Below 1 ropani)	4	22,900 b		17,816 b		20,915 b	
Big (Above 1 ropani)	8	1,348 a		-790 a		449 a	

Note: Different letters a and b denote significant difference at the 5% probability level (t-test)
Different letters a, b and c denote significant difference at the 5% probability level (ANOVA)
*** Denotes significance at the one percent probability level.
* Denotes significance at the ten percent probability level.
Source: Field Survey 2007/08

Table 11 Comparison of incomes per ropani in Khalchowk

Dependent Variables	No of farmers	Ave. gross income	F value	Ave. net revenu	F value	Ave. net income	F value
Farm Size							
Small farms (Less than average)	32	16,142 a		4,423 a		14,851 a	
Big farms (Above average)	9	5,777 b		2,014 b		5,164 b	
Education							
Uneducated (Not attended school)	26	11,236 a		368 a		10,027 a	
Secondary level (1-10years)	15	18,426 b		10,006 b		17,400 b	
Age							
Young (Below 50 years)	12	16,078 a		5,411 a		14,949 a	
Old (Above 50 years)	29	12,952 a		3,266 a		11,803 a	
Size of Livestock Herd (Animal unit)							
Small size (Below 2 au)	20	8,330 a		488 a		7,460 a	
Big size (Above 2 au)	21	19,140 b		7,138 b		17,738 b	
Area of Private Forest							
No Private forest	18	12,302 a	19.46***	-236 a	1.06^{ns}	11,250 a	18.1***
Small (Below 1 ropani)	3	14,875 b		5,757 a		13,303 b	
Big (Above 1 ropani)	20	15,123 a		7,332 a		13,965 b	

Note: Different letters "a" and "b" denote significant difference at the 5% probability level (t-test)
Different letters a, b and c denote significant difference at the 5% probability level (ANOVA)
*** Denotes significance at the one percent probability level.
Source: Field Survey 2007/08

Table 12 Comparison of incomes per ropani in Bistagaun

Dependent Variables	No of farmers	Ave. gross income	F value	Ave. net revenu	F value	Ave. net income	F value
Farm Size							
Small farms (Less than average)	33	29,515 a		25,845 a		24,730 a	
Big farms (Above average)	17	20,420 b		19,703 a		19,386 b	
Education							
Uneducated (Not attended school)	22	20,032 a	3.99**	5,076 a	3.07**	12,105 a	4.02**
Secondary level (1-10years)	20	21,061 a		400 a		9,744 a	
Tertiary level (Above 10 years)	8	48,630 b		24,925 b		35,430 b	
Age							
Young (Below 50 years)	22	30,081 a		6,443 a		16,345 a	
Old (Above 50 years)	28	21,042 a		5,577 a		12,705 a	
Tenural Status							
Owner farmers	38	25,389 a	0.10^{ns}	5,813 a	0.542^{ns}	14,517 a	0.68^{ns}
Owner-tenant farmers	8	25,371 a		12,881 a		18,112 a	
Tenant farmers	4	18,583 a		-1,218 a		12,023 a	
Size of Livestock Herd (Animal unit)							
Small size (Below 2 au)	27	21,842 a		11,313 a		11,834 a	
Big size (Above 2 au)	23	28,749 b		19,095 b		18,159 b	
Area of Private Forest							
No Private forest	28	27,802 a	1.46^{ns}	7,746 a	1.33^{ns}	17,011 a	1.06^{ns}
Small (Below 1 ropani)	14	16,172 a		-1,066 a		6,277 a	
Big (Above 1 ropani)	8	30,759 a		14,640 a		22,556 a	

Note: Different letters a and b denote significant difference at the 5% probability level (t-test)
Different letters a, b and c denote significant difference at the 5% probability level (ANOVA)
** Denotes significance at the one percent probability level.
Source: Field Survey 2007/08

and revenue per ropani in Kaule village. Small, educated owner farmers owing private forest below one ropani appeared to be more efficient.

In Khalchowk, farm size, education of household head and size of livestock herd were discovered to have significant impact on gross income, net income, and revenue. Small farms with educated heads owning a large number of livestock were found to be more efficient. Similarly, in Bistagaun farm size, education level of household head and size of livestock herd made a difference in gross income, net income, and revenue. Results shows that small farms with higher level of education of household head, owning larger number of livestock and private forest were more efficient.

Hence, in all three villages, major farm characteristics contributing to make a positive impact on gross income, net income and revenue were farm size, level of education, number of livestock and area of privately owned forest.

Gross Income Determination

A logarithm regression analysis was conducted in order to clarify the mechanism of gross income determination. In order to give a clear picture of the gross income determination process in the mid-hills of Nepal, the three study villages were combined together and a single model was constructed. Table 13 presents the results of the estimation. Variables taken into consideration are farm size, labor input, number of livestock, area of private forest and education.

The result of estimation revealed that all five variables and their regression coefficients are statistically significant, indicating that increase in the size of farm, private forest and level of education with more labor and livestock can increase the total gross income. The largest magnitude of the regression coefficient for labor proves that labor was the most important factor in the determination of gross income, followed by farm size, number of animals raised, area of private forest and years of education.

Table 13 Gross income determination in three villages

Independent Variables	Reg.coff.	t value
Constant	9.511	
Farm size(ropani)	0.205 ***	3.737
No of animal (animal unit)	0.199 ***	5.301
Area of private forest (ropani)	0.049 ***	3.123
Education level (yrs)	0.029 **	2.065
Labor(mandays)	0.264 ***	2.769
N	143	
R square value	0.44	
F value	21.11	

Note:*** Denotes significance at the one percent probability level.
** Denotes significance at the five percent probability level.

Overall, this model of gross income determination revealed that the major independent variables positively contributing to increase gross income were labor input, farm size, privately own forest, livestock and education in the mid-hills of Nepal.

Conclusion

This paper attempted to clarify the nature of interactions among crops, livestock and forest in the mid-hill farming system in Nepal. Data were gathered from three mid hill villages in 2006 and 2007. The quantification of input and output for each component, the strength and weakness of interactions and the roles of each component in gross income determination were analyzed. It can be concluded as follows :

- ☆ Among the existing interactions of the three components, the strongest was discovered to be between forest/trees and livestock and vice versa in all three villages.
- ☆ The linkage between forest and household also showed strong interaction. Households were highly dependent on forest for fuel and other products and contributed by planting trees or preventing them from being cut. This linkage was strongest in Kaule and Khalchowk compared to Bistgaun village.
- ☆ Among the three components crop was the most profitable component as it gave the largest net income and revenue to Bistagun farmers followed by Kaule farmers, but this was not true for Khalchowk farmers where forestry was the most profitable.
- ☆ Farm size, labor input, level of education of household head, size of livestock herd, and area of private forest were positive determinants of the total farm income in all three villages.

Overall, it is proved that there existed a close, strong interrelationship among crops, livestock and forestry. Three components played significant roles in the formation of farm income. Therefore, strengthening and improvement in the orthodox relationship between the three components could be an outstanding solution to increase the income in the mid-hills as small operated farm limits the opportunity from crop production only. The increment in the farm income will contribute to improve the living standard of the small, rural, marginal farmers which will ultimately contribute to the poverty reduction of Nepal.

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ネパール丘陵地における主要農業経営部門の経済分析

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要約：ネパールは生態系によって平坦地帯，丘陵地帯および山岳地帯の三地域に大別され，それぞれ異なる自然環境，土地基盤，社会経済条件を有し，多様なファーミングシステムを特徴としている。丘陵地帯の斜面やテラスで営まれている伝統的な営農システムは地域固有で環境適応型であるが，近年はより高い生産性を目指して変遷しつつある。伝統的システムは，作物，家畜，および森林の3部門から成る。作物は家畜に対してエサと敷き藁を提供し，家畜は役力と堆厩肥を提供する。森林は家畜のエサを提供するだけでなく地力維持にも貢献する。このような部門間の補完関係に注目し，本稿はネパール丘陵地帯の3村落での質問票調査に基づいて，高地農業と農家経済の持続性を物的経済的視点から検討した。

その結果，森林と家畜の相互依存が最も顕著であること，また農家経済の森林依存度が高いことが明らかになった。作物部門は最も高い収益性を示すと考えられたが，村落の土地および森林の条件によって異なった。経営耕地面積，教育水準，家畜規模および私有林面積の4変数が調査村の農家所得の重要な決定要因であることを示した。

キーワード：ファーミングシステム，作物，家畜，森林，補完関係，農家所得，回帰分析

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