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Impact of Fruit Tree Incorporation into Farming Systems on Employment and Income in the Hill Region of Nepal

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Abstract

Impact of fruit tree incorporation into farming systems on employment and income in the hill region of Nepal was analyzed, by applying the Gini decomposition analysis as a case study. In the study village, the introduction of orange production reduced employment opportunities in farming by 10% as a whole. The effect was most conspicuous for female labor (both family and hired) which decreased by 20%, while the use of hired male labor increased by 10%. It appears that the farm size was the major factor for the introduction of orange cultivation. Neither human resources (both quantity and quality) nor direct access to cash affected the dissemination of orange cultivation. Income from orange farming accounted for 44% of the total household income and for 56% of the total income inequality. Replacement of traditional upland crops by commercial orange may have worsened the income distribution, though absolute income increase might be significant. No villagers participated in marketing activities of orange, which has a large potential of employment and income generation. To further promote rural development focusing on the poor, use of labor for postharvest activities such as marketing and processing is recommended.

Discipline: Agricultural economics/Crop production/Horticulture
Additional key words: Gini decomposition analysis, mandarin orange, less-favored area

Introduction

The hill region of Nepal, which supports nearly half of the nation population, has been facing environmental degradation due to increasing population pressure as well as expanding cultivation and overgrazing. In this context, incorporation of high value fruit trees such as citrus into the farming systems could be an alternative to improve the welfare of small farmers without impairing the resource base. As the access to urban market improved, commercial production of mandarin orange has increased in some of the hill regions since the mid-1970s. This paper aims to clarify the impact of the incorporation of commercial orange production into the existing farming systems.

First, we describe the agrarian conditions of the study village, then compare the labor use between traditional and new cropping systems. In the third section, impact of income distribution of orange is examined. We conclude with policy implications for rural development in less-favored areas.

Data and methods

An in-depth household survey was conducted in 2 villages in Kavre district, central mid-hill region, in 1993. Farmers from randomly sampled 125 farm households were interviewed with a prepared questionnaire assisted by local resource persons. The field visits and group discussions with local key informants

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and some of the sample farmers were combined to verify the data collected.

The data of a village where orange is well disseminated were analyzed in this study. The sample size was reduced to 51 from originally surveyed 60 due to incompleteness and low reliability of some data.

Agrarian conditions and cropping systems in the study village

The study village is located 50 km east of Kathmandu, the nation capital. This site has a moderate slope with a south-facing aspect at 1,300 to 1,600 m above sea level. The climate is warm temperate, ranging from 7°C in December–January to 30°C in April to September. The annual precipitation is about 1,300 mm. Within the village there is a great deal of microclimate variation due to the topography, altitude and the slope orientation.

Rough description of land use is presented in Table 1. The data from group discussions with key informants revealed that one-third of the village land is classified as lowland (*Khet* in Nepalese) for rice cultivation. Upland (*Bari*) accounts for about 40% in which annual crops grow in 16% and orange trees are planted in the remaining 24%. Privately owned forests or bushes account for only 4%, while community forests and grazing lands occupy one-third of the village area.

Table 1. Farmland use in the study village, Nepal, 1994

Land type	%
Lowland (*Khet*)	26
Upland (*Bari*)	
Annual crops	16
Orchard (orange)	24
Private forests/bushes	4
Community forests and grazing lands	30
Total	100

Source: Informal survey, 1994.

Table 2. Size distribution of farmland holdings of sample farms in the study village, Nepal, 1993

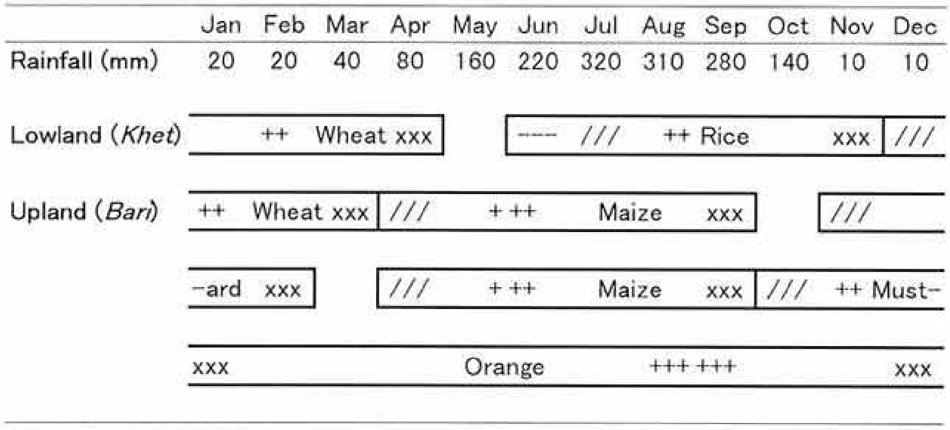
Area (ha)	Number of farms	Share (%)	
		in number	in area
–0.50	8	16	4
0.51–0.75	10	20	11
0.76–1.00	10	20	14
1.01–2.00	17	33	37
2.01–	6	12	34
Total	51	100[a)]	100
Total area (ha)	61.35		
Average (ha)	1.20		
Gini coefficient	0.70		

a): Round error.
Source: Household survey, 1993.

Table 2 shows the size distribution of farmland holdings of the sample households. All of them were owner farmers. Tenant farming is seldom observed in the village, while at the national level 16% of the total farms are under tenancy[1)]. Average farm size of 1.2 ha is equivalent to 0.96 ha of the national average[1)]. In terms of number, the middle-sized farms ranging from 0.51 to 2.00 ha accounted for 73% in number and 62% in area. However, only 12% of farms with more than 2 ha accounted for 34% of the total area. This distributional structure resulted in highly skewed land holdings with a Gini coefficient of 0.70 compared with the national figure of 0.52[1)].

Under rainfed conditions, seasonal distribution of rainfall is the major determinant of cropping systems. The wet season in this area extends from May to October with a rainfall peak in July–August as shown in Fig. 1. In the lowland, rice is transplanted in July and harvested in November. Immediately after rice harvest, wheat is planted then harvested in April–May. In the upland, maize is planted in April and harvested in September. After maize harvest, farmers plant wheat or mustard or both. Orange is planted in July only once in its life cycle and starts bearing fruits after 6–7 years. In August–September, weeding is performed in the orchard. Harvest season of orange falls in December–January.

Though the initial introduction of a few orange trees in the village dates back to nearly 100 years ago by a government official working at the Royal Palace in Kathmandu, commercial cultivation started only after 1974 when the government organized a mass campaign for the dissemination of new agricultural technologies. The government provided seedlings, input materials with subsidies and credit for fruit production in the hill regions. Some innovative resource-rich farmers quickly adopted orange cultivation at that time. However, the majority of the small farmers could not adopt immediately the cultivation of this crop, due to risks of long-term investment and low technical confidence. After observing the success of orange production by neighbor farmers, the followers gradually introduced this new commercial crop as a substitute for subsistence crops



---; Land preparation, ///; (Trans) Planting, +++; Weeding, xxx; Harvest.

Fig. 1. Major cropping pattern in the study village, Nepal, 1993

such as maize, wheat, mustard and millet in the upland. Mutual exchange of planting materials and technical know-how among farmers played a crucial role in wider dissemination. Initial capital mainly originated from informal sources such as relatives and middlemen[3].

Impact of orange production on employment

To determine how the introduction of orange cultivation affected the employment of the village farmers, we compared the cases of farmers who cultivated or did not cultivate orange. Labor input per ha by cropping system is presented in Table 3. The rice-wheat system was found to be the most labor-absorptive system followed by the maize-wheat/mustard system, while perennial orange required the least labor input. In terms of employment status (family vs. hired), rice-wheat system has a neutral feature in which family and hired labor is almost evenly distributed. So is the case of gender component (male vs. female). Comparison between the maize-wheat/mustard system and orange, shows that total labor used in the latter system was only 66% of that in the former, while the latter slightly relied on more hired labor (42 vs. 53%) and consisted mainly of male labor (44 vs. 71%).

Then to estimate the change in labor use at an absolute level, we calculated the labor input based on actual land use vs. the counterfactual one without

Table 3. Labor input of major cropping systems in the study village, Nepal, 1993

	Lowland	Upland	
	Rice-Wheat	Maize-Wheat/Mustard[b]	Orange[c]
	man-days/ha (%)		
Family labor[a]	173 (53)	141 (58)	76 (47)
Male	90 (28)	63 (26)	51 (32)
Female	83 (25)	78 (32)	25 (16)
Hired labor	153 (47)	103 (42)	85 (53)
Male	68 (21)	44 (18)	62 (39)
Female	85 (26)	59 (24)	23 (14)
Total	326 (100)	244 (100)	161 (100)

a): Including unpaid exchanged labor.
b): Assuming that wheat and mustard are planted in 0.5 ha each.
c): Case of maturing trees 7 years after planting.
Source: Household survey, 1993.

Table 4. Comparison of labor use in the study village, Nepal

	Actual in 1993 with orange cultivation[a)]	Counterfactual without orange cultivation[b)]	With/without orange cultivation
	man-days		
Family labor[c)]	7,494	8,625	0.9
Male	3,923	4,132	1.0
Female	3,571	4,493	0.8
Hired labor	6,570[d)]	6,884[d)]	1.0
Male	3,312	2,998	1.1
Female	3,259	3,885	0.8
Total	14,064	15,509	0.9

a): Rice-Wheat; 21.9 ha, Maize-Wheat/Mustard; 16.9 ha, Orange; 17.4 ha, Total; 56.2 ha.
b): Rice-Wheat; 21.9 ha, Maize-Wheat/Mustard; 34.3 ha, Total; 56.2 ha.
c): Including unpaid exchanged labor.
d): Round error.

orange (Table 4). In 1993, the sample farms actually cultivated a total of 56.2 ha in which 21.9 ha consisted of rice-wheat, 16.9 ha of maize-wheat/mustard and 17.4 ha of orange. Total labor input was estimated at 14,064 man-days for this pattern of land use. We assumed that there was no technical change in farming practices, especially in terms of labor use, during the process of orange dissemination. Assuming that the maize-wheat/mustard system is practiced also in the actual orange area of 17.4 ha, labor input can be estimated at 15,509 man-days. From this simulation, introduction of orange cultivation might reduce employment opportunities in farming by 10% for the sample farms. However, the impact varied with the gender and employment status due to the difference in the labor use pattern among the cropping systems. Orange production might have reduced female labor by 20% (both family and hired), while increased hired male labor by 10% and not changed the family male labor.

To analyze the economics of orange production, unique features of the tree crop must be considered. A typical economic life of orange tree is as follows[3)]. The gross margin (gross products - cash expenditure) is negative until 6 years after planting of seedlings as the tree does not bear fruit. After 7 years, the gross margin becomes positive with increasing rate until the 14th year, then it starts to decrease gradually. Simple comparison of the gross margin between maturing orange trees (Rs. 71,000/ha) and that of maize-mustard system (Rs. 9,000/ha) is misleading considering the conditions mentioned above. However it may be safe to state that orange production is much more profitable than traditional upland crop production.

Effect on income distribution

We shall determine how highly profitable commercial orange farming affected the income distribution among the village farmers. Before analyzing the effect on income distribution, the factors that may promote orange adoption will be outlined. Table 5 shows the Pearson's correlation coefficient between the area planted with orange and various characteristics of sample households. Human dimensions of the farm such as age and educational level of household head, endowment of family labor (both farm and non-farm) were not related to the orange area. Neither rice yield, proxy of farming skill level, nor the non-farm income, indicator of cash access, affected the adoption of orange cultivation. It is obvious that the larger the farm size, the larger the orange area. The upland area in which orange can be planted as well as the lowland area, where trees can not grow, may affect the diffusion of orange. This fact suggests that households with secure supply of staple food such as rice could expand commercial production.

The high correlation between the farm size and orange production suggests that the diffusion of orange might have worsened the income distribution among the village farmers. To answer this question, we applied the Gini decomposition analysis[2,5,6)] that enables to quantify the contribution of each income component to the overall income inequality. Gini decomposition is formulated as follows:

$$G(y) = \Sigma S_i R(y,\ x_i) G(x_i),$$

where y = Total household income,

$G(y)$ = Gini ratio of total income,

x_i = Income from ith source,

S_i = Average income share of ith source,

$R(y,\ x_i)$ = Rank correlation ratio,

$G(x_i)$ = Gini ratio of ith income.

The rank correlation ratio is defined as:

$$R(y,\ x_i) = Cov[x_i,\ r(y)] \ /\ Cov[x_i,\ r(x_i)],$$

where $r(y)$ and $r(x_i)$ denote the ranking of the household in terms of total income and income from ith source, respectively. $R(y,\ x_i) = 1$ if $r(y) = r(x_i)$. Otherwise $R(y,\ x_i)$ is less than 1. In general, the larger the rank correlation ratio is, the larger the correlation between the ranking of total income and the ranking of component income.

Thus the formula decomposes the total Gini ratio into 3 factors, namely, income share, correlation effect of total and component income and the Gini ratio of component income. As in the case of the study village, farm households in developing countries generally earn income from various sources. We can not determine to what extent a certain income component contributes to the overall income inequality by simply comparing the Gini ratio of each income. The component with a large Gini ratio may not contribute substantially to the overall income inequality if its share is quite small. Or even it may equalize the overall income distribution if its ranking is negatively correlated with that of total income.

The results of Gini decomposition are presented in Table 6. Total income Gini ratio of 0.43 was significantly smaller than that of land holding (0.70 in Table 2). This finding suggests that various non-farm job opportunities which accounted for 26% of the total household income, including hired farm jobs, contributed to the leveling off the economic status of the villagers.

Table 5. Correlation coefficient between orange-planted area and household characteristics in the study village, Nepal, 1993

	Correlation coefficient	Probability
Age of household head	0.025	0.859
Schooling years of household head	-0.002	0.990
Family farm labor	0.255	0.068
Family non-farm labor	0.001	0.995
Upland area	0.395*	0.004
Lowland area	0.765*	0.000
Rice production	0.612*	0.000
Yield of rice	-0.157	0.286
Non-farm income	0.128	0.367

* Significant at 1% level.

Table 6. Decomposition of income Gini ratio in the study village, Nepal, 1993

	Income share	Rank correlation ratio $R(y,\ x_i)$	Component Gini ratio $G(x_i)$	Component Gini contribution $S_i R(y,\ x_i) G(x_i)$
Rice	0.24 (0.24)[b]	0.76 (0.72)	0.41 (0.38)	0.08 (0.07)
Upland crops[a]	0.06 (0.07)	0.50 (0.46)	0.35 (0.37)	0.01 (0.01)
Orange	0.44 (0.44)	0.90 (0.88)	0.61 (0.59)	0.24 (0.23)
Farm wage	0.02 (0.03)	-0.16 (0.18)	0.89 (0.89)	-0.00 (0.00)
Non-farm wage	0.06 (0.06)	0.25 (0.37)	0.86 (0.87)	0.01 (0.02)
Small business	0.12 (0.10)	0.67 (0.54)	0.85 (0.84)	0.07 (0.04)
Formal job	0.06 (0.06)	0.66 (0.70)	0.88 (0.89)	0.03 (0.04)
Total	1.00 (1.00)	–	–	0.43[c] (0.41)

a): Wheat, maize and mustard.

b): Number in parenthesis is based on per capita income.

c): Round error.

The major income source contributing to total income inequality was the income derived from orange cultivation. The highest income share (0.44) and rank correlation ratio (0.90) resulted in the highest component Gini contribution (0.24), which accounted for 56% of the total income inequality (0.24/0.43). This finding is consistent with the fact that the orange-planted area was highly correlated with the farm size (Table 5). The contribution of rice income was the second largest, though its figure (0.08 or 19% of total Gini) was much lower than that of orange income. A previous study also revealed that even in a typical rice-dependent village, rice income does not play a major role in the overall income inequality[7]. Contribution of traditional upland crops (wheat, maize and mustard) was negligible (0.01 or 2%) since its share in the total income (0.06), rank correlation ratio (0.50) and component Gini (0.35) was significantly smaller than that of orange and rice. These facts suggest that replacement of upland crops by orange may have worsened the income distribution.

In contrast to the relatively lower component Gini ratio of farm income (0.35 to 0.61), that of non-farm income was much larger ranging from 0.85 to 0.89. However non-farm income, including farm wage income, as a whole accounted for only 25% of the total income inequality, while the remaining 75% was attributed to farm income. Farm wage income showed a highly skewed distribution with a component Gini ratio of 0.89 and a negative rank correlation ratio (−0.16), indicating that the poorer the households, the more they engaged in hired farm jobs. Though this absolute figure was very small (less than 0.005), farm wage income contributed to equalizing the total household income distribution. The common non-farm wage jobs in the village include employment at local building construction sites, brick factory and porterage of milk and daily necessities to and from local markets. Small businesses include miscellaneous self-employed jobs such as carpenter, tailor and small trade. Opportunities to work in the formal sector in the village are limited to the jobs of government officials, teachers, trekking company, police and army both in Nepal and India. Income share of small businesses and formal jobs (0. 18) was smaller than that of rice (0.24), though the component Gini contribution (0.10) was larger than that of rice (0.08), due to the larger component Gini ratio than that of rice (0.85, 0.88 vs. 0.41).

Conclusion

Introduction of profitable commercial orange production reduced employment opportunities in farming in the surveyed village by 10% as a whole. The effect was most conspicuous for female labor (both family and hired) which decreased by 20%, while the use of hired male labor increased by 10%. It appears that the area of both lowland and upland was the major factor for orange cultivation, though orange was planted only in the upland. Neither human resources (both quantity and quality) nor direct access to cash affected the dissemination of orange cultivation. Income from orange farming accounted for 44% of the total household income and for 56% of the total income inequality. Replacement of traditional upland crops by commercial orange may have worsened the income distribution, though absolute income increase might be significant. No villagers participated in marketing activities of orange, which has a large potential of employment and income generation. To further promote rural development focusing on the poor, use of labor for postharvest activities such as marketing and processing is recommended[4].

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