ACTA SCIENTIFIC AGRICULTURE (ISSN: 2581-365X)

Volume 3 Issue 1 January 2019

Research Article

Deed Model: A Decision Tool for Farm Management in Mid-Hills of Nepal

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Received: November 26, 2018; **Published:** December 21, 2018

Abstract

This dissertation is farm level study conducted in order to identify resource endowment, ecological and economic performance of mixed farms of Subeda and Kotedewal VDCs of Bajhang district in far-western mid-hills of Nepal. The DEED (Describe, Explain, Evaluate and Design) framework was used to observe the ecological performance focusing on soil organic matter content and nitrogen dynamics based on DEED framework. The selection of representative farms from each community was based on total land area, area under major crops and their productivity, use of internal and external resources, and available farm feed sources per year followed by soil analysis. It was found that farming was the major source of livelihood of the people who participated in the survey. The central components of local farming system comprised the livestock and access to natural resources in order to feed them. The contributions of common natural resources were high in both the communities. The FYM application was higher in Kotedewal (11.48 Mt/ha/yr) compared to Subeda (9.86 Mt/ha/yr). The soil analysis report showed that the SOM content of farms at Subeda VDC were higher (3.56% and 2.15%), while it was lower in Kotedewal VDC (1.18% and 1.28%). The report also showed that the nitrogen content in the farms of Subeda were higher (0.54% and 0.39%), while it was low in Kotedewal (0.18% and 0.21%). This study concludes that the ecological and economic challenges faced by the farmers can be overcome by using appropriate soil and manure management practices.

Keywords: DEED; Farm Design; Far-Western Mid-Hill; Productivity; Sustainable Yield

Introduction

Nepal is an agricultural country where most of the economic activities are based on farming. Even though the major income generating activity is farming, only 29.71% of total land is separated as the agricultural land [1]. The topography of hilly region of Nepal is difficult compared to the terai region. Thus, farming is practiced under different conditions. Crop production is practiced in valley bottom land, small plateau along the river banks and on terraced land in case of Nepal [2]. The farming in the lower elevation of hill consists two types of lands 'khet' and 'tar' [2]. The land flatter and larger in size are called tar while the irrigated, relatively alluvial, flat terraces with supply of irrigation system during dry season are called khet. The dominant agricultural land use systems in the Hills of Nepal are divided to 'bari' and 'khet' [3]. In the higher elevations, there are fewer irrigated lands called 'bari' are present.

A typical definition of farming system is, "a unique and reasonably stable arrangement of farming enterprises that the households manage according to well defined practices in response to physical, biological and socioeconomic environments and in accordance with households' goals, preferences and resources" [4]. The overall farming structure comprises of the agricultural land, pasture land, forest land and the livestock. The farming is accomplished by utilizing the forest and agricultural products to feed the livestock and use the manure produced by the farm animals in the agricultural land. The Nepalese agriculture is regarded as an integrated system, which is composed of three basic components namely crops, livestock and forests [5].

This study focuses on the farming system of mid-hills (Bajhang) of Nepal. The major food crops that are cultivated in Bajhang district of Nepal are paddy, maize, wheat, millet and buckwheat.

Paddy being the staple food crop of Nepal, plays an important role in income generation and nutritional aspect within the district. This study was conducted to identify farm resource endowment for agricultural production in Bajhang district, to identify ecological and economic performance of different farms in Bajhang district and to characterize the sustainability of farm.

Materials and Methodology

This study was conducted in Bajhang district of far-west Nepal. Within Bajhang district two villages were selected – Subeda and Kotedewal for the purpose of case study. These two villages were selected based on different agro-climatic region they lie in and hence diversified agroecology can be observed. However the respondents in these villages were selected randomly. The primary data was collected through open ended questionnaire. The questionnaire focused on the agronomic and socio-economic aspect of farm. The interview was conducted in four households, two households each from Subeda and Kotedewal, in June 2016. The secondary data related to the soil profile and productivity was collected from related institutions (Government and Non-governmental documents), books and publications. Most of the data requirement for modeling using Farm DESIGN was measured in field or analyzed in laboratory.

The evaluation and analyzing the current production strategies of the farm was done using the Farm DESIGN. This is an effective model used to calculate flows of nitrogen, phosphorus and potassium; SOC budgets, feed balance, manure use and composition, labor distribution and economic results of farm on an annual basis [6]. After generating the scenario(s), Farm DESIGN was used to check the results of the options to enhance system performance of the farms based on model analysis. Farm DESIGN uses the DEED (Design, Explain, Evaluate and Design) approach which is the integrated conceptual framework outlined and proposed by Giller., *et al* [7].

Result and Discussion

Farm Characterization

The farms of two communities were separated and named as S1 and S2 for two farms of Subeda and K1 and K2 for farms of Kotedewal which lies in sub-tropical and temperate climatic regions respectively. In both communities mixed agriculture was followed, which was labor-intensive, where the total land holding was separated into smaller parcels of land to cultivate various species of cash and food crops. The crops and livestock products were obtained allocating the local resources available. There were no problems relating to the irrigation system. The labors required to perform the farm activities were provided by the farmer's family itself and in some cases, they were hired as well. As the farming system that occurred was a complex interrelationship between the agriculture, livestock and forest, the forest products played important role too. For the purpose of feeding animals, the palatable crop products, grasses (that grows within the field and bunds as weeds) and the products of fodder trees were used. While for the provision of bedding materials for the livestock, forest products and non-palatable agricultural byproducts were used. In some cases, livestock were brought to forest for grazing purpose.

Farm code[1]	Community	Management Type	Family Size	Land area (ha)	Soil type	Livestock units per ha	Crop Labor (hr/yr)	Animal Labor (hr/yr)	Irrigated land (ha)
S1	Subeda	Traditional	5	0.38	Loam	15.2	1172	1717	0.38
S2	Subeda	Traditional	7	1.2	Loam	5.4	1710	1412	1.2
K1	Kotedewal	Traditional	5	0.9	Loam	0	1660	0	0.9
K2	Kotedewal	Traditional	7	0.5	Loam	13.5	1295	1588	0.5

Table 1: Overall characterizations of four selected farms in the case study region.

[1]S1: Madan Raj Regmi; S2: Karna Bahadur Rana; K1: Sharmila Dhami Rokaya; K2: Reuti Rokaya

Resource use at farm level

The land size of farmers of farms S1 and S2 were 0.38 and 1.2 ha respectively while in farms K1 and K2 were 0.9 and 0.5 ha respectively. The soil type was found to be loamy and traditional method of cultivation was used in all the cases. In both the communities the lands were allocated to produce of paddy, wheat, millet, vegetables and grasses. The difference is that in the Subeda VDC (S1 and S2) farmers primarily focused on production of vegetables rather than food crops. All the farms were using parts of their own products (maize, wheat and millet) for feeding animals instead of concentrates. Crop residues, crop by-products, and forages derived from communal range land areas were also contributing to the overall dry matter (DM) requirements for feeding or grazing livestock.

Figure 1: Productivity (kg/ha) of major crops in selected farms.

SOC and n budget at farm level

The negative balance of N, P and K were found in all the farms whereas positive organic matter balance was found. Higher use of urea, DAP, MOP and FYM was seen in farms of Kotedewal as compared to that of Subeda. The average use of urea was found to be 87.14 and 174.89 kg per haper year, DAP was 66.75 and 117.11 kg per ha per year and MOP was 7.89 and 59.55 kg per ha per year while the FYM application was 9.86 and 11.48 mt per ha per year in farms of Subeda and Kotedewal respectively.

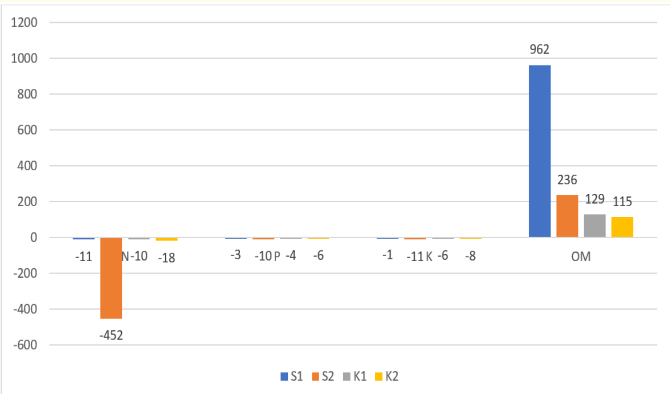

Figure 2: Nutrients and OM balance of selected farms (kg/ha).

Resource use at community level

The land holdings in both the communities varied greatly. The farmers had small land holdings that too were divided into even smaller parcels for cultivation of varied food and cash crops. The data showed that the livestock density (number of animals per ha land) was high implying that the higher number of animals were kept in farm despite its smaller size. Other household had cattle, goats and buffaloes. They had at least one oxen to use as draft animal. Due to small land holdings, the forage needed for the animals were low and hence the farmers had to depend on the products of nearby community forest. Although farms have access to the community forest, this land can be used only during a certain period of the year when they are allowed to harvest feed sources for the normal requirement of animal.

Characters	Subeda	Kotedewal
Households interviewed	2	2
No. of men interviewed	2	0
No. of women interviewed	0	2
Average land size (ha)	0.79	0.70
Average no. of livestock	6.25	3.5
Livestock density (no./ha)	10.3	6.75
Urea (Kg/ha/yr)	87.14	174.89
DAP (Kg/ha/yr)	66.75	117.11
MOP (Kg/ha/yr)	7.89	59.55
FYM (Mt/ha/yr)	9.86	11.48

Table 2: Characteristics of households being sampled.

Mechanization and commercialization were minimum in both the communities. They hardly used any sorts of chemical fertilizers and pesticides. From this, we can say that farmers are using more local resources. Reduced use or omission of chemical fertilizer combined with smaller land holdings indicates that farmers were using high organic inputs/amendments in the farm and livestock are the major source for organic manure in both sites. Similarly, we can see that higher number of large animals were kept in farms to provide the required nutrients in the soil through FYM. On the other hand, small farms having a large number of smaller animals may be related to lower initial investment costs, feed requirements, higher growth/turnover rate and accessible market for meat.

Smith (2008) documented that soil carbon sequestration can be achieved by increasing the organic inputs amendments, residue management and increased plant carbon input or by reducing the losses. But high animal density also can cause land degradation and its severity will be high in hilly region. Thus, there appear to be distinct trade-offs between excessive use of organic inputs and high animal pressure and SOM in the whole system in the study site.

SOM and N budgets at community level

The observed difference in soil N and SOM is due to difference in the management practices in the soil. In both the communities, the traditional method of cultivation was practiced. In this method, the dung is collected daily and kept in the heap. They are allowed to decay and are directly used in the farm. No any means of protection are used in this method of preparing FYM. So, there is high chances of nutrient loss from the manure. In certain case, they are not even well decomposed before applying on the field. Weber [8] reported that traditionally prepared FYM has lower (0.5-1.0%) nitrogen compared to well-prepared (protection from sunlight and water) FYM that may contain 1-1.5% N. Moreover, on a dry mater base, urine contains much more nitrogen than dung [8] and its effective use in SSM systems thus results in improved nutrient utilization while urine-derived nutrients are not properly utilized in traditional farms. The proper use of farm resources is being observed in the study farms which would be encouraging to other farmers as well for optimal resource utilization.

Farm Code	Overall N-efficiency (%)	N-efficiency (animal) (%)	Volatilization N-loss	Soil N-loss	N input	Crop N output	Animal N output
S1	1.54	9.02	-2.6	-10.5	8.7	1.1	2
S2	21.84	0.04	47.2	-522.6	3.2	1.6	0
K1	1.41	0	0.6	-11.9	3.1	0.1	0
K2	2.36	1.1	-1	-19.8	2.1	0	1.8
Average	6.78	2.54	11.05	-141.2	4.275	0.7	0.95

Table 3: Nitrogen use efficiency and losses of selected farms (kg ha^{-1}).

During the study it was observed that the farmers at Kotedewal used higher proportions of chemical fertilizers like urea, DAP, MOP. This region also lies in higher altitude than Subeda VDC and hence have colder microclimate. This results in reduced breakdown of SOM and thus higher steady level of SOM occurs in Kotedewal. This might be the reason of lowering SOM level in farms of Kotedewal.

It has also been documented that application of inorganic nitrogen fertilizer increases soil microbial biomass especially fungi and actinomicetes, which stimulates soil mineralization and increased breakdown of SOM thereby lowering soil organic carbon (Tiwari., *et al.* 2000). Similarly, SOM mineralization and decomposition processes are influenced by humidity, temperature and oxygen [9].

Economic performance

The economic result of the farms (S2 and K1) showed negative balance. Environmental and economic sustainability of all farming systems depend on the maintenance of soil fertility which is affected by agricultural practices [9]. It was observed that labor accounted the highest share of cost in every farm. In reality, the reward for farm labor was lower than what actually was given to the hired labor. The profit/loss of farms were found as NRs. 72627, -20818, -28670 and 112724 for farms S1, S2, K1 and K2 respectively. Loss of nutrients, especially nitrogen, reflected in economic performance of individual farm. Higher economic performance was observed to coincide with low N loss and high SOM accumulation.

Farm code	GM[1] crops	GM animals	Total GM	Labor costs	Total costs	Profit/loss	LB[2] (hrs)
S1	419839	419774	839613	86625	912240	72627	-36
S2	438840	409000	847840	92170	868658	-20818	-159
K1	149097	0	149097	39700	177767	-28670	1035
K2	82452	349642	432094	87900	319370	112724	-5

Table 4: Cost benefit analysis results from Farm DESIGN (in NRs.)/ Farms' economic situation.

[1]GM = gross margin, (includes home consumption and products sold at farm)

[2]LB= labor balance (negative balance indicates labor surplus at farm).

Conclusion

Farming is the major source of income for the farmers in both the communities. In all the farms, not only agricultural practices but also livestock and feeding resources played equal role in overall farming system. The fertilization was done by the manure produced within the farm. The farming system followed was labor-intensive in all the farms.

The use of FYM and other farm inputs are similar in both the communities. Although the chemical fertilizers were used in higher extent in Kotedewal VDC, we can see the increasing trend in its use in Subeda VDC aswell. Based on the soil analysis result, the SOM was found to be higher in Subeda VDC. This appears to be related to higher use of chemicals and cold micro-climatic condition in Kotedewal VDC. Similarly, high N efficiency in some farms that followed the soil management practices, corresponded with better economic performance of these farms. Farms adopting the soil management practices either have higher N efficiency or low nitrogen loss or both. These findings signal the effectiveness of SSM practices in enhancing both income and environmental performance of mixed farming system in the mid hill region. Therefore when farmers adopt SSM practices, soil fertility in terms of N and SOM on their farm can be increased significantly. Thus, we can also conclude that if proper amendments and soil management practices are followed, sustainable agriculture can be obtained in Bajhang district.

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