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DIFFERENTIAL ADOPTION OF MODERN RICE TECHNOLOGY AND REGIONAL WAGE DIFFERENTIAL IN NEPAL

Hari K. Upadhyaya, Keijiro Otsuka and Cristina C. David

HMG-USAID-GTZ-FORD-WINROCK PROJECT

STRENGTHENING INSTITUTIONAL CAPACITY IN THE FOOD AND AGRICULTURAL SECTOR IN NEPAL

FOREWORD

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Gerard J. Gill
Series Editor

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DIFFERENTIAL ADOPTION OF MODERN RICE TECHNOLOGY AND REGIONAL WAGE DIFFERENTIAL IN NEPAL[a]

Hari K. Upadhyaya, Keijiro Otsuka and Cristina C. David[b]

ABSTRACT

In Nepal, which consists of ecologically distinct favorable and unfavorable regions, modern rice technology has been widely adopted in favorable parts of the country. It is generally believed that modern rice technology has accentuated the existing regional income disparity. In this study, however, which is based on village surveys, we found that despite the significantly positive effect of new technology on demand for hired labor, wage rates are largely equalized across different environments due to permanent as well as seasonal migration from unfavorable to favorable areas.

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[a] This paper was originally published as IRRI Agricultural Economics Paper No. 88-19. It is reproduced here by permission of the authors.

[b] Respectively HMG/Nepal, Ministry of Agriculture; Tokyo Metropolitan University, Japan; International Rice Research Institute, the Philippines. This paper draws heavily on a PhD thesis by Upadhyaya (1988).

I. Introduction

Nepal is a predominantly agriculture-dependent country; 94 percent of the economically active population are engaged in agriculture contributing 58 percent of GDP in 1984. Within agriculture, rice is by far the most important crop occupying about half of the total cultivated area located mostly in the two ecologically distinct regions of the country, i.e., the hills and the tarai or lowland areas.

Traditionally, the Nepalese population has been concentrated in the hill region, including the Kathmandu Valley. With growing population pressure in the hills, and the eradication of malaria and construction of highways linking the east and western parts in the tarai, a large number of the hill population have migrated to the tarai region since the 1950s. The availability of uncultivated frontier land and the higher productivity associated with more favorable production environments in the tarai are considered to be the major factors, which have attracted migrants from the hills to tarai (Khadka, 1977; Dahal et al., 1977; New Era, 1981).

The modern varieties (MVs) of rice were introduced to Nepal in the early 1960s but their adoption was still limited to only 36 percent of paddy areas by the mid-1980s (IRRI, 1985). As in other developing countries in Asia, irrigation is a major factor constraining the adoption of MVs, since their productivity effect critically depends on the degree of water control (Barker and Herdt, 1985). The MVs of rice have been more widely adopted in the tarai where most large scale irrigation projects were constructed in the 1960s and 1970s. Even

before the introduction of MVs, however, income of farm population in the tarai was generally higher than in the hills (Islam, 1984). There is concern, therefore, that the differential adoption of modern rice technology has accentuated the existing regional income disparity between the favorable and unfavorable areas.[1] In the Nepalese context, this means not only between irrigated and non-irrigated areas but also between the tarai and hills regions.

The equity effect of the differential technology adoption critically depends on the extent to which the favorable and unfavorable areas are linked by interregional migration. If people migrate from unfavorable to favorable areas responding to the wage differential created by the differential adoption of new technology, wages in the two areas will tend to be equalized. If the interregional labor market does not adjust efficiently to the wage differential, interregional income disparity will widen, or at least persist, as adoption of new technology spreads in the favorable areas (Evenson, 1975; Quizon and Binswanger, 1983).

No research, however, has been made to examine the impact of modern rice technology on interregional income distribution in Nepal.[2] In this paper, we will explore labor supply adjustments to the differential adoption of new technology towards the equalization of wage rates across production environment through permanent and seasonal migration. Specifically, the following questions are asked. First of all, whether and to what extent did the adoption of modern rice technology raise the labor demand? Secondly, did migration in fact result from the

differential shifts in labor demand? And finally, did the migration contribute significantly to closing the interregional wage gap, which otherwise would have existed between favorable and unfavorable areas?

II. Sampling Procedures

In Nepal, the availability of official data necessary to answer the above questions is extremely limited. In this study, we conducted two sets of surveys from August 1987 to January 1988. The first is an extensive survey of 42 villages located in wide areas of hills and tarai which served as the basis for estimating migration, wage differential and technology adoption functions. Data on yields, technology, labor market characteristics, seasonal migration, and history of permanent migration at the village level were obtained by interviewing knowledgeable farmers. The villages were selected by a stratified random sampling procedure from six districts using environmental and technology information obtained from district agricultural officers. Two of the districts are the largest rice growing areas in the tarai portion of the Eastern Region (see fig.1). The other four districts (two each in the hills and the tarai, respectively) are the leading rice growing areas in the Central Region. Nearly two-thirds of the country's total paddy area and production originate from these two regions.

The second set of data which is the basis for estimating labor demand function is an intensive household survey of two villages, each representing the favorable and unfavorable production environments.

These villages, both located in the Sarlahi district in the Central Region, were selected from the extensive survey. The two villages, which are adjacent to each other, were deliberately chosen for ease of identifying the labor demand effects of irrigation and modern rice technology as factor and output prices and other characteristics of the production environment besides irrigation are highly similar. A census of all households was first conducted to collect migration information. Detailed data on production related questions were then collected from a sample of farmers.

III. Labor Demand and Migration in the Tarai

It has been well established by a large number of case studies conducted in other countries that the MV rice increases the labor demand, in general, and the hired labor demand, in particular (e.g., Barker and Herdt 1985). MVs considered in those studies were either the IR varieties developed by the International Rice Research Institute or the crosses between the IR varieties and local varieties which are characterized by short stature, non-photoperiod sensitivity, short growth duration, and fertilizer responsiveness. The dominant "modern" variety in Nepal, however, is Masuli, which was developed by the assistance of Japanese scientists in Malaysia in 1965, using the Ponlai variety (or Taichung 65) and the local variety as parents (Kawakami 1983). Masuli is generally less responsive to fertilizer application and thus yield gain over local varieties is more modest than the IR-varieties. This variety, however, is adaptable over wider areas

including the cold environment which may explain its popularity in Nepal.

Characteristics of two tarai villages

Labor demand effects of Masuli is analyzed using the intensive survey of 2 villages in tarai. In one of the villages (called the favorable village) almost 90 percent of cultivated area is irrigated. Settlement in this village started only in the early 1950s. An irrigation dam was constructed in the late 1960s but widespread adoption of MVs did not take place until Masuli was introduced in the mid-1970s. The other village was settled in as early as the 1930s but the lack of irrigation hindered the widespread adoption of MVs. Lately, however, a few farmers have started using deepwater tubewells for irrigation and adopted the Masuli.

Although the favorable village is larger than the unfavorable village in terms of the number of households and the total cultivated area, the average farm size was much smaller (table 1). While the ratio of irrigated paddy area and the rate of MV adoption were higher in the favorable village, there was no difference in the overall cropping intensity. Rice is produced once a year in almost all fields in the favorable village but only in 60 percent of areas in the unfavorable village, reflecting the difference in the production environment for rice production. The fertilizer application measured in terms of nitrogen and paddy yield per hectare were significantly higher in the favorable village, though they are not high as compared with other Asian countries.

The number of working family members above 15 years and below 60 years of age were larger in the favorable village inspite of the smaller farm size. Moreover, the ratio of agricultural landless worker households was higher in the favorable village. There seems to be no appreciable difference in the quality of labor between the two villages, judging from the ratio of working family members who completed the five years of primary school education. Thus, the supply of labor relative to land seems higher in the favorable village than in the unfavorable village. The major question is how the difference in the adoption of modern rice technology affected the structure of labor demand in the two villages.

Labor use in rice production

Table 2 presents the labor use per hectare, measured by mandays, in rice production by activity in the two villages. In land preparation and crop care, the labor input was modestly higher in the favorable village, but in other activities no difference was observed. As a result, the total labor input per hectare was higher in the favorable village only by 10 mandays, which is far from impressive.

Labor input usually increases with the adoption of MVs, particularly in crop care activity due to the larger application of fertilizer and the resulting need for weeding, and also in harvesting and threshing activities due to higher yield per hectare (Barker and Cordova 1978). Yet in the villages under consideration, fertilizer application was quite low and the yield difference was relatively small.

Consequently, the aggregate labor demand effect of the modern rice technology was small.

Nonetheless, the composition of the family and hired labor was remarkably different between the two villages. The hired labor input in mandays per hectare was 118 days in the favorable village compared with 101 days in the unfavorable village. On the other hand, the family labor input in mandays was smaller in the favorable village than in the unfavorable village, despite the fact that the farm size was smaller and the number of working family members was larger in the former village. Therefore, the effect of modern rice technology on the composition of labor demand seems substantial.

Estimation of labor demand function

We have estimated the labor demand functions per hectare separately for hired and family labor, using the double log specification except for the variables expressed in ratios. The wage rates and other factor prices are not included as independent variables because of the lack of variation between the two villages which are only 6 kms apart.

Equations (1) and (3) in table 3 show estimation results of the labor demand functions by the ordinary least squares method including the rate of MV adoption as an independent variable. The MV variable is highly significant in the hired labor demand regression with a coefficient of 0.49, which literally implies that the complete adoption of MVs raises the demand for hired labor by as much as 49 percent. There is no evidence that an increase in the use of hired labor reduced the demand for family labor, since the coefficient of MVs in the family

labor demand function is non-significant. As expected, larger farm size is associated with larger employment of hired labor and smaller employment of family labor, whereas the number of working family members has opposite effects. The ratio of educated working family members and tenancy dummy, however, do not have any significant effects in either equation.

Somewhat surprisingly, the irrigation ratio is not significant, either. Yet as the estimation result of MV adoption function shown in equation (5) demonstrates, which is based on the two-limit probit regression proposed by Rosett and Nelson (1975), the irrigation is undoubtedly a highly significant factor contributing to the adoption of MVs. Therefore, the irrigation affects the labor demand indirectly through its effect on the MV adoption. Indeed, if we omit the MV variable and estimate the reduced form equations, the irrigation ratio turns significant in the hired labor demand function [see equation (2)]. It is also found that neither the farm size nor tenancy dummy has significant coefficient in the MV adoption function, which is consistent with the generalization of Ruttan (1978) on the green revolution that tenure difference and the difference in farm size are not important sources of differential growth in productivity.

IV. Modern Rice Technology and Labor Supply Adjustments

Since the MV technology is intensive in the use of hired labor, wage rates of hired labor will increase, at least in the short-run, in the favorable areas adopting the new technology. The wage differencial

is expected to induce migration from unfavorable to favorable areas equalizing wages in the long-run.

Permanent migration from the hills, the generally unfavorable rice areas, to the lowland tarai region is a well-known demographic phenomenon in the Nepalese history. Official district level data where the extensive survey was conducted indicate the relation among land endowments, irrigation, and population growth (table 4). In general, man-land ratio was higher in the hills in 1971 but was largely equalized in the two regions by 1981. An exception is Sarlahi where the man-land ratio was higher than in the hill districts in both years. This district, however, was characterized by the highest proportion of irrigated area, much of which were constructed prior to the 1970s. The increase in man-land ratio was highest in Morang, which initially had the lowest man-land ratio.

The more rapid growth in man-land ratio in the tarai was due mainly to the much higher growth in population, though the cultivated area also increased in the tarai compared to the hill districts. The average annual population growth rate in the two hill districts was 2.1 percent, whereas the corresponding figure in the four tarai districts was 4.4 percent from 1971 to 1981.

The large difference in the population growth rates between the hill and tarai districts indicates substantial interregional migration from the hills to the tarai during the 1970s. Moreover, the facts that the labor was more scarce relative to land in the tarai in 1971 and that the tarai districts are more favorable in terms of irrigation strongly suggest that the availability of land and the adoption of modern rice

technology in tarai were important pull factors in the hill-to-tarai migration. In this and the following section, we explore the causes and the consequences of such demographic changes with particular focus on the impact of modern rice technology and the regional wage differential.

Characteristics of Sample Villages

Table 5 shows the characteristics of 42 sample villages in the extensive survey classified by the region and by irrigation. Purely for the expository purpose, villages in which more than 30 percent of area was irrigated are considered favorable. In general, the ratio of irrigated area was much higher in the tarai than in the hills. Due to the difference in the availability of irrigation water, the adoption rate of MVs was higher in favorable than in unfavorable villages. Within the favorable environment, however, there is no difference in the ratio of MV adoption between the tarai and hills, despite the fact that the irrigation ratio was lower in the hills.

The difference in the average paddy yield was closely related to the difference in the ratio of irrigated area, the highest being 3 t/ha in the favorable tarai villages and the lowest being 1.6 t/ha in the unfavorable hill villages. On the other hand, cropping intensities were relatively similar across four areas.

The average farm size and paddy area per farm were found to be greater in the tarai than in the hills. The ratio of paddy area was larger in the tarai, because rice is a dominant crop in this region. Corresponding to the larger farm size, the ratios of landless households were much higher in the tarai than in the hills. This may be the result

of the migration of landless and near-landless people from the hills to the tarai. It must be also observed that the ratio of landless households was higher in the favorable villages than in the unfavorable villages in both regions. This is consistent with our hypothesis that the modern rice technology attracts the migration of landless households. Yet the ratio of the landless households in the hills was very low even in the favorable villages. This may be explained by the greater availability of seasonal migrants in the hills during peak seasons, such as transplanting and harvesting (see table 5).[3] Unlike in the tarai, where rice is a dominant crop, many different crops are grown in different villages with different peak seasons in the hills. Therefore the short-distant seasonal migrants are readily available in the hills, even though the transportation network is poorly developed in this region. The availability of off-farm jobs may be also an important factor in rural labor market, but there appears to be no systematic difference in the accessibility to commercial centers across areas in terms of the distance from the villages.

The above observations suggest the hypotheses that the MV adoption is largely determined by irrigation and that the rightward shift of hired labor demand function arising from the adoption of modern rice technology was followed by the rightward shift of hired labor supply functions due to the permanent inmigration of landless people and also due to the seasonal inmigration. These hypotheses will be subjected to the statistical testing below.

MV adoption, landless population, and seasonal migration

We estimated the MV adoption function, landless ratio function, and seasonal inmigration function, expressing dependent variables as ratios and employing essentially the same set of independent variables in three functions. Information on the rate of permanent migration obtained from the extensive survey, however, was of very dubious quality due to the difficulty for farmers to recall the dates and the number of migrants in the past. Results of intensive survey indicate that the ratio of landless households is positively related with the adoption of modern rice technology.[4] Hence, the ratio of landless households was used as a proxy variable for permanent inmigration.

The regression results are shown in table 6.[5] Again, it is found that the irrigation is a major determinant of MV adoption, whereas tarai dummy, distance from the nearest commercial center, and the farm size are unimportant. The coefficient of the ratio of owner cultivator is significant, which suggests that owner cultivators were more active in the adoption of innovation.[6]

The second equation in table 6 shows that the irrigation affected the ratio of landless households positively, which supports our hypothesis that the adoption of modern rice technology represented by irrigation cum MVs affected the labor supply positively by attracting the landless population from less favorable areas. Both tarai dummy and the average farm size have positive and significant coefficients.[7] These findings suggest that the landless migrated to tarai not only because of the larger demand for hired labor associated with the larger farm size in the tarai, but also because of other possible advantages,

such as the lower man-land ratio and the larger opportunity to become tenants.[8] The distance variable, whose coefficient is also significant, is likely to capture certain advantageous effects of remote area on the hired labor employment, such as the larger skewness of farm size distribution, which would result in the larger aggregate hired labor demand.

The goodness of fit of the seasonal inmigration function is low, essentially because of the difficulty to obtain accurate village level information on the extent of seasonal inmigration during peak seasons. This was particularly so in the hills, where production environments are quite diverse even within one village. It is remarkable, however, to find the positive and significant effect of irrigation and negative and significant effect of tarai dummy on the seasonal inmigration. The positive effect of irrigation renders clear support for our major hypothesis that the modern rice technology increases the seasonal inmigration by increasing the hired labor demand. On the other hand, the negative locational effect of tarai is consistent with our earlier observation that the seasonal migration is less common in the tarai because of the dominance of rice production. The coefficient of output sharing harvesting contract dummy is positive and significant, because everybody can participate in harvesting under this contract, unlike the case of daily wage contract, which often requires certain qualifications.

To sum up, differences in the landless ratio and seasonal inmigration across different environments are observed to be consistent with the hypothesis of interregional labor market adjustments to the

differential adoption of modern rice technology and the differential endowment of land relative to labor. Particularly interesting is the finding that the supply of the casual labor tends to be higher in the tarai because of the higher ratio of the landless but lower because of the lower availability of seasonal immigrants during peak seasons. How these characteristics are related to the regional wage differential is a topic to which we now turn.

V. Technology and Regional Wage Differential

Regional wage differential

The average wage rates of casual laborers in major activities across the hills and the tarai villages classified by production environments are shown in table 7. Wages are standardized to eight hours work a day and expressed in real terms using paddy price as a deflator. The value of free food provided by employers was estimated and included in wage payment. Female workers usually perform jobs that require relatively less physical strength such as transplanting, weeding, manuring, and harvesting, whereas male workers are mostly engaged in plowing and threshing, which require more physical efforts. In table 7, therefore, gender-specific wage rates are shown. In certain villages in the tarai, output sharing contract was practiced in harvesting. In such cases, we have estimated the imputed labor earnings per day.

Except for land preparation, the difference in wage rates between the hills and tarai was generally small. Wage rate was higher in the

hills in land preparation partly because of the larger physical efforts required to plow paddy fields located in mountainuous topography. The difference in wage rates between the favorable and unfavorable villages within the tarai was generally small, whereas in the hills wage rates are consistently higher in the favorable villages than in the unfavorable villages. This may be partly explained by the fact that unfavorable villages are located more remote areas in the hills.

The imputed wage rates under output sharing contracts were much higher than the daily wage in harvesting. According to the theory of contract, the daily casual wage is likely to be lower than the imputed contract wage, partly because daily wage workers are less motivated to work since their income is fixed regardless of their efforts, and partly because more able workers prefer the output sharing contract to the daily wage contract for its higher remuneration at the higher level of work efforts (Stiglitz 1975; Roumasset and Uy 1980; Otsuka and Hayami 1988).

In general, wage rates were different for different activities. Therefore, we estimated the wage rate functions separately for land preparation, transplanting, weeding and manuring, harvesting, and threshing. The daily wage rates were almost identical between weeding and manuring, and harvesting. For harvesting wage function, we used the imputed wage rates where both daily wage and output sharing contracts coexisted, since the latter contract was more prevalent in every case.[9] We do not have explicit data on labor quality, but activities considered here are unskilled, standardized jobs, and hence, it is unlikely that the quality differences in workers can explain a major part of the regional wage differentials.

Estimation of Wage Determination Function

Ideally we should like to identify separately the direct effect of modern rice technology on the wage rate through its effect on the hired labor demand and its indirect, offsetting effects on the wage rate through its influence on the ratio of landless population and the seasonal inmigration. We could not estimate such simultaneous equation systems, however, because of the paucity of exogenous variables. Therefore, we simply estimated the reduced form wage functions employing the same set of independent variables as in the estimation of MV adoption, landless ratio, and seasonal inmigration functions.

According to the estimation results shown in table 8, none of the estimated coefficients of irrigation ratio is significant, even though they are consistently positive. Given that the irrigation was a major determinant of MV adoption and that the adoption of MVs significantly raised the hired labor demand, non-significant wage effect of irrigation can hardly be explained unless we take into account the subsequent labor supply adjustments to the higher labor demand through the changes in the landless population and seasonal inmigration.

Such interpretation is reinforced by the finding that the tarai dummy has significant and negative coefficients in non-peak season activities of land preparation and threshing, but positive, though not always significant, coefficients in peak season activities of transplanting, weeding and manuring, and harvesting.[10] The schedule of non-peak activities can be staggered, whereas the peak season activities cannot be delayed without significant production loss. While the labor demand for non-peak season activities is generally met with

the supply of family labor and the resident landless labor, seasonal migrants become an important source of the labor supply during the peak seasons. As was shown in the last section, the tarai is characterized by the larger supply of the resident landless and the lesser availability of seasonal inmigrants compared with the hills. The lower wage rates during non-peak seasons and somewhat higher wage rates during peak seasons in the tarai are clearly consistent with such difference in the labor market characteristics between the two regions. An important implication of this finding is that the "average" wage rates throughout the crop season would not be different substantially between the hills and tarai.

The estimated coefficients of distance from village to the nearest commercial center are consistently negative and significant, which would reflect the difficulty of conveying the labor market information and the large cost of travelling to distant areas. The farm size is found to have no effect on any wage rates, even though it is positively associated with the hired labor demand. The ratio of owner cultivators has significant coefficient only in transplanting, whereas the harvesting contract dummy has large and significantly positive coefficient in harvesting wage regression.

The statistical evidence provided in this section, coupled with earlier findings on the labor supply adjustments, strongly supports the hypothesis that the interregional labor markets in Nepal are sufficiently integrated so that the adjustment of supply and demand in local labor markets leaves no significant differences in the wage rates

over wide rural areas through permanent as well as seasonal migration. This is remarkable in view of the fact that the favorable and unfavorable areas are, in a large measure, geographically separated and the transportation and communication facilities are underdeveloped in Nepal, so that the migration costs appear to be far from negligible.

VI. Concluding Remarks

Analysis on the indirect effect of technological change on income distribution has been largely neglected in the green revolution literature. In this study, we focused on the effect of the differential adoption of modern rice technology on regional wage differential with special reference to the adjustments of labor supply to the shift of labor demand in Nepal. We found that responding to the increased demand for hired labor due to the adoption of the MV technology, the interregional labor market adjustments in the form of permanent as well as seasonal migration from unfavorable to favorable areas took place so as to equalize wage rates between the different production environments. As a result, as far as the average wage is concerned, no substantial difference was observed between irrigated and non-irrigated areas and between such geographically separated favorable and unfavorable areas as the tarai and the hills.

An important policy implication of our analysis is that the adoption of MV technology in favorable area did not create the significant regional income differential within the poor segment of the rural population, whose livelihood depends on wage earnings, despite the fact that it created the regional productivity differential. In Nepal,

rice yield is still very low and the most widely grown variety is Masuli, which is not as high yielding as more "modern" MVs. In order to raise the efficiency of rice production in Nepal further, the development of new MVs suitable for Nepalese environment is needed. Like Masuli, however, productivity gains from such varieties will be limited mainly to favorable part of the country. However, the trade-off between efficiency and equity arising from such technology development will not be as large as commonly thought judging from the efficient adjustment of interregional labor market towards the equalization of wage rates across regions observed in this study.

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FOOTNOTES

[1]The same concern has been widely expressed in the green revolution literature (Lipton, 1985; Ruttan, 1978).

[2]In India, several cross-sectional studies found the positive impacts of modern rice technology on wage rates (Bardhan 1979; Dhar 1984; Johl 1975; Lal 1976; Rozensweig 1984). These findings, however, are based on the wage data in the early 1970s, when the substantial change in technology was taking place. A more recent study in the Philippines by Otsuka, Cordova, and David (1988) found no such relation between the technology and wage rates.

[3]Data on the ratio of seasonal immigrants to the total number of hired laborers shown in table 6 refer to the average ratio in transplanting and harvesting, since the importance of seasonal migrants did not differ significantly between these two peak season activities.

[4]Upadhyaya (1988) found from the intensive survey in the tarai that the ratio of landless has increased over time in the favorable village due to inmigration but not in the unfavorable village.

[5]We omitted the ratio of owner cultivator and included the dummy for the practice of output sharing contract in harvesting in the seasonal inmigration function, because there is no economic reason to assume that the ratio of owner cultivators affects seasonal inmigration,

whereas the practice of output sharing contract, as distinct from the daily wage contract, is considered to attract seasonal inmigrants since everybody can participate in harvesting under this contract.

[6]In the green revolution literature, however, there is no definite consensus on the effect of tenure on the adoption of new technology. See, for example, a survey by Feder, Just, and Zilberman (1985).

[7]We considered the farm size as exogenous, since its difference was not well explained by other exogenous variables including irrigation. The lack of farm size adjustment to the difference in technology is likely to reflect the imperfection of land market emphasized by Binswanger and Rosenzweig (1984, 1986).

[8]Upadhyaya (1988) observed that some of the landless and near landless people, who have migrated from other areas, have become tenants in the intensively surveyed tarai villages.

[9]Totally we have sixteen cases in which the two contracts coexisted.

[10]Although the labor demand for weeding and manuring are less time-bound than transplanting and harvesting, seasonal inmigrants were also employed in these activities.

TABLE 1

Socioeconomic Characteristics of the Favorable and Unfavorable Tarai Villages in Nepal Based on the Intensive Survey, 1987.

	Favorable village	Unfavorable village
No. of households	319	116
Average farm size (ha)	1.6	2.1
Average paddy area (ha):	1.6	1.3
Ratio of irrigated area (%)	89	9
Ratio of MV adoption (%)	70	5
Cropping intensity	2.1	2.0
Rice cropping intensity	1.1	0.6
Fertilizer (nitrogen kg/ha)	15.5	7.7
Paddy yield (t/ha)	2.45	1.87
No. of working family members:[a]	4.0	3.6
Ratio of educated (%)[b]	65	61
Tenure (%):		
Owner cultivators	51	53
Tenants[c]	17	26
Landless	31	21

[a]The number o family members above 15 and below 60 years of age.

[b]Education is defined as the completion of five years of schooling in primary school.

[c]Includes owner-tenants.

TABLE 2

Labor Use per ha in Rice Production in the Favorable and Unfavorable Tarai Villages in Nepal Based on the Intensive Survey, 1987 Wet Season (mandays/ha)

	Favorable village	Unfavorable village
Land preparation[a]	38	33
Transplanting	36	36
Crop care[b]	44	39
Harvesting and threshing	41	41
Total:	159	149
Family[c]	41	48
Hired[d]	118	101

[a]Includes plowing, harrowing, puddling and seedbed preparation.

[b]Includes fertilizer and pesticide application, manuring, irrigating, and weeding.

[c]Includes exchange labor.

[d]Includes permanent labor.

TABLE 2

Regression Results of the Demand Functions for Hired and Family Labor Per Hectare, the Favorable and Unfavorable Tarai Villages in Nepal Based on the Intensive Survey, 1987 Wet Season.

	Log hired labor		Log family labor		MV
	(1)	(2)	(3)	(4)	(5)[a]
Intercept	4.80	4.83	3.16	3.15	-.81
	(22.91)	(22.37)	(8.94)	(8.98)	(-4.96)
MV	.49**		-.13		
	(2.56)		(-.40)		
Irrigation ratio	.05	.38**	-.23	-.32	1.82**
	(.29)	(3.21)	(-.77)	(-1.65)	(9.13)
Log farm size	.54**	.55**	-.69**	-.69**	-.04
	(6.57)	(6.57)	(-4.98)	(-5.05)	(-.57)
Log working members	-.49**	-.50**	.69**	.70**	
	(-3.78)	(-3.71)	(3.16)	(3.18)	
Ratio of educated members	-.11	-.11	.01	.01	.08
	(-1.07)	(-1.00)	(.06)	(.05)	(.85)
Tenancy dummy	-.05	-.10	-.11	-.10	-.33
	(-.39)	(-.80)	(-.51)	(-.46)	(-1.20)
R^2	.45	.40	.31	.31	
(Log-likelihood)					(-69.10)
F-value	10.85	10.97	6.35	7.67	
(Chi-square)					(174.71)

t-values are in parentheses: **significant at the 1% level, and * at the 5% level.

[a]Two-limit probit regression.

TABLE 4

Man-Land Ratio and Ratios of Paddy and Irrigated Areas in Selected Districts in Nepal.[a]

District	Man-land ratio[b] (persons/ha)			Ratio to cultivation area in 1981 (%)	
	1971	1981	Annual growth rate (%)	Paddy	Irrigation
Hills:					
Nuwakot	3.8	4.5	1.7	44	11
Kabhre	3.9	4.9	2.3	29	9
Tarai:					
Sarlahi	4.1	6.1	4.1	65	80
Chitwan	3.3	4.7	3.5	49	24
Morang	2.8	5.0	5.9	79	41
Sunsari	3.1	4.8	4.4	64	44

[a]From the Central Bureau of Statistics (1986, 1987).

[b]The ratio of population to cultivated area.

TABLE 5

Socioeconomic Characteristics of Sample Villages in the Extensive Survey by Region and by Environment in Nepal, 1987 Wet Season.

	Hills		Tarai	
	Favorable	Unfavorable	Favorable	Unfavorable
No. of villages	7	9	17	9
Irrigation ratio (%)	34	4	70	11
MV adoption (%)	73	13	69	16
Paddy yield (t/ha)	2.7	1.6	3.0	2.2
Average farm size (ha)	1.1	1.0	1.9	1.8
Average paddy area (ha)	.6	.4	1.5	1.3
Ratio of landless households (%)[a]	5	2	30	20
Ratio of owner cultivators (%)[b]	89	91	49	70
Ratio of seasonal immigrants (%)[c]	41	3	21	12
Distance from the nearest commercial center (km)	3.7	5.0	3.4	2.5

[a]Ratio to the total number of households.

[b]Ratio to the total number of farming households excluding the landless households.

[c]Ratio to the total hired labor during peak seasons of transplanting and harvesting.

TABLE 6

Estimation Results of MV Adoption Function, Landless Ratio Function, and Seasonal Inmigration Function, Based on the Extensive Survey in Nepal.

	MV	Landless ratio	Seasonal inmigration ratio
Intercept	-.15 (-.78)	-.12 (-1.00)	-.08 (-.26)
Irrigation ratio	.81** (5.77)	.19* (2.10)	.28* (2.02)
Tarai dummy	.08 (.93)	.17** (2.90)	-.20* (-1.82)
Distance	-.01 (-1.18)	.02* (2.39)	-.01 (-1.07)
Log farm size	-.01 (-.20)	.04* (2.20)	-.01 (-.10)
Ratio of owner cultivator	.25* (1.73)	-.06 (-.68)	
Contract dummy			.23* (2.39)
R^2	.57	.54	.24
F-value	9.68	8.47	1.80

t-values are in parentheses: **significant at the 1% level, and * at the 5% level.

TABLE 7

Daily Wage Rates of Hired Labor by Activity and by Environment, Sample Villages in the Extensive Survey in Nepal, 1987 Wet Season (kg paddy/day).[a]

	Hills		Tarai	
	Favorable	Unfavorable	Favorable	Unfavorable
Land preparation (male)	7.45	6.56	5.77	5.66
Transplanting (female)	4.69	4.14	4.74	5.19
Weeding and manuring (female)	4.45	3.94	4.48	4.76
Harvesting (female)	4.45	4.10	4.48 (10.88)[b]	4.76 (9.78)[b]
Threshing (male)	6.91	6.43	6.97	6.47

[a]Standardized wage rates for eight hours per day, expressed in real paddy terms.

[b]Imputed wage rates per day under output sharing arrangements.

TABLE 8

Estimation Results of Log-Wage Rate Functions Based on the Extensive Survey in Nepal.

	Land preparation	Transplanting	Weeding & manuring	Harvesting	Threshing
Intercept	1.87 (8.42)	1.24 (5.42)	1.28 (5.79)	-1.42 (6.95)	1.88 (7.34)
Irrigation ratio	.14 (.85)	.05 (.27)	.07 (.46)	.23 (1.58)	.21 (1.15)
Tarai dummy	-.22* (-2.10)	.20* (1.85)	.12 (1.17)	.05 (.46)	-.28* (-2.30)
Distance	-.03* (-1.92)	-.04** (-2.79)	-.03* (-2.20)	-.02* (-1.87)	-.04* (-2.27)
Log farm size	-.02 (-.32)	-.05 (-.61)	-.01 (-.20)	-.04 (-.58)	-.01 (-.16)
Ratio of owner cultivators	.10 (.59)	.37* (2.18)	.23 (1.37)	-.03 (-.17)	.04 (.21)
Contract dummy				1.12** (11.17)	
R^2	.24	.33	.22	.88	.26
F-value	2.31	3.55	1.98	41.25	2.54

t-values are parentheses; **significant at the 1% level, * at the 5% level.

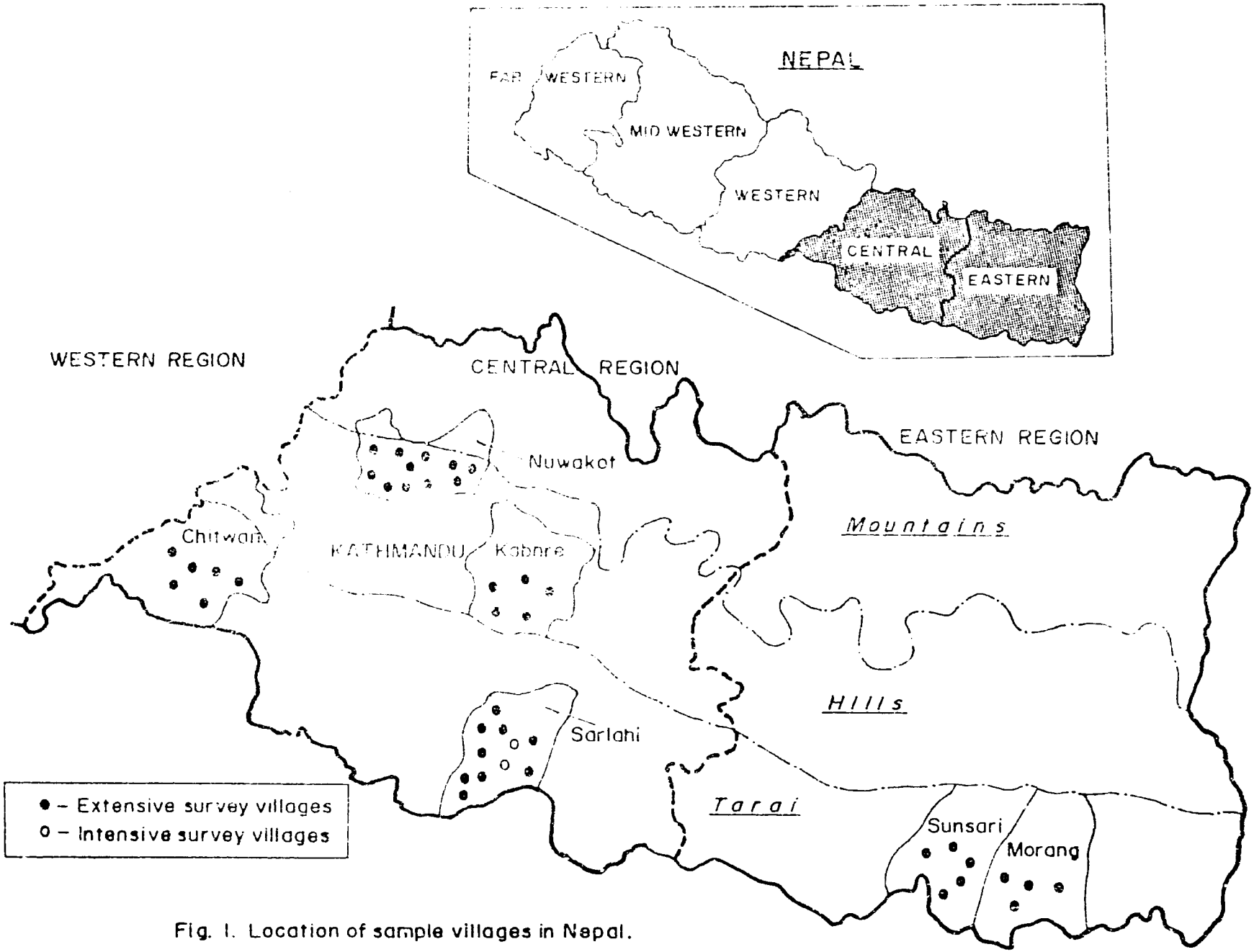

Fig. 1. Location of sample villages in Nepal.

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