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Socio-economic and spatial determinants of farm production and local livelihoods in the middle mountain of Nepal

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Introduction

The Middle Mountains occupy about 30% of the Nepal's land (Jodha, 1995), cover 42% of the total area and accommodate 44% of the population (Pradhan, 2003) including the densely populated Kathmandu Valley which has 31% of the total urban population of the country (Thapa and Murayama, 2010). This shallow basin of the valley is enriched with varieties of production practices and biophysical make-ups (Bhatta, 2010). Market-oriented production that dominates in peri-urban fringe is a key factor driving land-use intensification in the valley bottom. The subsistence farming that predominates in the rural areas is based on cultivation of marginal lands and both of these production practices illumine the scar on sustainability of local livelihood (Bhatta *et al.*, 2009).

Differential farming practices within a short transect impacts on local livelihoods. Not only is the resources availability within the rural-urban interface, but are their accessibility and quality, competition between activities on the farm, household and off-farms, and economical dimensions among others matter very much. Most of the variations in the local livelihoods are governed by the road availability (Brown, 2003), which is fundamental for determining market relations. Spatial differentiation of farm becomes pronounced when farms nearby market core are compared with those located farther. Thus, both biophysical settings of resources and the socio-economic characteristics of farm families can be influenced by their spatial position (KC, 2005). This paper attempts to find the socio-economic and spatial determinants of farm production and livelihoods of the farmers in the highly populated peri-urban and rural transects of the Kathmandu Valley.

Research methodology

The study areas in the Kathmandu Valley (Figure 1) represent a unique rural-urban interface in Nepal as many villages in the districts are not too far from the urban core but have a rural flavor to them. Many locations have urban concentration with all the urban amenities accompanied by a decent standard of living (Thapa *et al.*, 2008). Variations in topography, slope and aspect and resource availability are feature of the rural-urban interface of the Kathmandu Valley.

Figure 1: Map of Nepal with the three districts of the Kathmandu Valley

Research concept

This research is based on the concept of differentiation of spatial and socio-economic attributes of the farm families. Farm families manage natural resources whose socio-economic attributes are principally governed by their spatial locations. This is owing to the distances between the fields, markets, and access to information and location for off-farm opportunities. This paper first examines farm income as affected by several socio-economic and spatial factors followed by spatial integration of the socio-economic variables to know their distribution along the spatial gradient and consequent effect on local livelihoods.

Sampling design

The study is based on micro-survey of the farm households that were selected using spatial and random sampling procedures. Through spatial sampling, a total of 95 farm households were selected while 35 farm households were selected randomly. Spatial sampling was adopted because information on the number of households that had settled down was not available and the settlement was scattered in a wide area. Spatial buffers were prepared and an attempt was made to select centrally located household from the buffer.

Data analysis

Socio-economic data that are derived from household survey were subjected to regression analysis. A log-linear regression model was run to regress farm income using several regressors such as crop area, education, market distance, credit taken and road availability among others.

Different analogue maps were purchased from Nepal Department of Survey and baseline GIS data for the study area was prepared using such maps. Spatial distribution of aggregated socioeconomic information such as land availability, livestock units and farm-family income were linked to the GIS by using each family's respective geographical position as measured by Global Position System (GPS) and their spatial autocorrelation was found out. The continuous thematic raster layers were produced for those factors found spatially auto-correlated by performing interpolation.

Using ArcView GIS, inverse distance weighted (IDW) method of interpolation was followed which is based on the weights, which are inversely proportional to the square of the distance from the centre of the zone of interest. Output grid surfaces were created in which value of each cell was calculated considering the values of 12 neighboring sample points and their distance to the point of estimation.

Cost distances from the different parts of the study zones to the market center was measured running GIS based cost weighted distance model (ESRI, 1997) and distance grid cells to travel from the household to the central market were prepared. Road infrastructure and slope were considered for cost weighted distance model. This technique is based on the idea that each cell in a map can be given a relative "cost" associated with moving across that cell (ESRI, 1992). The "cost" of moving across a cell is calculated as the cell size (in meters) times a weighting factor based on the quality of the road and slope.

Results and Discussion

Regression model

It was assumed that area, education, livestock unit, family labour in the farm, farming as a profession of the household head, credit taken and road availability affect farm income positively and distance to the market and dependency ratio affect it negatively. Results of regression analysis show that all of the variables have expected direction relations. The food crop area failed to show significant effects on farm income while the vegetable area has significant effect ($p<0.05$). The reason why food crop areas failed to show significant effects is that it has differential productivity in different places. The same unit of land in the low-lying area has more than two fold productivity than that in the hilly terraces. By contrast, yield *per se* of food crops in the same type of land with and without irrigation is highly variable. In addition, the area under food crops is higher in the hilly areas, which are not contributing much to the farm income. Conversely, the vegetable area has almost equal potency irrespective of the farm location.

The distance to the market affected farm income significantly ($p<0.01$) (Table 1) stating that the higher the distance from household to the market the lesser the farm income will be. It has a slope value of 898, which signifies that with an increase in distance, the farm income is reduced by NRs 898. Household head education and TLU failed to show a significant effect on the farm income. Farm income increased significantly ($p<0.01$) with higher family labour in the farm activities as witnessed by its positive coefficient. This suggests that availability of more family labour will provide incentive to produce more output on the farm.

Table 1: Effects of different variables on the farm income in the study area, 2008

Variables	Coefficient	SE	T stat	Sig.
Intercept	4.0140	00.089	45.05	0.000
Food crop area (*Ropani*[§])	0.0065	0.0051	1.26	0.210
Vegetable area (*Ropani*)	0.0755	0.0364	2.08	0.040
Distance to market (km)	-0.0147	0.0056	-2.81	0.010
Household head education (year)	0.0056	0.0094	0.59	0.554
Dependency ratio	-0.2070	0.0691	-3.00	0.003
TLU	0.0036	0.0174	0.21	0.834
Family labor used (man-days)	0.1154	0.0398	2.90	0.004
Profession (*1 if agriculture, 0 otherwise*)	0.5512	0.1344	4.13	0.000
Credit taken (*1 if yes, 0 otherwise*)	0.3771	0.1276	2.96	0.004
Hiring farm labour (*1 if yes, 0 otherwise*)	0.2870	0.1419	2.02	0.045
Availability of the road (*1 if yes, 0 otherwise*)	0.5513	0.1305	4.22	0.000
$R^2 = 0.85$, Adj $R^2 = 0.83$, $F (11, 118) = 59.83$ ($p<0.00$), Durbin-Watson= 1.85				

[§]20 ropani = 1 hectare

All of the dummy variables in the regression are significant. It can be said that a household with a main profession of farming would earn, on an average, 55% more farm income than the household with a head not in farming, *ceteris paribus*. Similarly, a farm family with credit used in the last year has on an average 38% more farm income than that without credit used. A farm family with external labour used on an average has 29% more farm income than that without use of external labour in the farm. Most importantly, farm families who have good road access have on an average 55% more farm income than those without road access. Overall, the explanatory variables cause 85% variation in the farm income (R^2=85%) and significantly higher value of F-statistic ($p<0.01$) shows the overall model fits the data.

Distribution of socio-economic variables along the spatial gradient

Spatial difference in food crop area is prominent- households with poor access have the larger holdings and more reliant on the subsistence agriculture (Figure 2a). Households with road access have the smaller landholdings and are more reliant on off-farm employment to meet their families' needs. Brown (2003) noted similar spatial tendency of landholdings in the mid-hill of Nepal. Opposite to the food crop area is the vegetable crop area, which is slightly higher towards the accessible urban fringes (Figure 2b). This is due to the commercial motivation of the vegetable production and cash generation within the short span of time. At the same time, because of the huge demand of vegetables in the urban cores, farmers would like to allocate the available land to vegetable farming.

a) b)

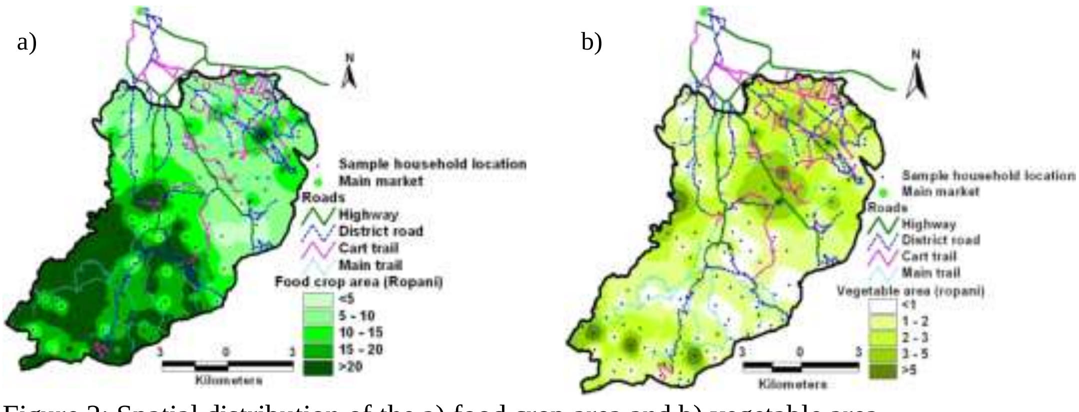
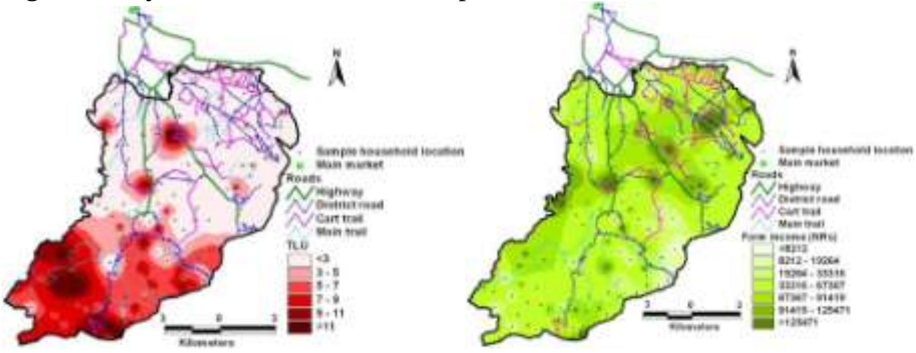


Figure 2: Spatial distribution of the a) food crop area and b) vegetable area

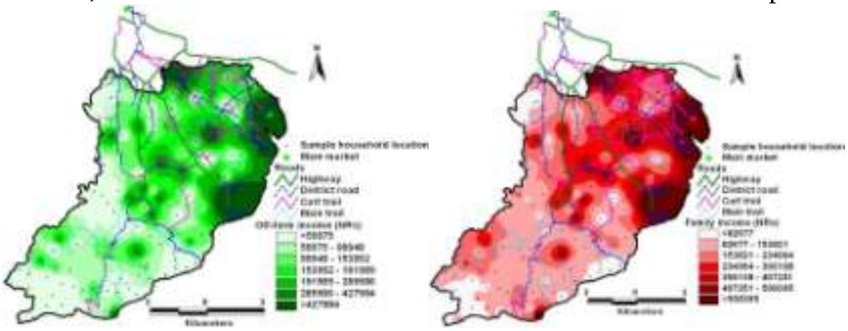
Clustering of higher tropical livestock unit (TLU) is found in the rural areas and it goes on decreasing from the remote to urban areas (Figure 3a). This shows that livestock is the key source of livelihoods in the rural areas. Farm income is relatively lower in the higher altitudinal gradient and it becomes higher in the flat land nearby the urban centres (Figure 3b). Off-farm income follows a similar tendency as of the farm income with more apparent pattern in the space. It is lower in the remote area and goes on increasing with increasing nearness to the urban centres (Figure 4a). In the rural areas, farm incomes are lower and off-farm employment are lacking while the prospects of off-farm employment is better in the urban areas. This along with the market-oriented production and less cost of the transportation will eventually give higher family income in the urban and peri-urban areas.



a) b)

Figure 3: Spatial distribution of the a) livestock units and b) farm income (NRs)

Interpolation of the family income shows spatial tendency as of farm and off-farm incomes. Clustering of higher family income towards the accessible areas (Figure 4b) is basically due to the availability of more off-farm opportunities, higher level of education of the people and availability of the urban amenities nearby while in the rural area agriculture including livestock is the mainstay of the livelihood and alternative means of earning is rarely available. Unavailability of basic infrastructures like transportation, schools, roads and extension services has further exacerbated the problem of off-farm earning.



a) b)

Figure 4: Spatial distribution of the a) off-farm income and b) family income, both in NRs

Cost distance modelling

Cost weighted distance analysis showed the several clear clusters of distances in terms of travel time. In this illustration, short cost-distances are shown in the light tones whereas long cost-distances are shown in dark tones. The travelling time to market centre is increasing very rapidly as one goes to the higher altitude and in the rural area while the tendency is very slow in the peri-urban villages basically due to good quality of road infrastructure and less sloppy land structure (Figure 5). More travelling time to market centres means more cost of transportation on the one hand and on the other hand less influence from the market centre. Moreover, for the perishable products like vegetables, large chunk of the produce will be lost during transportation. As travelling time is increasing, the opportunities like off-farm earning, health and housing, quality education and extension service become sparser affecting local livelihood.

Although the present cost distance model that incorporates slope and road types is the key variant in the travelling cost in terms of minute, this model does not capture all the information about road infrastructures. It is, however, equally important to consider the flow of vehicles in the road with the specified speed. This means that different types of transport infrastructure have different characteristics. A surfaced road, for example, allows faster travel speed in the plain area than a dirt road in the rural hills. Particular vehicles in a blacktopped road with a smooth surface run at a higher speed than the same types of road with a broken surface and holes on it. Similarly, the speed differs as per the season.

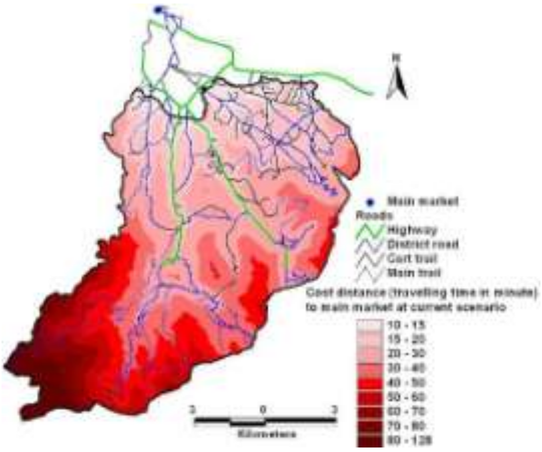


Figure 5: Cost weighted distance in terms of travelling time (minute)

Conclusions and Outlook

- There is a great variation in topography, slope and aspects. This variation leads to the differential farming practices to be adopted by the farmers and also influence micro-climate and crop adaptability.
- Several socio-economic and biophysical factors affect farm income. Therefore, these two factors should be taken into account while predicting livelihoods of the farm families.
- Spatial differences in area, livestock unit and farm-family income are related to road access leading to access of all required facilities such as market, extension services, employment opportunities and education to place a few.
- Cost distance model shows that travelling time to the market centre increases very rapidly as one goes to the higher altitude and in the rural area. This reveals that much of the harvest from the remote areas is subjected to post harvest losses due to poor road network and extended period of transportation. This area unifies the disadvantages of remoteness and less favorable land conditions. Cost distance model also highlights the significant influence of the road on socio-economic issues along with the need to focus development activities spatially.

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