INTEGRATION OF CROP, ANIMAL AND TREE IN RICE-BASED FARMING SYSTEMS OF HILLS AND TERAI OF NEPAL: SOME SUCCESSFUL CASES

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ABSTRACT

Nepalese farmers have evolved and sustained diverse farming systems with the integration of crops, animals and trees. However, documentation of such farming systems is very rare. The objectives of this case study were: (1) to describe the dynamics of the farming systems practiced by the selected farmers of mid-hills (1100-2000 m) and terai (350 m); (2) to investigate the strategies of sustainability of their farms; and (3) to enumerate men's, women's and children's responsibility in different farm operations. A purposive sampling technique was used to select the farmers. The results showed that the farms were sustaining well in both regions, with the greater degree of sustainability in the hills. Family labor contributed two-thirds of total labor in crop production, whereas, the family labor contribution was 87 and 95% for hills and terai, respectively for animal production. Children significantly contributed to farming systems in the hills, but not in terai. Men and women were equally responsible in sustaining the farming systems in both regions. Greater degree of crop, animal and tree integration, farmers indigenous/traditional knowledge and strong institutional support were some of the strategies for the hill farms to be sustainable. Besides, the effective utilization of family labor and good coordination among family members also resulted in sustainable farming systems in both study areas. The results suggest that documentation of the farming systems of the successful farmers across the different agroecologies should be a continuing effort of any farming systems research program.

INTRODUCTION

Farming systems in mid-hills and terais of Nepal are predominantly small farm-based and subsistence in nature. They are more intensive and diversified in the mid-hills than in the terais. Rice is the major crop in all the low-lying areas of terai and in many areas of low to mid-hills. In addition, several other crops, including trees, are grown either in mixed or sequential fashions. Animals constitute a component of farming system. Many of the advanced farmers have evolved and sustained technologies by integrating crops and animals with rice. For instance, crop residues and by-products are essentially utilized for animal feeding and the manure from the animals are used for fertilizing the land. In addition, animals supply the main power for tillage. Still in other cases, green manuring crops are grown for better production of rice. The sustained technologies are results of coordination among men, women

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and children in the households. Both men and women in the households are involved in farming (Timsina and Timsina 1988, Timsina et al 1989) and hence, both have contributed towards successful farming.

Few examples of successful farming communities need elucidations. In Dhankuta and Terhathum districts (mid-hills), many farmers are practicing and evolving new cropping patterns and raising swine and buffaloes for several years. Likewise in Ilam district (mid-hill), dairy cattle are popular among farmers. Besides diversification on crops and animals, a great diversity of fodder trees exists in the mid-hill areas (Thapa 1985, Sharma and Pradhan, 1985, Thapa 1985). Fodder trees are the main sources of green fodder during winter months, when no other green forage is available for livestock. Farmers also grow diverse species of fruit trees and vegetables in these areas. Successful and well-sustained crop-animal-tree integrated farming systems have been reported also for other mid-hill areas (Chhetri 1988, Oli 1988, Shrestha and Sherchand 1988).

In Chitwan district, and inner terai, rice-maize-mustard is a predominant cropping pattern (Timsina 1986, Timsina and Subedi 1986). In Janakpur and Parsa districts (both terais), farmers have been growing Sesbania sp., a green manure crop proved to successfully increase rice yields.

Indeed, there are lots of crop-animal integration practices that exist in several farms of Nepal. However, very little attention has been given to document such practices. Documentations regarding farmer's traditional/indigenous knowledge have been made only recently (Bhattaria et al, 1989, Chand et al 1990). Jodha (1990) for instance, analyzed the issues of sustainability in the mountain agriculture of Nepal. He reported that inaccessibility, fragility, marginality, diversity or heterogeneity, niche availability and human adoption mechanisms are "mountain specifics", and farmers have developed strategies in response to those specificities.

With the realization of the fact that farmers are dynamic, innovative, possessing traditional knowledge and have been evolving technologies suitable to their farms, documentation of technologies that they practiced becomes extremely important. Such farmers could then be considered as successful or "model" farmers, and such technologies along with the improved technologies generated from scientific researches would be valuable for dissemination to other farmers.

The objectives of the case studies were as follows:

1. To compare the socio-economic characteristics of farmers of the mid-hills and the terai
2. To describe and analyze the systems dynamics in the hills and the terai
3. To analyze the farmers' strategies in the choice of crops, animals and trees to maximize farm productivity
4. To enumerate men's, women's and children's roles in making their farms successful

Methodology

Description of study sites

The study was conducted in Dhankuta, Terhathun (representing mid-hills) and Chitwan (representing terai) districts of Nepal.

Dhankuta and Terhathum. The study sites included Hattikharka, Sanne, Ghorlikharka and Phalante villages from Dhankuta and Sukrabare, Pokhari and Aangdeem villages from Terhathum (Fig 1). The terrain of these areas is steep with terraced hillsides cut by many streams and rivers. The farmers have lands ranging from river basin in low (<1100 m) to steep lands in mid (1100-2000 m) and high (2000-5000 m) altitude areas. Climatically, such lands are respectively classified as **besi** (hot/dry subtropical), **Kacchad** (warm temperate) and **Lekh** (cool temperature). Soils are extremely variable, reflecting differences in bed rock, geomorphology, microclimate and past land use. They are weakly acidic with pH range of 6.0 - 7.0 (Goldsmith 1981). The soil texture is sandy loam to loam in the mid-altitude, but is red colored clay in the low attitude. The latter soils are classified as T. Rhodadalfs and U. Rhodadalfs, while the former are D. Eutrocherpts and T. Dystrochrepts (Sherchand 1987).

Chitwan. The study sites, Dhaka, Shivangar and Kesharbag villages, are located at about 350 m elevation. The climate is sub-tropical and has annual rainfall of about 1800 mm with four wet (more than 200 mm) and eight dry (less than 100 mm) mo. The soil texture is clay loam and belongs to class Inceptisol. The major land types are lowlands (rainfed and irrigated) and uplands (rainfed). The above facts are simple extrapolations from Rat-nanagar (Timsina and Subedi 1986), a site very close to our study areas.

Sampling procedure

A list of rice growing farmers from the study areas in the hills was obtained from Pakhribas Agricultural Centre (PAC) while that in terai was obtained from local key informants. Eleven farmers (five from Dhankuta and six from Terhathum) from the hills and 13 from the terai were selected via purposive judgemental sampling. Sample farmers were chosen from various farms and family sizes, and represented relatively better-off farmers from the farming communities.

Data collection

The data were gathered through personal interview using an interview schedule. Information regarding the farmers' household and farm characteristics, farm management practices, crops and animals raised, products and by-products utilization, farmer's traditional/indigenous knowledge and practices in crop-animal integration, gender specific roles in farm related decisions and participations and others were included in the interview schedule. Each interview was followed by a visit by the study team to the farmer.

Data analysis

The case studies were in-depth exploratory and descriptive in nature. The data were analyzed using simple statistical tools such as means, percentages and ranges. System dynamics for hills and terai were described.

Results and Discussion

Farmers and farming systems

The hill farmers have an average family size of 11.1 and a farm size of 4.88 ha, with a farm to individual ratio of 0.44 ha. The corresponding values for the terai were 9.0, 2.0 and 0.44 ha. Taking into account the significant uncultivated areas occupied by terrace walls, slopes, streams and gulleys, the farm size is still small in the hills. Majority of the farmers in both agroclimatic regions were literate (Table 1).

The farmers from the hills have two types of lands; Besi and Kacchad. The farmers stayed in the kacchad areas but also owned lands in besi. The term **Khet** was used for irrigated rice terraces while **bari** was for unirrigated contour terraces in both besi and kacchad areas. The terai farmers have also two types of lands: lowlands and uplands. The lands that were bunded and could accumulate water during rain or irrigation were classified as lowlands while the lands without any bund and are located in relatively higher landscape are classified as uplands. Table 2 shows the predominant cropping patterns adopted by the farmers of the hills and the terai. Fewer but highly intensive cropping patterns existed in terai against several cropping patterns in the hills. Rice-based farming systems was dominant in the khet lands especially in besi, but maize-based system was predominant in the bari lands. Maize crop was mixed with beans, soybean, fingermillet and several vegetables. Rice-based farming system is dominant in the terai.

Cattle, buffaloes and goats were important components of farming systems in both hills and terai. A large number of farmers also raised poultry (Table 3). Cattle, buffaloes, goats and swine were stall-fed. Poultry were raised in pens or open-grazed while the pigeons were open-grazed.

The hill farmers raised diverse species of fodder trees and grasses that supply nutritious fodder during winter season when green forages were scarce (Table 4). The terai farmers, however, have fewer fodder trees (Table 5). The tables show that some of the trees are grown even for triple purposes, such as fodder, fuel and timber.

The system dynamics or the flow or different products and by-products and the relationship among different farm resources of the farmers of the hills and the terai are presented in Figures 2 and 3.

Technology adoption

Crops. The hill farmers reported the use of traditional varieties of rice, mustard, and fingermillet; and traditional and improved varieties of maize and wheat. In the terai, on the other hand, farmers largely used Mansuli, an improved variety of rice (Table 3). For fertilizer, farmers applied a large amount of compost and farm yard manure, especially to maize, with the use of chemical fertilizers very minimal.

Animals. Except for a few, most of the hill farmers owned local breeds of animals. The feeds (both concentrates and roughages) provided to animals were home prepared with the raw materials produced in their own farms. Rice straw was the main source of dry roughage. The fodder trees grown in their bari lands, the grasses from risers and bunds and the crop weeds provided green forage. In terai, farmers raised improved breeds in relatively greater proportion. Maize crop was an important source of fodder. Besides using the home made concentrate feed, they also used commercial feed meals. Fodder supply was a serious problem particularly during winter.

Strategies for Sustainability

The analysis of the farmers' farming systems showed that these farmers have developed a number of strategies for sustainability. Besides, social and institutional factors have also contributed a lot towards the success of the farms.

Some of these strategies are as follows:

Crop-animal-tree integration

Farmers were in favor of growing traditional varieties of crop species over the improved ones, except for situations where entirely new species (e.g. wheat) is introduced in the farming communities. Local/traditional varieties were highly acceptable to the farmers because they are: (i) easily available in the farming communities (ii) highly adaptable in the local environments; (iii) produce significantly high biomass required for their livestock and for manuring purposes; (iv) require no or minimal amount of imported input such as chemical fertilizer and pesticides; (v) are relatively resistant to insect pests and diseases; and (vi) are socially acceptable, like for example "local seti" variety of maize being preferred because it tastes like rice.

Except for a few, most of the hill farmers were in favor of raising local poultry and goats over the improved breeds which could not tolerate low temperature that they either become very weak or die. Most cattle and buffaloes were local although few farmers were raising Jersey cattle Murrah buffaloes. The reluctance to raise the improved breeds of animals was mainly associated with (i) greater susceptibility to diseases and (ii) requirement for balanced diet which is not, in general, available in the villages. Most pigs on the other hand, were crossbreds of local and improved breeds.

In terai, farmers raised local as well as improved breeds of cattle, buffaloes, and poultry. They felt that the improved breeds produced more milk and meat than the local ones but also required more feed. The main problem in this region was the lack of quality concentrate feed and the lack of improved animals.

The hill farmers grew several species of fodder trees and grasses in the contours of the farmlands to meet the demand of the ruminants. The terai farmers, however, have fewer species of fodder trees and grasses than that of the hills showing a lesser degree of crop-animal-tree interaction. Control of soil erosion and environmental protection were additional intangible benefits from such trees and grasses. Such strategy of growing trees is scientific and innovative since

environmental degradation and maintenance of hill ecosystems are of major concerns not only for the sustainability of hill development itself, but also for the reduction of the havoc in the flatland terais due to afforestation of the hills.

Multiple uses of crops and animals and their by-products

Crops and animals and their by-products were used in multiple ways. For example, aside from rice which was consumed by the farmers and their families, rice hulls/husks, brans flours and straw were intensively used also. Rice hulls/husks were either burnt in the field for manures or used as litters. Rice brans were fed to animals by mixing with other farm products. Broken rice was used as human or animal food. Rice straw was used as animal feed, as roofing material, as a material for making cushions or carpets and even as fuel. Likewise, other crop by-products also offered several uses to the farmers (Table 6).

In case of animals, cattle, for example, cows were used for milk (and milk products after processing) and the male ones were used for plowing and for carrying farm products from farm to the market and vice-versa. Both male and female cattle produced manures which were used in their farms as fertilizers. The cow was also worshipped as sacred animal in Hindu culture. The multiple uses/opportunities offered by other animals and their by-products are in Table 7.

Such diverse uses of crop and animals and their by-products suggest that the farmers, especially in the hills, are trying to maximize the use of their farm resources. To a subsistence farmer, such diversities are important for income generation, risk adjustment and sustained living.

Farmers' interest and indigenous knowledges in farming

The farmers expressed a great deal of interest, motivation and enthusiasm towards farming. They realized that farming is a way of life and mentioned some indigenous practices which they used to control insects and diseases of plants and animals (Table 8).

Extension and training opportunities for the farmers

The extension services in the study areas were satisfactory. Almost all the farmers of the hills received at least one or two trainings on seed, livestock, vegetable production and tree nursery raising. These trainings were given by PAC, Paripatle Horticulture Farm, Jhumka Seed Production Farm and other agriculture centers or farms in the country. One farmer (Mr. Tek Bahadur Basnet, Aangdeem, Terhathum) even reported that he had received 40 different formal and informal trainings on different aspects of agriculture. He has relatively bigger farm size (12 ha) and was involved in many enterprises, including seed production of vegetable crops; nursery raising of fruits, fodder trees, tea and cardamom; and animal production. He tried to convince the farmers in his locality to involve in these activities, and latter campaigned from farmer-to-farmer. While such training and extension opportunities were deemed to be paramount, the issues on whether such opportunities could be provided to the farmers of other localities seemed to be debatable. This was because many factors including political influences, social status in terms of wealth and property, and favoritism and nepotism were serious bottlenecks in Nepal. However,

the farmer's self-enthusiasm and initiatives to obtain training opportunities should always be considered.

The terai farmers received less extension services and training opportunities than those of the hill farmers.

Institutional support

Institutions were also working fairly well in the hills, especially in Terhathum. Two institutions are existing:

(i) **National Level institutions.**

The Agricultural Development Bank (ADB) and Agricultural Inputs Corporation (AIC) were providing a great deal of support to the farmers. The AIC assured the family of supply of chemical fertilizers and necessary inputs and the buying of the seeds of vegetable crops immediately after harvest. This way, farmers never face shortage of inputs and constraint on shortage. They stored vegetable seeds, either through the indigenous way of hanging the unthreshed seeds in the kitchen; or by using storage drums supplied by the Rural Save Grain Project at a nominal cost. The ADB also provided needed loans to the farmers so that they could buy the necessary inputs on time.

(ii) **Community Level institutions.**

The farmers of the hills maintained sufficient stock of crop and vegetable seeds, and seedlings of fruits, vegetable, fodder trees, tea and cardamom. Hence, they served as farmers' or community level institutions supplying seeds and seedlings to the farmers in their locality and those from the neighboring villages. They reported that they don't have to go to the market to sell the products, rather, their neighbors come to buy whatever they need. There was also farmers' association for animal improvement.

In the terai, farmers reported that the ADB's support was appreciative but AIC was not active. There was a community level dairy center which bought all the milk that the farmers wanted to sell.

Gender responsibility in farming system

Gender analysis yielded interesting information. All the households under investigation were male-headed and the head decided on all the crop production related activities. Women's decisions were comparatively less (Tables 9 and 10). However, for most of the animal production activities, women's decisions were more important, particularly in hills. Such results are in line with the study of Timsina et al (1989) conducted in other hills and terais of Nepal.

Gender analysis on actual labor participation showed that the family labor provided two-thirds of total labors required in the farm (Table 11). This was true for both hills and terai. The children and women contributed about 5.0 and 46.5%, respectively, to the total labor demand in the hills. The data on children's

contribution were not collected for terai since initial survey showed that they did not significantly participate in any of the activities. The study revealed that there were gender specific tasks like crop management, which included insect pests, diseases and weed control, done mostly by the women in the terai, but predominantly a men's task in the hills.

In animal production, family labor contributed about 87 and 95% of the total labor demand, two-thirds of which were contributed by the men (Table 12). The children's contribution was about 8.0% in the hills. Although men's contribution was greater in terms of total labor supply, women were more responsible in some tasks such as feeding, cleaning and milking of different animals. In general, the outside activities were performed by men while the inside works were done by women. Fodder and forage production was men's responsibility since it required climbing of trees. Women expressed that if shrubs and perennial grasses were available, they would be involved more in their management since they do not require climbing.

It can be argued that the effective utilization of labor in the farm family, gender specific tasks in farming and good coordination among the family members might have contributed largely to the sustainability of the farms.

Implications and Conclusions

The case studies presented have valid implications towards the farming systems practitioners and policy making bodies of the government. To a farming practitioner, such study can provide direct input about farmers' criteria on changing any cropping pattern, choosing and accepting crop varieties and animal breeds, and indigenous ways of practicing agriculture, which can be utilized in designing, testing and recommending technologies to a large number of farmers with similar recommendation domains. To a policy maker, such study can provide tremendous feedback about farmers' knowledge and institutions' role which can be utilized in planning, prioritizing and implementing the agricultural programs.

The study clearly showed maize and rice as important crops in hills and terai, respectively. One of the hill farmers also expressed that he was in favor of moving from rice to cardamom culture, since the latter requires less inputs but gives more output (Yadav karki, Phalante village, Dhankuta). He acquired this knowledge by visiting a nearby cardamon growing areas. While many other innovations could be learned from the farmers, such studies should be carried out to as many hills of Nepal, where farmers have been practicing traditional agriculture over centuries and are evolving new farming systems for income diversification and risk adjustment. Documentation of such studies will provide a wealth of information to disseminate the technologies to the farmers of similar recommendation domain. The documentation can also help to develop models that can work under farmers' complex socio-economic and changing bio-physical situations.

Caution however, should be made in disseminating or extrapolating the technologies of the farmers under investigation. It was made clear that the hill farmers had farm size that could well be managed by the family members. Hired labors were seldom used. Being physically located in remote areas, they had no other choice except to involve in farming. Besides, support of institutions such as AIC and ADB was noteworthy. The farmers were also well-trained and received good extension service. In terai, however, institution's role was comparatively less and the farmers received less training. Being physically located near the town and urban

areas, external influences and opportunities diverted farmer's interest from farming. Hence, one should prepare correct inventory of socio-economic, bio-physical and institutional settings where such technologies are to be disseminated.

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Table 1. Socio-economic attributes of hills and terai farmers.

Attribute	Hills (n=10)	Terai (n=13)
Age (yr)	47	46
Education (%)		
Illiterate	30	31
Literate	70	69
Family size (no)	11.1	9
Farm size (ha)	4.88	2.0
Farm: Individual ratio (ha)	0.44	0.22
Means of transportation	on foot	Truck, Tractor, bullock, cycle Riksha
Accessibility to market	3 hr	6.3 km

Table 2. Cropping patterns by land type adopted by hills and Terai farmers (in number).

Cropping patterns	Hills (n=10)		Terai (n=13)	
	Beshi	Kacchad	Lowland	Upland
Rice-Mustard-Maize	1	-	2	6
Rice-Fallow-Maize	-	1	1	-
Rice-Wheat-Maize	2	-	2	6
Rice-Wheat-Fallow	5		-	2
Rice-Mustard-Fallow	1	-	1	3
Rice-Lentil-Maize	-	2	-	1
Rice-Maize-Fallow	2	-	-	2
Rice-Raddish-Fallow	1	1	-	-
Rice-Cabbage-Fallow	1	1	-	-
Rice-Wheat+pea-Maize	-	1	-	-
Rice-Squash-Fallow	1	-	-	-
Rice-Fallow-Fallow	-	1	-	-
Rice-Lentil-Fallow	-	-	-	1
Maize-Mustard-Maize	-	-	-	1
Maize-Sesame-Mustard	-	-	-	1
Maize-Mustard-Fallow	-	3	-	2
Maize-Fingermillet-Fallow	-	1	-	-
Maize-Rice-Potato+Mustard	-	1	-	-
Maize/Fingermillet-Wheat	-	1	-	-
Maize-Potato+Cauliflower - Fallow	-	1	-	-
Maize-Wheat-Fallow	-	1	-	-
Vegetable seed production	-	1	-	-
Maize + Soybeans + Beans	-	3	-	-

Table 3. Crop varieties grown and animals raised by farmers.

Species	Hills		Terai	
	Crops			
Rice				
	Atte marshi	(6)*	Mansuli	(10)
	Patle marshi	(3)	Basmati	(2)
	Pokhareli masinu	(3)	Wasan	(3)
	Darmali	(3)	Ghaiya	(2)
	Tauli	(3)	Local (unknown)	(2)
Maize	Local seti	(6)	Rampur Yellow	(8)
	Local Paheli	(4)	Khumal Yellow	(4)
	Rampur yellow	(3)	Local (Unknown)	(1)
	Hetauda composite	(3)		
	Mankamana - 1	(3)		
Wheat				
	RR 21	(5)	RR 21	(7)
	NL 64	(2)	Kalyansona	(1)
	Annapurna-1	(1)	Local (unknown)	(1)
	Annapurna-2	(1)		
Mustard				
	Taulo	(1)	Taulo	(1)
	Gopi	(1)	Local (unknown)	(12)
	Local (unknown)	(5)		
Fingermillet				
	Mudke	(3)	-	
		Animal (holding size)		
Cattle	8	(10)	8	(13)
Buffalces	4	(8)	4	(8)
Goats	8	(10)	6	(11)
Swine	2	(2)	-	-
Poultry	32	(6)	15	(6)
Rabbits	6	(1)	-	-
Pigeon	10	(2)	-	-
Ducks	5	(1)	-	-

*Figures in parenthesis represent the number of respondents.

Table 4. Important fodder trees, shrubs and grasses grown in the risers and bunds or wastelands by the respondents of the hills.

Species		Local name	Uses	Months of fodder availability
Trees & shrubs				
Ficus roxburghii	(7)*	Nebharo	Fodder	Dec-Mar
F. nemoralis	(5)	Dudhilo	Fodder, Fuel	Apr-Dec
Sauraria nepaulensis	(1)	Gogun	Fodder	Mar-Oct
Dendrocalamus sp.	(1)	Bans	Fodder, Fuel Construction	Jan-Feb
Litsea polyantha	(3)	Kutmero	Fodder	Mar-Apr
F. lacor	(2)	Kabhro	Fodder	Mar-Apr
Bauhinia purpurea	(3)	Tanki	Fodder	Apr-May
F. Semicordata	(3)	Khanyu	Fodder	Apr-May
Celtis australis	(4)	Khari	Fodder, Fuel Timber	Mar-Apr
Artocarpus lakoocha	(2)	Badahar	Fodder	Mar-Apr
Prunus Cerasoides	(2)	Painyu	Fodder, Fuel Timber	Mar-Apr
Juglans regia	(1)	Okhar	Fodder, Fuel	
Thysanolaena maxima	(3)	Amliso	Fodder Broom	Jan-Apr
Leucaena leucocephala	(1)	Ipil-ipil	Fodder, Fuel	Mar-Apr
Grases				
Avena sativa	(2)	Oat	Fodder	Nov-Jan
Desmodium sp.	(5)	Desmodium	Fodder	Jan-Apr
Setaria anceps	(5)	Setaria	Fodder	Sept-May
Pennisetum purpureum	(7)	Napier	Fodder	Sept-May

*Figures in parenthesis represent the number of respondents growing the trees or grasses.

Table 5. Important fodder trees and grasses grown in farmlands by the respondents of the terai.

Species		Local name	Uses	Months of fodder availability
Trees				
Ficus semicordata	(5)*	Khanyu	Fodder	Jan-Jun
Bauhinia purpurea	(2)	Tanki	Fodder	Aug-May
F. locor	(1)	Kabhro	Fodder	Aug-May
Artocarpus lakoocha	(9)	Badahar	Fodder	
Dendrocalamus sp	(1)	Bans	Fodder, Fuel, Construction	
Ficus sp.	(4)	Dumri	Fodder	
Leucaena leucocephala	(6)	Ipil-Ipil	Fodder	
Morus alba	(2)	Kimbu	Fodder	
Garuga pinnata	(2)	Dabdabe	Fodder	
Grasses				
Avena sativa	(4)	Oat	Fodder	Nov-Mar
Pennisetum purpureum	(5)	Napier	Fodder	
Ficus hispida	(1)	Thotne	Fodder	

*Figures in parenthesis represent the number of respondents growing trees or grasses.

Table 6. Uses or practice of crop and their by-products.

Crop	Bi-products		Uses/Practices
Rice	Hulls, husks	1	Fed to animals
		2	Burnt in field for manuring
		3	Burnt as fuel
		4	Bedding material for animals
	Flour	1	Eaten by farmers
		2	Fed to animals, especially to ruminants
	Bran	1	Eaten by farmers
		2	Fed to animals
	Straw	1	Fed to animals as animals roughage
		2	Roofing material for house construction
		3	Material for making customs and carpets
Maize	Stalk	1	Fed to animals
		2	Used as manure
		3	Dried stalk burnt as fuel.
		4	Used as fence
		5	Used as staking material.
	Cob husk	1	Fed to animals
	Flour	1	Eaten by farmers (in hills)
		2	Fed to animals
	thrushed cob	1	Burnt as fuel
	Leaves	1	Fodder for animal (in terai)
Wheat	Flour	1	Eaten by farmers
		2	Fed to animals
	Straw	1	Fed to animals
		2	Used as rooting materials
		3	Used as mulch in nursery (in hills)
	Hulls	1	Burnt in fields for manuring.
Mustard	Cake	1	Fed to animals after mixing and cooking with other farm products.
		2	Used as coating material for wooden containers ans baskets to provide roughness
	Straw	1	Burnt as manures
		2	Bedding materials for animals
		3	Fed to animals
Soybeans/ beans	Grain	1	Eaten by farmers
	Leaves and stems	1	Fed to animals
		2	Used as green manures
Fingermillet	Flour	1	Eaten by farmers (in hills)
		2	used for preparation of local liquors (in hills)
	Straw	1	Fed to animals
Potato	Leaves and stems	1	Used a manures in farms

*The uses/practices are valid for both hills and terai, unless otherwise stated inside the parentheses.

Table 7. Uses of animals and their by-products*.

Animal		Uses/Practices
Cattle	1	Males for plowing and carrying farm products: females for milking
	2	Males for threshing of crops
	3	Females are worshipped
	4	Males and females provide manures for farms
	5	Milk is processed to several products
Buffalces	1	Males for plowing and carrying farm products (in terai)
	2	Females for milking
	3	Males for meat
	4	Males and females provide manures for farms
	5	Milk is processed to several products
Swine	1	For meat, especially in festivals (in hills)
	2	For manures (in hills)
Goats	1	For meat
	2	For manures
Poultry	1	For meat, eggs and manures
	2	For breeding stock
Ducks	1	For meat, eggs and manures (in hills)
	2	For breeding stock (in hills)
Rabbits	1	For meat, eggs and manures (in hills)
	2	For breeding stock (in hills)
	3	For hobby sake (in hills)
Pigeons	1	For meat and manures (in hills)
	2	For hobby sake (in hills)

*The uses/practices are valid for both hills and terai, unless otherwise stated inside the parenthesis.

Table 8. Farmers traditional/indigenous knowledges used in crop and Animals Production in the Hills.

Problems	Indigenous knowledge
Crops	
1 Leaf roller of rice	1 Broadcast extracts of local liquor (jand) in the rice field. 2 Collect leaf-roller-affected leaves and burn
2 Smut of wheat and maize	Collect smut-affected parts and either bury or burn.
3 Stem-borer of maize	1 Collect stem borer-affected parts together and burn. 2 Apply wood ash to the affected parts.
4 Aphids	1 Collect aphids-affected parts together and burn. 2 Apply wood ash to the affected parts.
5 Storage insects of grain legumes	Mix wood ash or neem (Azadirachta idica leaves with grain legumes and store in earthen pots
Animals	
1 Blackquarter	Shelled maize cob is applied with the citrus juice and rubbed on the tongue of animals
2 Liverfluke	Feed citrus juice 2 or 3 times a day in empty stomach
3 Head down of chicken	Feed garlic juice.
4 Ticks & lice	1 Tobacco solution or krosene oil is rubbed on the body. 2 Mustard oil and salt are mixed and rubbed on the body.
5 Castration Methods	1 Festicles are pressed with plier 2 Local knives are used for cutting testicles and burnt cloth pieces are inserted to control bleeding.
6 Deworming	1 Concentrated lemon and tamarind are mixed and fed to animals
7 Animal identification	Local names are used mainly according to color and height of the animals.

Table 9. Gender perception on decision making for different crop production activities (in percent).

Activities	Hills		Teria	
	Men	Women	Men	Women
Seed selection	82	18	61	39
Land preparation	58	42	65	35
Manures & fertilizer application	67	33	69	31
Crop management	69	31	55	45
Sowing & harvesting	67	33	61	39
Buying & selling	67	33	75	25
Storing	67	33	47	53

Table 10. Gender participation on decision making of different animal production activities (in percent).

Activities	Hills		Terai	
	Men	Women	Men	Women
Feeding				
Cattle	10	90	53	46
Buffalces	10	90	50	50
Swine	-	100	na	na
Goats	-	100	46	54
Poultry	-	100	71	29
Rabits	-	100	na	na
Pigeons	-	100	na	na
Cleaning				
Cattles	38	62	65	45
Buffalces	36	64	67	43
Swine	40	60	na	na
Goats	23	77	60	40
Poultry	33	67	70	30
Rabits	25	75	na	na
Pigeons	20	80	na	na
Milking				
Cattles	42	68	53	47
Buffalces	42	58	53	47
Slaughtering				
Goats	50	50	63	47
Poultry	-	100	20	80
Rabits	50	50	na	na
Pigeons	-	100	na	na
Animal health care				
Deworning	82	18	93	7
Vaccination	82	18	93	7
Pasture and forage production				
Sowing	67	33	72	28
Harvesting	73	27	72	28
Forage presenvation				
Straw	59	41	65	35
Breeding/stock				
Selection	77	33	92	8
Procurement	77	33	92	8
Breeding	100	-	92	8
Disposal	71	29	92	8
Marketing				
Cattles	55	45	87	13
Buffalces	50	50	91	9
Swine	-	100	na	na
Goats	36	64	91	9
Poultry	29	71	67	33
Rabbits	-	100	na	na
Pigeons	20	80	na	na

Table 11. Gender perception on labor participation in different crop production activities (%).

Activity	Hills						Terai			
	Family			Nonfamily			Family		Nonfamily	
	M*	W	C	M	W	C	M	W	M	W
Seed Selection	30	44	4	4	18	-	32	50	9	9
Land preparation	22	15	2	29	32	-	38	24	21	17
Manures & fertilizer application	32	29	3	11	25	-	27	28	24	21
Crop management	62	38	-	-	-	-	20	24	27	29
Sowing & harvesting	21	21	8	24	26	-	18	18	32	32
Buying & selling	43	24	5	19	10	-	69	31	-	-
Storing	30	33	15	11	11	-	39	52	4	5
Total labor contribution (%)	34.2	29.1	5.3	14.0	17.4	-	34.7	32.4	16.7	16.2

* M = Men W = Women C = Children

Table 12. Gender perception of labor participation in different animal production activities (%).

Activity	Hills						Terai			
	Family			Nonfamily			Family		Nonfamily	
	M*	W	C	M	W	C	M	W	M	W
Feeding										
Cattle	22	50	24	-	-	6	50	45	5	-
Buffaloes	21	53	21	-	-	5	47	53	-	-
Swine	-	50	50	-	-	-	na	na	na	na
Goats	21	53	21	-	-	5	45	50	5	-
Poultry	25	44	25	-	-	6	38	54	8	-
Rabbits	50	50	-	-	-	-	----------		na	------
Pigeons	50	50	-	-	-	-	----------		na	------
Cleaning										
Cattle	35	47	12	6	-	-	48	52	-	-
Buffaloes	35	45	10	5	-	-	47	53	-	-
Swine	-	-	-	100	-	-	----------		na	------
Goats	35	45	10	5	-	-	47	53	-	-
Poultry	29	50	14	7	-	-	50	50	-	-
Rabbits	33	34	33	-	-	-	----------		na	------
Milking										
Cattle	47	53	-	-	-	-	58	42	-	-
Buffaloes	43	57	-	-	-	-	56	44	-	-
Slaughtering										
Goats	43	-	-	57	-	-	61	39	-	-
Poultry	75	-	-	25	-	-	100	-	-	-
Rabbits	50	-	-	50	-	-	----------		na	------
Pigeons	100	-	-	-	-	-	----------		na	------
Animal Health care										
Deworming	64	9	-	27	-	-	80	20	-	-
Vaccination	20	-	-	80	-	-	23	-	77	-
Fodder & forage production										
Sowing	56	31	13	-	-	-	71	29	-	-
Harvesting	47	43	5	5	-	-	75	25	-	-
Forage preservation										
Straw	34	32	10	17	7	-	58	37	5	-
Breeding/stock										
Selection	100	-	-	-	-	-	93	7	-	-
Procurement	91	-	-	9	-	-	100	-	-	-
Breeding	61	-	-	39	-	-	63	6	31	-
Disposal	91	-	-	9	-	-	80	20	-	-
Marketing										
Cattle	87	-	13	-	-	-	80	20	-	-
Buffaloes	87	-	13	-	-	-	77	23	-	-
Swines	100	-	-	-	-	-	----------		na	------
Goats	64	27	-	9	-	-	78	22	-	-
Poultry	28	72	-	-	-	-	60	40	-	-
Rabbits	-	100	-	-	-	-	----------		na	------
Pigeons	-	100	-	-	-	-	----------		na	------
Total labor contributions (%)	47.1	31.4	7.8	12.9	0.2	0.6	6.4	31.4	5.2	0.0

*M = Men W = Women C = Children

Fig. 1. Map of Nepal showing three major agroecological regions and the study areas.

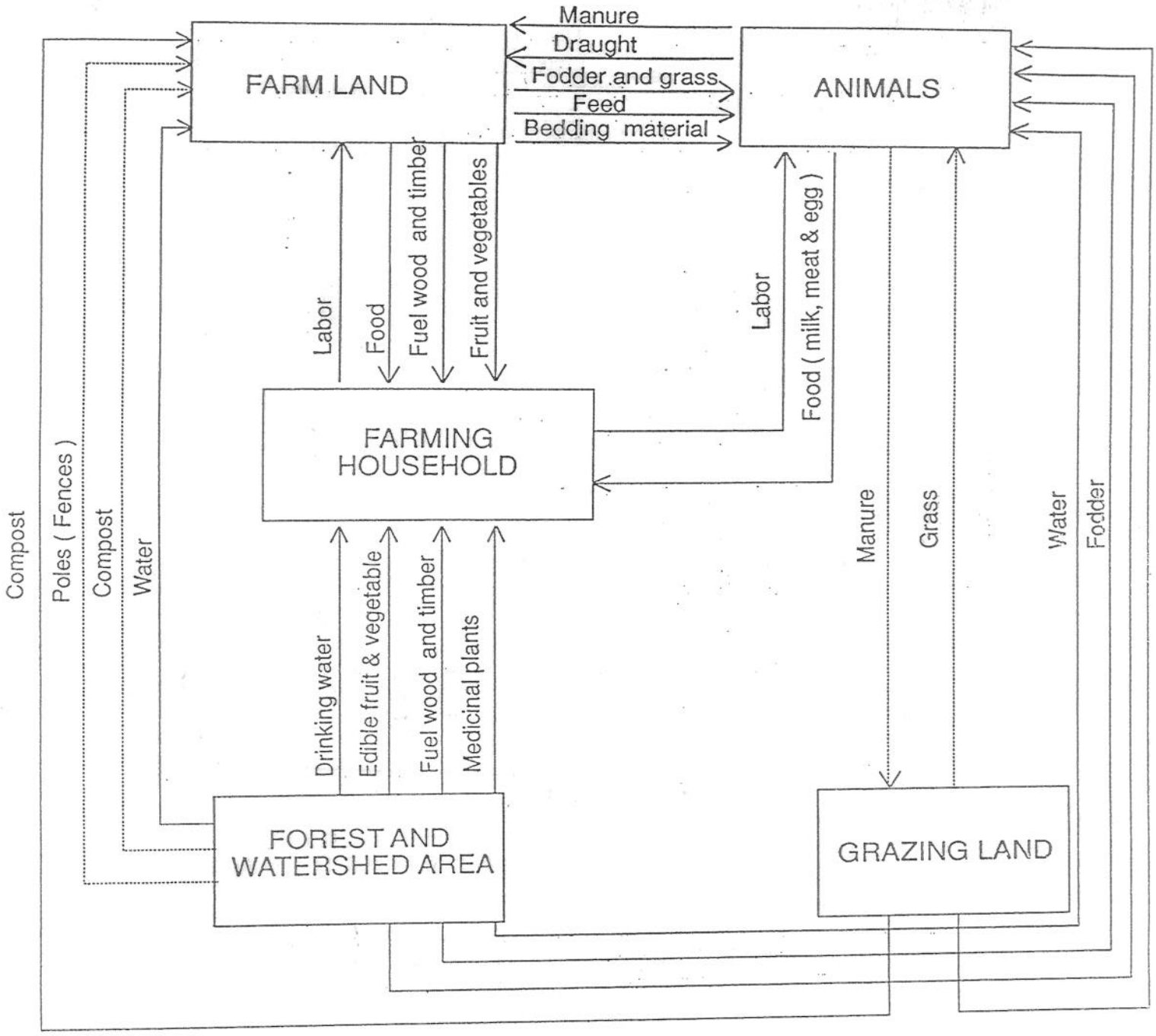

Fig. 2. Existing farming systems dynamics of the successful farmers of Dhankuta and Terhatrum hills (_____ and ..... indicate strong and weak interaction, respectively).

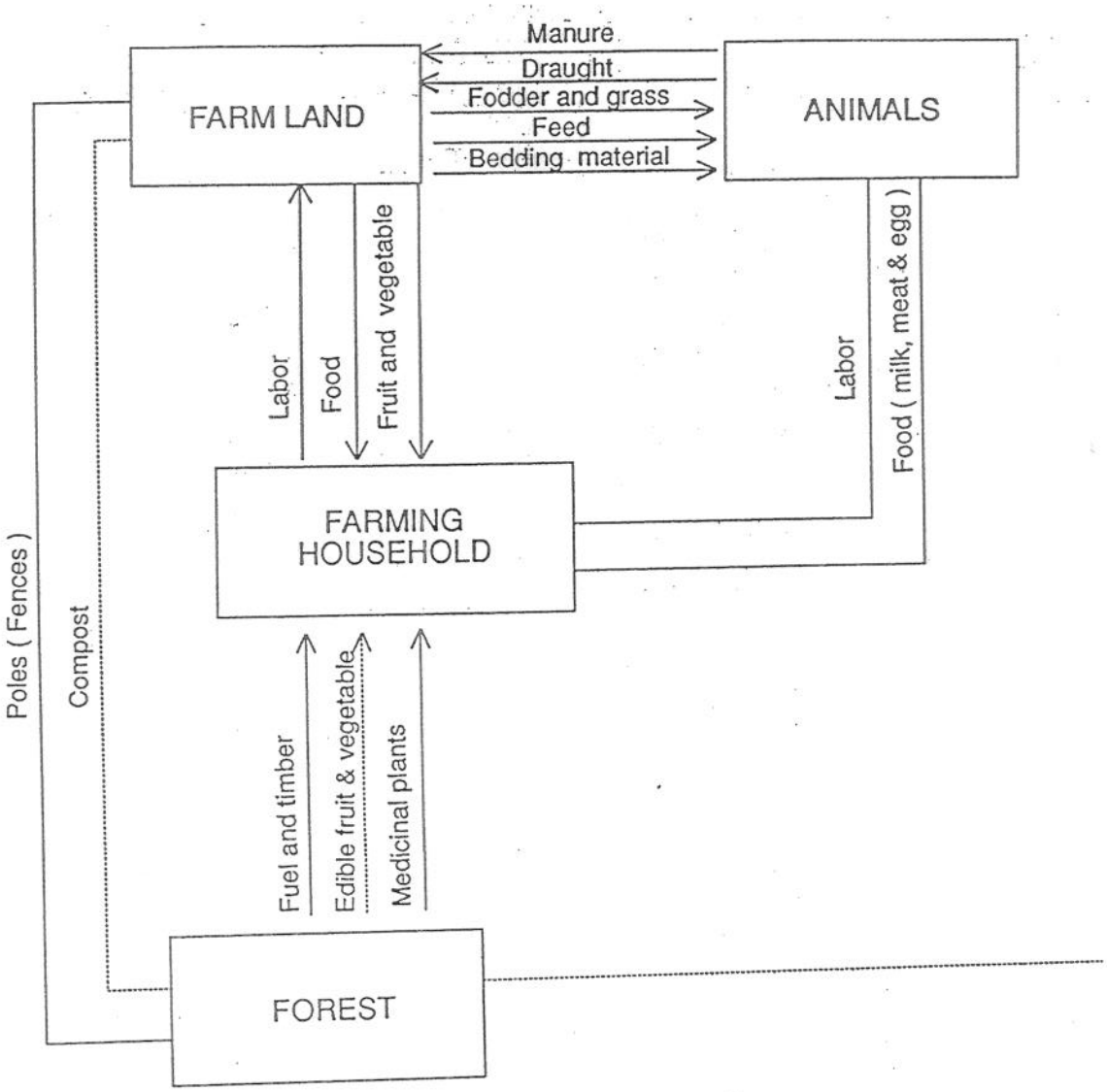

Fig. 3. Existing farming systems dynamics of the successful farmers of Chitwan, terai area (___ and ..... indicate strong and weak interactions, respectively).