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# The Role of Agricultural Diversification in Raising Income and Employment of Mountain Farming Households: A Case Study in Himalayan Region of West Bengal, India

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**Abstract—***Farm households diversify their cropping pattern to realise the goals of either maximisation of income or minimisation of risk or stabilisation of income. The process of diversification can also be assessed as a survival and copying strategy for the households who face frequent production shocks and marketing constraints in agriculturally backward region like Himalayan Region of West Bengal. The mountain farm households face a matrix of constraints resulted from complex mountain physiographic and fragile environmental conditions. Consequently, their crop-yields, value and income generation of per unit cropland are low, which acts as a primary constraint for their survival and for raising their living standards. The households thus commit their cropland to large number of crops to cope with multiple shocks. Hence, a grass-root level farm household survey was recently conducted incorporating 150 households of six hamlets from Kalimpong Subdivision, the principal agricultural unit of the study region to analyse their cropping pattern, to evaluate extent of diversification and to assess their diversification strategy. Latter, the crop value, income and mandays generation are estimated by five household and three dummy variables along with non-farm income and crop diversification applying multiple regression analysis. The main findings of this study are cereal dominant cropping pattern at the hamlets with less cereal dominancy and commitment of more relative crop acreage to pulses and commercial crops at hamlets with lower irrigation access, moderate diversification within crop-groups but low diversification across crop-groups at the hamlets along with comparatively greater diversification at hamlets with lower irrigation access, significant positive impact of cropland and crop diversification but negative influence of non-farm income on crop value, income and mandays generation for the households along with significant positive influence of education level of workers on crop value and income, and significant positive influence of agricultural training dummy on crop income.*

**Keywords***: Agricultural Diversification, Crop Value, Income and Employment, Himalayan Region of West Bengal*

## 1. INTRODUCTION

The complex physiographic and eco-fragile environment conditions and consequent negative mountain specificities result in relatively lower cropping activities and low crop-yields for mountain farmers [1]. The comparatively low crop-yields in hill agriculture act as its primary production constraints [2]. The regions also experience socioeconomic constraints including small landholding-sizes, labour shortages, poor marketing and marketing networks as well as limited road and communication access [3]. All these have led to under utilisation of resource-base, limited generation of agricultural surplus, and low living standards of farmers in mountain regions [4] like Himalayan Region of West Bengal. With relatively lower non-farm employment opportunity and its confinement in urban tracks in the region, a substantial proportion of mountain people are still dependent on agriculture for their livelihoods. Nevertheless, the physiographic and agro-climatic diversity in the regions offer diversified production 'niches' to the mountain farmers to cultivate a variety of crops. Consequently, the cropping pattern of mountain farmers is diversified [5].

The process of agricultural diversification can be defined as a shift of farm resources including land and labour from the production of one regional dominant crop towards the production of a large number of crops [6]. Factors in agricultural diversification are general incentives and pressures that lead the farmers to cultivate diversified crops. The literature defines a wide range of motives, goals and pressures under which diversification is seen to occur and also observes that it can take diverse forms to different households. Thus while larger landowners diversify to accumulate, the small landholders diversify their land activities to survive [7-8]. Farm households cultivate diversified crops to realise the goals of either maximisation of income or minimisation of risk or stabilisation of income [9-11] or other under distinct possibilities of necessity or choice [12]. Agricultural diversification towards high-value cash crops through utilising local environmental niche is considered as an economically viable

strategy for generation of employment opportunities, and conservation and improvement of natural resources [13-14]. The mountain farm households cultivate diversified crops to cope with multiple shocks primarily resulted from mountain physiographic conditions [15]. Diversification is also an important strategy which can reduce vulnerability of the farming households [16]. However, because of highland-lowland linkages and proximity or distance from markets, the choice of diversification strategy by the hill farmers must be location-specific [17]. Hence, regional studies on the effect of diversification on income and employment are needed to evaluate the strategy of diversification.

In this backdrop the paper attempts to analyse the cropping pattern, to evaluate the extent of crop diversification as well as to assess the role of agricultural diversification in terms of crop diversification in raising crop value, income and employment generation of farming households based on recent grass-root level farm data of 150 households from six hamlets from Kalimpong Subdivision (presently Kalimpong District), the principal agricultural unit of the study region applying multiple regression analysis.

## 2. METHODOLOGY

### General Description of the Study Region

Darjeeling is the northernmost among the districts in West Bengal. Darjeeling hill belongs to the Hill Region in the north agro-climatic zone of West Bengal [18]. Darjeeling District lies between 27º13' 05" and 26º17'10" North latitudes and between 88º 53' 00" and 87º 59' 30" East longitudes [19]. The district encompasses a mountainous area of 2477.83 sq.km spreading over Darjeeling Sadar (921.68 sq. km) and Kurseong subdivisions (503.03 sq. km) to the west of the Teesta, and Kalimpong subdivision (1053.13 sq. km) to the east of Teesta, and a plains area of 802.01 sq. km covering Siliguri subdivision in the Terai [20]. Out of 3 mountainous subdivisions forming Darjeeling Himalaya of West Bengal, Kalimpong is principally agricultural, while the rest two are principally tea-growing subdivisions following the British legacy of land use and settlement policy.

As per Census, 2011, the district population was 1846823, which was 2.02 per cent of the state population, despite its 3.55 per cent state area share [21]. The proportion of urban population to total population was 39.4 per cent for the district compared to 31.9 per cent of the state. The literacy level of the district was 3.3 per cent higher than the state literacy of 76.3 per cent. The rural and urban literacy of the district were 2.1 and 2.7 per cent more compared to the respective rural and urban literacy of 72.1 and 84.8 per cent of the state. The gross cropped area [GCA] of the district was 122478ha which was 1.39 per cent GCA of the state in 2010-2011 [22].

### Sampling and Data

The survey was conducted following multi-stage purposive sampling procedure. The survey encompassed 150 farm households, each 25 households from six hamlets, three from Kalimpong CD Block-1 and three from Kalimpong CD Block-2. The surveyed village-clusters and hamlets were selected purposively in terms of agro-climatic and physiographic location, proximity or distance from the markets, access to motorable roads, etc. The primary data were recently collected through the survey to cover rural land and assets holding, cropping patterns, crop production and crop cultivation costs, wage and land rental in addition to household socioeconomic information in the study region. The secondary electronic data on sericulture was collected from the website of Planning Commission and Ministry of Agriculture, Govt. of India.

Table 1 below shows the hamlets based on grading of their relative locational characteristics.

**Table 1: Village Grading on Relative Locational Characteristics**

| Hamlet Groups | *SORTING SCALES* | | | | | |
|---|---|---|---|---|---|---|
| | Distance | Elevation | Aspect | NCA | Irrigation Access | Slope Degree |
| High | | | | | | |
| | Chisopani<br>Lamini Gaon<br>Ramitay | Bimbong<br>Lwr Gairi Goan<br>Ramitay | Chisopani<br>Ramitay | Bimbong | Chisopani<br>Lwr Gairi Goan<br>Ramitay | |
| Medium | | | | | | |
| | | Chisopani<br>Lamini Goan<br>Yogda | Lwr Gairi Goan | Chisopani<br>Lamini Goan<br>Ramitay<br>Yogda | Bimbong<br>Yogda | Lwr Gairi Goan<br>Ramitay |
| Low | | | | | | |
| | Bimbong<br>Lwr Gairi Goan<br>Yogda | | Bimbong<br>Lamini Goan<br>Yogda | | Lamini Goan | Bimbong<br>Chisopani<br>Lamini Goan<br>Yogda |

Source: *Sample Survey*

### Analytical Method

The empirical analysis of this research relied on testing the hypotheses that agricultural diversification has positive significant effect on a) crop value and income augmentation and b) crop employment generation. So, descriptive statistics are used to present the socioeconomics of the households, their cropping pattern and diversification by applying simple percentage technique. Latter, agricultural diversification is calculated with Berry Index [BI] of diversification, and multiple regression analysis is applied to find out the effect of agricultural diversification on crop value, income and employment. The Berry Index of diversity is defined as $BI = 1 - \sum_{i=1}^{N} P_i^2$, where $A_i$ = cropland committed to $i^{th}$ crop, $A = \sum_{i=1}^{N} A_i$, denoting gross crop acreage, where N is total number of crops, and $P_i = A_i/A$, indicating the proportion of cropland devoted to $i^{th}$ crop. The index value assumes 1 for perfect diversification, while 0 for perfect specialisation. For analysing the effect of agricultural diversification on crop value, income and employment, it is hypothesized that these are functions of age and literacy of the workers, labour availability, the extent of diversification, total cropland, irrigation quality of cropland, access to market, credit access, agricultural training and proportion of non-farm income to total income.

## 3. RESULT AND DISCUSSION

### Socioeconomic Profile of the Households

While the cultivation technology, prevalent seasons, market forces and social endowment of a region jointly determine the crop-choice, its sustenance and cropping pattern potential in the region, the capacity of a household in harnessing this potential depends on its socioeconomics. Table 2 below compares the household socioeconomics of the selected hamlets.

**Table 2: Comparative Socioeconomics of the Hamlets**

| Hamlet | Avg. Family Size | Mean Active Population | *Literacy Rate* | Mean Education of Hh Heads | Per capita Crop land (ha) | *% of Crop land to total Land* | *% of Irrigated to total Crop land* | WPR in Main Works | *% of Non-farm toTotal Workers* | *Cropping Intensity* | Per Hh Contribution of Cropland (Rs./yr.) Value | Income | *% of Gross Crop Income to Total Income* | Productivity of per ha Crop land (Rs./yr.) | Livestock/Hh (Cows, goats and pigs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hamlet with SC & ST Population>50%* | | | | | | | | | | | | | | | |
| Yogda | 6.7 | 3.7 | *84.0* | 4.2 | 0.085 | *66.8* | *12.6* | *32.7* | *30.3* | *147* | 44111 | 24623 | *23.0* | 77387 | 4.5 |
| *Hamlets with SC & ST Population between 25% to 50%* | | | | | | | | | | | | | | | |
| Bimbong | 5.8 | 3.6 | *78.0* | 4.4 | 0.132 | *62.5* | *4.1* | *32.9* | *26.5* | *110* | 27000 | 12641 | *18.9* | 35102 | 4.4 |
| Ramitay | 5.7 | 4.0 | *84.0* | 5.4 | 0.089 | *77.1* | *95.3* | *39.9* | *32.6* | *202* | 35736 | 10666 | *14.5* | 70236 | 4.8 |
| Chisopani | 6.2 | 4.2 | *93.1* | 8.8 | 0.085 | *75.1* | *78.8* | *37.4* | *44.4* | *168* | 52011 | 24714 | *6.6* | 99030 | 3.4 |
| *Hamlets with SC & ST Population<25%* | | | | | | | | | | | | | | | |
| Lamini Gaon | 6.4 | 4.3 | *78.8* | 5.5 | 0.092 | *57.4* | *9.6* | *38.8* | *36.3* | *112* | 30721 | 15704 | *12.3* | 51965 | 6.3 |
| Lower Gairi Gaon | 5.6 | 3.8 | *82.7* | 5.4 | 0.078 | *61.2* | *36.9* | *37.1* | *26.1* | *152* | 34363 | 11376 | *16.4* | 78312 | 5.2 |
| **Total Selected Village** | **6.1** | **3.9** | ***83.5*** | **5.6** | **0.093** | ***66.2*** | ***35.9*** | ***36.4*** | ***32.6*** | ***146*** | **37324** | **16621** | ***12.2*** | **65804** | **4.8** |

Source: *Sample Survey*

Different access to irrigation at the hamlets has primarily resulted in their substantial variation in cropping intensity. The relative extent of cropping along with productivity of per hectare cropland and per household crop value and income generation was relatively lower at hamlets with moderate to low irrigation access such as Yogda and Bimbong than at hamlets with higher irrigation access such as Ramitay. With greater proportion of uncultivable land which is an important source for green fodder, the hamlets with lower irrigation access such as Lamini Gaon and Yogda thus compensated their lower cropping activities by holding greater number of livestock on the average. The non-farm work opportunities were limited and literacy level as well as mean education level of household heads was relatively lower at hamlets located further away from the Kalimpong town such as Bimbong and Yogda. So, the work participation rate in main works, proportion of non-farm workers to total workers and per household non-farm income generation were relatively lower, but proportion of gross crop income to total income was relatively higher at these hamlets than at hamlets located closer to the market centre like Chisopani. The households at hamlets located further away from the Kalimpong town such as Bimbong also faced marketing and communication constraints for selling crops, particularly crops required higher frequency of market transaction like vegetables. Nevertheless, the scarcity of cropland was relatively lower at hamlets with lower irrigation access, particularly those located further away from the market centre like

Bimbong. With greater pressure of maintaining relatively larger family, more dependent members and lower per household non-farm income, the households at hamlets with lower irrigation access and located further away from the market centre such as Yogda and Bimbong were more dependent on cropping activities. Thus the cropping pattern and extent of crop diversity is expected to be guided by a push factor in this region, particularly at hamlets with lower irrigation access and located further away from the market centre.

**Cropping Pattern and Diversity**

The crops under which the cropland were committed by the households during three crop seasons (i.e., *kharif* (June-October), *rabi* (October-January), and *pre-kharif* (January-June)) are classified into four groups, namely cereal, pulse, spice and vegetable. Table 3 below shows inter hamlet crop group-wise cropping pattern and diversity.

**Table 3: Inter Hamlet Comparison of Cropping Pattern and Diversity**

| Hamlet | Mean Gross Crop Area (ha) | Cropping Pattern | | | | Average Number of Crops | | | | | Crop Diversification (BI) | | | | | | Cropping Intensity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cereal | Pulse | Spice | Vegetable | Cereal | Pulse | Spice | Vegetable | Total | Cereal | Pulse | Spice | Vegetable | Total Across | Total Within | |
| *Higher Diversification Trend* | | | | | | | | | | | | | | | | | |
| Yogda | 0.801 | 55.7 | 24.8 | 4.4 | 15.0 | 1.6 | 1.7 | 3.8 | 15.0 | 22.0 | 0.324 | 0.143 | 0.747 | 0.882 | 0.603 | 0.734 | *147* |
| Lower Gairi Gaon | 0.657 | 78.1 | 6.2 | 5.6 | 10.2 | 2.1 | 1.5 | 3.7 | 11.1 | 18.5 | 0.555 | 0.592 | 0.746 | 0.871 | 0.374 | 0.726 | *152* |
| Chisopani | 0.869 | 73.0 | 3.7 | 4.2 | 19.1 | 1.8 | 1.6 | 3.1 | 12.0 | 18.6 | 0.484 | 0.637 | 0.601 | 0.850 | 0.428 | 0.718 | *168* |
| *Lower Diversification Trend* | | | | | | | | | | | | | | | | | |
| Bimbong | 0.775 | 59.0 | 28.2 | 3.9 | 8.8 | 1.3 | 1.5 | 3.4 | 11.8 | 18.0 | 0.236 | 0.067 | 0.634 | 0.892 | 0.563 | 0.658 | *110* |
| Ramitay | 1.009 | 84.4 | 4.6 | 1.7 | 9.3 | 1.9 | 1.6 | 2.9 | 9.8 | 16.3 | 0.501 | 0.615 | 0.798 | 0.797 | 0.277 | 0.642 | *202* |
| Lamini Gaon | 0.590 | 75.4 | 6.0 | 4.5 | 14.1 | 1.2 | 0.9 | 3.6 | 11.8 | 17.6 | 0.056 | 0.572 | 0.763 | 0.829 | 0.405 | 0.457 | *112* |
| **Total Selected Villages** | **0.784** | **71.2** | **12.2** | **3.9** | **12.7** | **1.7** | **1.5** | **3.4** | **11.9** | **18.5** | **0.490** | **0.357** | **0.812** | **0.919** | **0.461** | **0.730** | *146* |

Source: *Sample Survey*

The land commitment under major cereals incorporates *aman* paddy [*Oryza sativa*], maize [*Zea mays*] and millet [*Panicum sumatrense*], and that under major pulses comprises *masyam dal* (vigna bean) [*Phaseolus aureus*], urad (*kalo dal*) [*Phaseolus aureus*], soybean [*Glycine max*] and green pea [*Pisum sativum*]. The land was also committed to high value major commercial crops like ginger [*Zingiber officianale*], cherry peppers (*dalley* chillis) [*Capsicum sp.*], large cardamom [Zingiberaceae *Amomum*], and coriander leaf [*Coriandrum sativum*]. The principal vegetables under which land were committed are bean *[Phaseolus sp.*], cabbage [*Brassica oleracea var. capitata*], cauliflower [*Brassica oleracea var. campestris*], radish [*Raphanus sativa*], potato (summer and winter) [*Solanum tuberosum*], cucumber [*Cucumis sativus*], *raya saag* (mustard greens) [*Brassica nigra*], squash [*Sechium edule*] and pumpkin [*Cucurbita moschata*].

The water adaptation strategy of the households, along with their climatic adaptability of alternative crops, determines the cropping pattern at the hamlets. The need of agricultural households for food security led to a cereal-dominant cropping pattern at the hamlets. With more *aman* paddy acreage in hamlets with better irrigation access, the cropping pattern was more cereal-dominant at such hamlets like Ramitay than at hamlets with lower irrigation access like Bimbong. The cropping pattern was *aman* paddy-based at hamlets with higher irrigation access like Ramitay, while it was maize-based at hamlets with lower irrigation access like Bimbong. Conversely, relative extent of crop acreage commitment to pulses was higher at hamlets with lower irrigation access like Bimbong and lower at hamlets with higher irrigation access like Chisopani, mainly because of distinct cultivation practices of *masyam dal*. Most households grew *masyam dal* within maize for using its stick as supporter at hamlets with lower access to irrigation, whereas *masyam dal was* cultivated mainly as paddy-intercrop at hamlets with higher irrigation access. Owing to more favourable practice of ginger cultivation in hamlets with lower irrigation access, the relative extent of crop acreage committed to commercial crops like ginger was greater at such hamlets like Yogda and lower at most hamlets with higher irrigation access like Ramitay. With more access to irrigation the households were able to commit greater acreage to vegetables at most hamlets with better irrigation access like Chisopani compared to most hamlets with lower irrigation access like Bimbong. Because the perishability of vegetables necessitated more frequent marketing transactions, more households were able to commit land to vegetable cultivation at hamlets located closer to the market centres. Hence, access to market enables such hamlets to commit greater acreage to vegetables.

The crop diversification across the crop-groups in terms of Berry index was low at the hamlets because of cereal-dominant cropping pattern, while it was moderate within the crop-groups at most hamlets. With low physical yield and profitability of

cereals, the households allocated their cropland among 19 crops on the average for reducing production and market risks. The average number of crops touched double digits at the hamlets and reached at 22 at the distant hamlet Yogda with lower irrigation access. With greater number of crops and relatively more balanced acreage distribution in vegetable and commercial crops like ginger, diversification in vegetable and commercial crops was greater compared to cereals and pulses at most hamlets. With less cereal dominant cropping pattern at hamlets with lower irrigation access, cropping was more diversified across the crop-groups at these hamlets like Yogda than at most hamlets with better irrigation access like Ramitay. Despite the lower comparative yield of vigna beans vis-à-vis other pulses, more land at lower irrigated hamlets was devoted to the cultivation of vigna beans. Niche adaptation in the extent of lands committed to vegetable cultivation and the preservation of some cultivation of drought-resistant inferior crops especially at the hamlets with lower irrigation access pointed towards the need for agricultural diversification as a survival and coping strategy. Hence, it is needed to study the impact of crop diversification on crop value and income generation at the hamlets.

**Implication of Crop Diversification on Crop Value, Income and Employment Generation**

The determinants of crop value, income and employment are estimated applying Ordinary Least Square [OLS] Estimation. The independent variables represent the capital asset endowments of the households [ such as land, labour, knowledge] (cropland, proportion of irrigated land to cropland, availability of labour force, mean education level of workers, mean age of workers, agricultural training dummy), access to market dummies as nearer distant villages, credit access dummy, the influence of non-farm income on crop value and income in terms of proportion of non-farm income to total income, along with crop diversification index. Table 4 below shows the OLS estimation of the determinants of crop value, income and employment of the households.

The selected variables account for the variances in crop value (42 per cent), crop income (35 per cent), and crop labour mandays (64 per cent). Household variables cropland produces significant positive impact on crop value, income and labour mandays generation, while mean education level of workers results in significant positive influence only on crop value and income, and proportion of irrigated cropland to total cropland has significant positive effect only on crop labour mandays. The crop-choice and commitment of cropland to the crops as well as cultivation operation are better for the more educated wokers compared to less educated workers, and thereby crop value and income generation of the former was relatively higher than the latter. Households with higher irrigation access to their cropland committed greater proportion of the cropland to irrigation sensitive and more labour intensive paddy whose turn out rate is much lower compared to vegetables and commercial crops like ginger, and thereby the proportion of irrigated to total cropland has positive significant influence only on crop labour mandays.

**Table 4: Determinants of Crop Value, Income and Labour Mandays: OLS estimation**

| | Money Value of Crop Output | | Crop Income | | Crop Labour Mandays | |
|---|---|---|---|---|---|---|
| Independent Variables | β | t-value | β | t-value | β | t-value |
| Intercept | -19533 | -2.479* | -14485 | -2.521** | -31.267 | -1.005 |
| Cropland (acre) | 6593 | 4.772* | 3767 | 3.739* | 48.769 | 8.943* |
| Proportion of Irrigated to Total Cropland (%) | 54 | 1.743 | -21 | -0.913 | 0.860 | 7.074* |
| Availability of Labourforce (Number) | 876 | 1.359 | 119 | 0.252 | 2.500 | 0.982 |
| Mean Education Level of Workers | 909 | 2.394** | 567 | 2.048** | 1.827 | 1.219 |
| Mean Age of Workers (years) | 98 | 0.765 | 61 | 0.649 | 0.283 | 0.559 |
| Dummy: Agricultural Training | 6136 | 2.264** | 4988 | 2.524** | 12.097 | 1.131 |
| Dummy: Nearer Distant Hamlets | 612 | 0.223 | 2290 | 1.145 | -24.641 | -2.276** |
| Dummy: Credit Access from Organised Sources | 345 | 0.136 | 202 | 0.11 | -12.284 | -1.229 |
| Non-farm Income in Total Gross Income (%) | -167 | -3.492* | -131 | -3.752* | -0.605 | -3.21* |
| Crop Diversification Index (within crops) | 32391 | 3.981* | 25091 | 4.23* | 129.509 | 4.033* |
| R square | | 0.458 | | 0.390 | | 0.664 |
| Adjusted R square | | 0.419 | | 0.346 | | 0.640 |
| F-value (ANOVA) | | 11.744* | | 8.875* | | 27.477* |

Source: *Sample Survey*

*: One per cent Level of Significance and **: Five per cent Level of Significance

Among the dummies agricultural training dummy has positive significant impact on crop value and income generation, while the distance dummy produces significant negative influence on crop labour mandays generation. The households having agricultural training were more capable to diversify their cropping pattern towards more remunerative crops compared to the households without agricultural training, and so the crop value and income generation of per unit cropland was higher of the former compared to the latter. With comparatively higher wage rate as well as more non-farm opportunities at the nearer distant

hamlets compared to the hamlets located further away from Kalimpong town, the households at the nearer distant hamlets utilised relatively less labour for cultivating per unit cropland, while the households at the distant hamlets used more family labour in their cropping activities. Thus the distance dummy has negative influence on crop mandays generation.

The proportion to non-farm income out of total gross income has significant negative impact on crop value, income and man-days generation as such households with higher proportion of non-farm income out of total income did not put so emphasis on cropping as did by the households having lower portion of such income. Hence, the proportion of non-farm income out of total income produces negative influence on crop value, income and labour mandays generation.

The diversification of cropping within the crop-groups results in significant positive influence on crop value, income and mandays generation. Increment of crop value, income and madays generation was the basic motive behind crop-choice and commitment of cropland to such crops of the farm households, although many such households diversified their cropping pattern as a survival and copping strategy as well as to reduce their production and market risk of cropping activities, particularly those households having lower irrigation access of their cropland and located at hamlets further away from Kalimpong town. So, the crop diversification strategy of the households has significant positive impact on crop vale, income and labour mandays.

## 4. CONCLUSION AND POLICY ISSUES

The mountain farm households face a matrix of production and marketing constraints including small size of cropland, lower access to irrigation of their cropland, lower extent of cropping activities, poor marketing and marketing networks as well as limited road and communication access resulted from complex mountain physiographic and fragile environmental conditions. Consequently, the crop-yields as well as crop value and income generation of per unit cropland of the households are low, which acts as a primary constraint for their survival and for raising their living standards. The households thus diversify their cropping pattern by selecting large number of crops under their crop-choice regime and commit cropland to them for reducing production and marketing risk as well as raising crop value and income. They thus follow crop diversification process as a survival and copying strategy.

With limited winter rainfall and lower access to irrigation of cropland of many households, the cropping intensity was low at most hamlets, particularly at the hamlets with lower irrigation access. The need of agricultural households for food security led to a cereal-dominant cropping pattern at the hamlets. With more *aman* paddy acreage in hamlets with better irrigation access, their cropping pattern was more cereal-dominant and their commitment of cropland to vegetables was higher, whereas relative extent of crop acreage commitment to pulses and commercial crops separately was higher at hamlets with lower irrigation access. Because the perishability of vegetables necessitated more frequent marketing transactions, more households were able to commit land to vegetable cultivation at hamlets located closer to the market centres. Thus the water adaptation strategy of the households, their need of food security and their access to market along with climatic adaptability of alternative crops, determine the cropping pattern at the hamlets.

The crop diversification within the crop-groups was moderate at most hamlets because of greater number of crop selection, while diversification across the crop-groups was low at the hamlets because of their cereal-dominant cropping pattern. With less cereal dominant cropping pattern at hamlets with lower irrigation access, their cropping was more diversified across the crop-groups. With greater number of crops and relatively more balanced acreage distribution in vegetable and commercial crops like ginger, diversification in vegetable and commercial crops was greater than in cereals and pulses at most hamlets.

Household variable cropland produces significant positive impact on crop value, income and labour mandays generation, while mean education level of workers has significant positive influence only on crop value and income generation, and proportion of irrigated cropland to total cropland has significant positive effect only on crop labour mandays. Agricultural training dummy has positive significant impact on crop value and income generation, while the distance dummy produces significant negative influence on crop labour mandays generation. While the extent of non-farm income of the households has generated significant negative influence, crop diversification produces significant positive impact on crop value, income and labour mandays generation. Thus agricultural diversification in terms of crop diversification towards high value crops is a crucial, viable strategy for raising crop value, income and employment of the farm households and an alternative means for rural development in the study region.

Since mean education level of workers generates significant positive influence on crop value and income generation, for improving the living standard of the farm members, the concerned authority has to take steps for providing easier access to education of such workers. The local agricultural institution has to arrange frequent agricultural training for the farmers to select appropriate remunerative crops for raising their crop income, since agricultural training dummy has significant positive influence on crop income. As crop diversification produces significant positive influence on crop value, income and mandays generation, along with arrangement of proper agricultural training for the farmers, the concerned authority has to adopt some incentive

measure so that the farmers diversify their cropping pattern towards high value crops which are adaptable to local climatic conditions, especially when non-farm work opportunity is limited in the rural tract of the region. At the same time, the authority has to adopt some measures so that the irrigation access of cropland of the households has enhanced because most of such high value crops are irrigation sensitive.

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