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THE IMPACT OF TECHNICAL CHANGE ON RURAL LABOR MARKETS IN THE PHILIPPINES*

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INTRODUCTION

Since the mid-1960s, modern rice varieties, chemical fertilizers, and irrigation have been some of the major sources of output growth in Philippine agriculture. While output growth in most other crops in the 1970s was due to area expansion, increases in yields accounted for 83 percent of output growth of *palay* during the same period (David et al. 1984). Increases in paddy yields were unprecedented in most rice-producing areas. However, the benefits from these increments have not been uniformly distributed across regions as well as among participants in agricultural production. As a result, regional economic disparities widened specifically between the more favorable regions represented by areas with good water control and the less favored regions such as most rainfed upland regions (Ruttan 1977; Bardhan 1977). Producers in the latter region have been further hurt by the fall in the real price (i.e. price deflated by CPI) of rice as a result of increased production.

The location specificity of the new agricultural technology has had various effects on the structure and operations of rural labor markets. In the more favored regions where adoption of modern rice varieties was relatively widespread, the impacts on labor

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markets were reflected in increased labor demand and farm wages, and in changes in aspects of labor contracts that reflected underlying conditions in local labor markets, the nature of technological change, and the institutional structure in these village economies. In regions where demand exceeded supply of labor, farm wages increased as in the case of Punjab in Northern India (Nicholson 1984). However, in regions where population pressure was high and where traditional village structures governed contractual relations, the effects on farm wages were reflected in new contract terms characterized by lower income, increased risk and effort, or a combination of these as in the case of the observed shift from the traditional output sharing scheme called "gama" in the Philippines or "ceblokan" in Indonesia (Hayami and Kikuchi 1981; Hafid 1979).

On the demand side, the adjustments occurred as increasing intensification, economies of scale in supervision and transaction costs, the technology itself, as well as the underlying conditions interacted to determine the specific form of labor market adjustment. Changes in the composition of hired labor, in the division and specialization of particular types of labor in specific farm operation, and in specific aspects of contracts, for example, contractual form, payment scheme, etc., were some of the observed adjustments on the demand side of rural labor markets.

In the context of the above framework, this paper examines the impact of technical change on the structure and operation of rural labor markets. More specifically, the study:

1) describes the quantitative and qualitative effects on labor markets;
2) assesses the impact of technical change on labor demand; and
3) examines the influence of technical change on village-level migration among rural households.

PRODUCTION ENVIRONMENT AND SOCIO-ECONOMIC CHARACTERISTICS OF SAMPLE VILLAGE ECONOMIES

Production Environment and Technology Adoption

The data used in this study were obtained from a survey of households from five sample villages from Central Luzon and Iloilo representing varying production environments.[1] Using irrigation as the principal basis for classifying production environment, sample villages with irrigation were classified as having "favorable" production environment while those with no irrigation as having "less favorable" production environment.

Three villages, two in Nueva Ecija and one in Iloilo, considered as having favorable production environments, have at least two rice harvests per year. On the other hand, villages which were classified as having unfavorable production environments had moderate to mountainous topography. A significant portion of rainfed farm areas are still planted to traditional rice varieties in contrast to 100 percent adoption of modern rice varieties in the irrigated villages.

In general, while there are observed varying levels of technology adoption among villages between the two types of production environments, irrigated areas tend to have greater proportion of crop area planted to modern rice varieties, higher use of fertilizer, insecticide and herbicide per hectare, as well as the use of tractors in land preparation (Table 1). This is not surprising since these components of the so-called modern rice technology are complementary to irrigation.

Demographic and Socioeconomic Profiles of Sample Villages

Table 2 gives information on the socioeconomic and demographic characterics of the sample villages. Like most villages,

1. For details of the sampling framework and scope of the household survey, see Bautista, 1988.

Table1
ADOPTION OF MODERN BIOLOGICAL TECHNOLOGY IN THE SAMPLE VILLAGES: 1985 WET SEASON

	Favorable			Unfavorable	
	Nueva Ecija 1	Nueva Ecija 2	Iloilo 1	Iloilo 2	Iloilo 3
No. of farms	92	54	37	63	50
Average crop area (ha)	2.1	1.8	1.1	1.5	0.9
% area under modern varieties	100	100	100	79	59
% area w/ fertilizer	100	100	100	100	79
Fertilizer Use:					
Pesos/ha	1393	1161	827	961	685
Kg Nitrogen/ha	70	59	54	59	54
Kg Potassium/ha	32	25	12	19	4
Kg Phosphorus/ha	9	16	1	16	1
% area using insecticide	97	93	86	98	63
Insecticide use (Pesos/ha)	324	185	220	183	45
% area using herbicide	84	73	80	83	18
Herbicide use (Pesos/ha)	153	71	120	120	9

Table 2
DEMOGRAPHIC CHARACTERISTICS OF SAMPLE VILLAGES CLASSIFIED BY PRODUCTION ENVIRONMENT, 1985

	Favorable			Unfavorable	
	Nueva Ecija 1	Nueva Ecija 2	Iloilo 1	Iloilo 2	Iloilo 3
Population (1985)	1497	859	853	921	646
Land area (sq km)*	6.0	4.2	1.9	3.2	2.1
Population density	250	207	436	286	307
No. of households (HH)	267	178	147	173	123
% farm HHs	78	72	59	84	85
% landless HHs	20	24	18	9	13
% non-agric HHs	2	8	24	7	2
Average HH size (ha)					
Farm households	6	5	6	6	5
Landless households	5	5	5	4	4
Dependency rate (percent)**	81	76	59	66	68

*Based on enumeration.
**Computed as the proportion of the total village population aged 15 years old and below and 65 years old and above to village population aged 15-64 years old.

majority of households are employed in agriculture either as cultivators or as wage laborers. Dependency rate in the sample villages range from 59 percent to a high of 81 percent and an average household size of five family members.

A distinctive feature of irrigated villages, however, is the significantly higher proportion of landless agricultural households. This may be indicative of the attractiveness of the differential employment opportunities for wage labor as a result of the high level of adoption of the new rice technology. This made possible increased cropping intensity and higher labor demand for harvesting and other crop care activites in areas where widespread adoption of new rice varieties occurred.

IMPACT ON RURAL LABOR MARKETS

Total Labor Use

Although there are substantial differences in total labor use and inter-village farm activities, labor use per hectare in irrigated areas tend to be higher *vis-a-vis* nonirrigated areas. These differences are particularly observed in land preparation, crop care, and crop establishment (Table 3).

In irrigated villages, variations in labor use for land preparation is explained by the more intensive use of labor-saving technology such as tractors. Thus, labor use in land preparation tend to be lower in these villages due to mechanization. This is, however, compensated by more turn-around time in activities for increased cropping intensity per unit area.

In crop establishment, variations in labor utilization result from the method use in crop establishment. Direct seeding, as extensively practiced in the sample Iloilo villages, lowers labor demand. The increasing use of direct seeding in recent years has been facilitated by the development of more effective chemical herbicides. Moreover, the increased labor cost and uncertainty in

Table 3

TOTAL LABOR USE (MAN-DAYS/HA) BY ACTIVITY BY VILLAGE CLASSIFIED BY PRODUCTION ENVIRONMENT, WET SEASON, 1985

Activity	Favorable			Unfavorable	
	Nueva Ecija 1	Nueva Ecija 2	Iloilo 1	Iloilo 2	Iloilo 3
Land preparation	15	15	13	27	31
% farms using hand tractor	(93)	(78)	(92)	(38)	(0)
Crop establishment	28	18	5	5	24
% farms using direct seeding	(21)	(50)	(84)	(97)	(52)
Care of crops	6	8	28	7	9
% using herbicide	(81)	(61)	(84)	(75)	(20)
% using "sagod"	(0)	(0)	(59)	(0)	(0)
Harvesting, threshing and post-harvest activities	37	36	35	31	27
% using mechanical thresher	(100)	(100)	(97)	(100)	(86)
Others	1	2	5	2	1
All Activities	87	79	84	62	92

Note: Figures in parentheses are in percent.

labor supply during peak periods has made transplanting a relatively more unattractive method since it requires the use of a hired pool of skilled transplanters.

In crop care activities, the observed variation in labor use results from the use of the *sagod* system - an institutional arrangement or contract which stipulates obligatory weeding without pay in exchange for an exclusive right to harvest the weeded plot. This "exclusionary" labor arrangement contrasts with the traditional harvesting system called *hunusan* in Central Luzon or *pasapar* in Iloilo which is characterized by the communal or open-field method allowing an indefinite number of people to take part in the harvesting operation. As such, labor use in harvesting tend to be much lower in areas where *sagod* contracts are used.

Composition of Labor Use

Family vs. Hired Labor. A qualitative effect on rural labor markets is reflected in the shift in the composition of the type of labor. As shown in Table 4, irrigated areas employ a higher proportion of hired labor more than family labor. Hired labor is especially concentrated in harvesting, transplanting, and weeding, particularly in the case of the sample Iloilo village where *sagod* was widely practiced. Crop care activities, on the other hand, tend to be performed by family labor.

These results are consistent with many farm-level studies (Barker and Herdt 1985). The high incidence of hired labor in irrigated areas is easily explained. The increases in cropping intensity and yields in the irrigated areas accentuate peak season labor requirements which can only be met by hired labor. In addition, the subsequent increased incomes in these areas enable the substitution of hired for family labor (Smith and Gascon 1979). This, along with the principle of comparative advantage, explains the tendency of family labor to concentrate on higher level tasks such as supervision, which is less arduous, leaving the more arduous

Table 4
COMPOSITION OF LABOR USE (MAN-DAYS/HA) BY ACTIVITY BY VILLAGE CLASSIFIED BY PRODUCTION ENVIRONMENT: WET SEASON, 1985

	Favorable						Unfavorable			
	Nueva Ecija 1		Nueva Ecija 2		Iloilo 1		Iloilo 2		Iloilo 3	
Activity	Family[a]	Hired	Family[a]	Hired	Family[a]	Hired	Family[a]	Hired	Family[a]	Hired
Land preparation	11	4	12	3	3	10	10	7	28	3
Crop establishment	5	24	4	14	1	4	1	4	16	9
Crop care	5	1	8	0	6	22	5	2	8	0
Harvesting, threshing & post-harvest	8	29	10	26	3	32	4	27	4	23
Others	1	0	2	0	5	0	1	0	1	0
All activities	30	58	36	43	18	68	21	40	57	35
% to total labor	(34)	(66)	(46)	(54)	(20)	(80)	(34)	(66)	(62)	(38)

[a]Includes exchange labor.
Figures in parentheses are in percent.

tasks such as transplanting, harvesting, and weeding to hired labor. Corollarily, Roumasset and Smith (1981) theorized that the above pattern can be explained in terms of the "transactions cost" approach to agricultural organization. Because of the potentially high excess burden of hiring a management staff and other forms of skilled labor, the identity of family members continues to serve as the dominant institution for economizing on transactions costs. Thus, hired labor is employed in transplanting, harvesting, and weeding because these require more workers and are subject to time constraints and to economies of scale in supervision. Moreover, quality shirking can be monitored by *ex post* inspection of the field (Roumasset and Uy 1980). On the other hand, fertilizer and chemical applications are expensive to monitor so that enforcement may be cheaply achieved by performance of the operator himself or by other family members.

Short-term vs. Permanent Labor. Another qualitative effect on rural labor markets is the increasing incidence of permanent labor contracts especially in irrigated Central Luzon villages. Field-level observations indicate that permanent labor appears to be positively correlated to farm size (Table 5). These observations match farm-level findings in India that point to positive correlation of incidence of permanent labor contracts to irrigation or agricultural development (Bhalla 1976; Bardhan and Rudra 1981).

Table 6 lists the characteristics of observed permanent labor arrangements. A distinctive feature of permanent contracts is that, in addition to job security, workers receive other benefits such as food and/or interest-free loans. Permanent workers likewise realize higher net returns vis-a-vis casual or spot laborers. This incentive structure is an "attempt by landlord or employer to transform hired labor into workers whose behavior would approximate that of family labor, thus reducing the burden of on-the-job supervison" (Eswaran and Kotwal 1985).

Table 5
AVERAGE LABOR USE PER HECTARE (MAN-DAYS/HA) BY FARM SIZE AND BY TYPE OF CONTRACT: WET SEASON, 1985

Village/Labor Contract	Farm Size (in ha)			
	< 0.99	1.0-1.99	2.0-2.99	>3.0
Favorable Villages				
Nueva Ecija 1				
Permanent	0.67	1.57	1.84	4.71
Casual	39.05	54.38	53.23	54.91
Iloilo 1				
Permanent	1.31	0	0	0
Casual	67.29	75.24	57.38	57.72
Nueva Ecija 2				
Permanent	0	0.69	0.97	0
Casual	37.04	43.20	41.46	44.20
Unfavorable Villages				
Iloilo 2				
Permanent	0	0	0	3.51
Casual	32.99	43.52	33.02	41.76
Iloilo 3				
Permanent	7.69	0	0	0
Casual	23.80	38.28	25.07	40.03

Table 6
COMPARATIVE FEATURES OF CASUAL AND PERMANENT LABOR ARRANGEMENTS OBSERVED IN TWO SAMPLE VILLAGES, NUEVA ECIJA, 1985

Features	Casual Worker	Permanent Worker		
		Type 1 (Permanent)	Type 2 (Semi-attached)	Type 3 (Percent sharing)
1. Duration of contract	short (daily)	long-term (seasonal, annual)	long-term (seasonal, annual)	long-term (seasonal, annual)
2. Job security	None	Yes	Yes	Yes
3. Scope of work (e.g., plowing)	Task-specific	All farm and household operations	Pre-assigned task activities	Almost all farm
4. Payment	According to prevailing rate for particular task	10-15 cavans/ season	10-15 cavans/ season	10 percent gross harvest
5. Additional benefits	None	Interest-free loan, free dwelling, food	Allotment of land or interest-free loan	Allotment of land or interest-free consumption loan

Impact on Labor Demand

To examine the impact on labor demand, regression equations were estimated on total labor and hired labor.[2] Table 7 presents the estimated elasticities using the pooled data. The results confirm the hypothesis of the positive influence of irrigation, farm size, *sagod*, modern varieties, and output price on labor demand. On the other hand, wage, mechanization, and direct seeding exert a negative influence on labor demand.

Among the variables that positively influence labor demand, only irrigation, farm size, and *sagod* have statistically significant coefficients. The low value of the elasticity of irrigation, however, suggests that expansion of irrigated hectarage *per se* will not generate significant increases in employment. This maybe due to the effects of mechanization and adoption of direct seeding in irrigated areas which cancel out the effects of irrigation.

The positive and highly significant coefficient of *sagod* supports earlier findings on the labor-inducing effect of this arrangement. Apart from the hypothesized wage equalization effect of *sagod* (Hayami and Kikuchi 1984), the *sagod* system enables the employer or farmer to economize on the use of herbicides. Since the absolute share of the worker is directly proportionate to the yield, workers have an incentive to keep the plot/s free of weeds to prevent reduction in rice yields.

Farm size and output price, as hypothesized, exert positive influence on the demand for labor. The highly significant and large coefficient of farm size points to its relative importance as a determinant of labor demand. The relative magnitude of the elasticities for total labor (0.933) and hired labor (1.174) indicates that, as farm size increases, the demand for total labor rises but the

2. For details of the variables included in the regression, see Appendix.

Table 7
ESTIMATED ELASTICITIES OF THE DEMAND FOR TOTAL AND HIRED LABOR: POOLED DATA, 1985

Variables/Labels	Total Labor	Hired Labor
Wage	-0.248	-0.456
	(-7.895)**	(-6.027)**
Output price	0.068	0.523
	(0.538)	(1.756)
Farm size	0.933	1.174
	(54.259)**	(28.673)**
Irrigation	0.011	0.026
	(3.039)**	(3.119)**
Modern varieties	0.011	0.008
	(1.159)	(0.352)
Mechanization	-0.006	-0.0006
	(-1.607)	(-0.077)
Direct seeding	-0.029	-0.033
	(-8.023)**	(-3.961)**

demand for hired labor rises even more rapidly. This maybe attributed to the observed substitution of hired for family labor in various farm operations.

The coefficients for output price and modern varieties, even if they are of the correct signs, are not statistically significant. This finding is consistent with estimated price elasticities ranging from 0.2 to 0.4 in other studies. On the other hand, the rather insignificant effect of modern varieties maybe due to already pervasive adoption of modern varieties (MVs) even in rainfed environment, thus dampening its effects.

Table 7 *continued*

Variables/Labels	**Total Labor**	**Hired Labor**
Sagod	0.019 (2.864)**	0.069 (4.261)**
Season	0.033 (0.931)	0.087 (1.042)
Intercept	5.259 (30.307)**	4.881 (11.510)**
R^2	0.8	0.7
F-Value	424.8	131.14
D.F.	495	495

*Significant at 5 percent
**Significant at 1 percent
NOTE: Figures in parentheses are t-values.

Results for the wage variable indicate an inelastic labor demand. The magnitude in the range of -0.2 to -0.4 is consistent with results from other studies (Barker and Herdt 1985). The implications of the estimated elasticities is that a 10 percent increase in wage will reduce total labor input by about 2 percent. Given a positively sloped labor supply curve (Rosenzweig 1984), a rightward shift in the supply function of labor in the agricultural sector will be absorbed only through a large decrease in wages. Thus, policies biased towards the urban sector which induce rural to urban migration may benefit those left in the agriculture sector.

On the other hand, policies designed to stem migration from the rural sector can have severe effects on wages of those remaining in the rural areas (Evenson and Binswanger 1984). Taken together, the increasing adoption of more labor saving technology and direct seeding is likely to deter mobility of rural labor to the more favorable areas and thus prevent inter-regional labor market adjustment through migration.

As expected, the use of direct seeding has a negative effect on labor demand. The estimated coefficents suggest that a percentage reduction in the proportion of area brought under direct seeding reduces total labor use by about 3-4 percent. Cordova et al. (1984) estimated that direct seeding reduces total labor by as much as 20 to 30 percent. While the labor-saving effect may not seem to be substantial, its net saving effect in terms of the direct and implicit cost is substantial. The implicit cost arises from the uncertainty of labor supply during peak planting periods which translates into additional cost as the employer may have to bid up wage offers to attract workers for transplanting.

The coefficent of mechanization, while of the right sign, is not statistically significant, implying that the present stage of mechanization still does not have significant labor-displacing effects.

Impact on Village-Level Migration

To assess the effect of differential technical change on village migration, in-migration functions for farm households, landless households, and the pooled sample were estimated using a generalized least-square technique.[3] Table 8 reports the results.

3. Generalized least-square technique was used because the data set consists of pooled time-series, cross-section observations. Accordingly, ordinary least-squares (OLS) technique is not appropriate since the disturbance terms are likely to consist of time series-related disturbances as well as cross-section disturbances. Consequently, the results are biased and inefficient. See Intrilligator (1978).

Table 8
GENERALIZED LEAST-SQUARE ESTIMATES OF IN-MIGRATION FUNCTION BY TYPE OF HOUSEHOLD

Variable	All Households	Farm	Landless
Man-land ratio	-0.833 (-2.915)**	-1.935 (-3.903)**	-0.666 (-2.469)*
Modern varieties	0.085 (3.017)**	0.040 (0.767)	0.086 (2.636)**
Irrigation	0.012 (0.426)	-0.013 (-0.267)	0.086 (1.181)
Mechanization	-0.004 (-0.114)	0.018 (0.276)	0.003 (0.076)
Inequality	-0.143 (-0.577)	0.026 (0.061)	-0.405 (-1.678)
Intercept	6.979 (3.069)	11.060 (2.801)	6.665 (3.642)
OLS R^2	0.38	0.56	0.47
D.F.	19	19	19

* Significant at 2.5 percent.
** Significant at 1 percent.
NOTE: Figures in parentheses are t-values.

Based on the above results, only population density (man-land ratio) and modern varieties (MVs) exert significant influence on village migration. The sign of the coefficient for man-land ratio confirms its deterring effect on migration. Conversely, an increase in the proportion of area under modern varieties and irrigation act as inducement to immigration. However, only the coefficient sign of modern varieties is statistically significant. Results for the other variables show statistically insignificant coefficents and/or incorrect coefficient sign or both.

Interesting insights are revealed by comparison of household categories. Between farm and landless households, the magnitude of the coefficient for population density is much larger and significant in the farm household regression. On the other hand, while the coefficient of MV is positive in both regressions, only the coefficient in the landless regression is significant. This seems to suggest that households respond differentially to various factors affecting migration decision.

A possible explanation for such behavior is their relative economic position in the social hierarchy. Landless households may be expected to be more responsive than farm households to spatial or regional wage differential and area under modern variety because of their dependence on wage labor. Since an increase in area using modern varieties generates additional demand for hired labor, especially in crop care and harvesting activities, the incremental employment effects of such a change is expected to figure more importantly in migration decision for rural landless households than for farm households. Farm households, on the other hand, are expected to be relatively more responsive to land-related factors, for example, farm size and tenancy, since changes in these variables directly affect their realized returns from cultivation. Consequently, to the extent that increases in man-land ratio reduces average farm holding and income, increased man-land ratio will be a deterrent to in-migration of farm households.

SUMMARY AND IMPLICATIONS FOR POLICY

Analyses of micro-level data confirm the effects of differential technical change on both the demand and supply side of rural labor markets. On the demand side, the effects are both quantitative and qualitative in nature. The quantitative effects are in terms of substantial increases in total farm labor use, particularly of hired labor, especially in areas with good irrigation and water control where pervasive use of modern varieties and complementary inputs has occurred. Coupled with this are qualitative effects on the structure and operation of rural labor markets as reflected in the evolution of labor market arrangements such as the *sagod* and the increasing incidence of permanent labor. These arrangements embody exclusionary features, which restrict other labor market participants and hence, mobility of rural labor.

The analysis of rural migration suggests that technical change influences the direction of rural migration to a certain extent. However, its effect on migration behavior is not uniform across various social strata of the rural population. The relationship between migration and technological change in agriculture implies that possibilities exist for the benefits of technical change in the more favored areas to be shared by those in the unfavorable areas. However, the extent to which the spillover effects of technical change is realized depends substantially on the nature or bias of technical change and on the characteristics of rural markets. If the observed trend towards mechanization and adoption of direct-seeding continue, the benefits will directly accrue to those who obtain access to the increasingly limited employment opportunity in the irrigated areas. Moreover, the increasing incidence of permanent labor contracts imply lesser opportunities for rural migrants to find employment in the irrigated regions. These would have negative consequences of widening income disparities between the irrigated and invariably more developed areas and the less favorable areas.

With the inability of the nonagricultural sector to absorb the increasing labor force, agriculture will continue to provide employment opportunities. While there are limitations to the absorptive capacity of agriculture, experiences in various countries illustrate that an efficient agriculture sector can provide the initial base by which to propel an economy to a higher growth path. This requires, however, a fundamental shift in public investment policies and priorities towards agriculture in particular and the rural sector in general to take advantage of both the direct and indirect effects on the rest of the economy.

An example in this respect is investment in irrigation. As results of the study show, irrigation generates substantial direct employment effects. More important and substantial, however, are the indirect effects of the increased demand for nonconsumption goods via the forward or backward linkages to the rest of the economy. These provide for the foundation of agglomeration economies as small firms and manufacturing activities respond to meet the increased demand. Such a scenario is exemplified by the transformation and development of agriculturally-based towns and sub-regional centers such as Gapan and Cabanatuan City, both of which benefited from increased agricultural output as a result of the introduction of new rice varieties in the late 1960s and of the development of the Upper Pampanga Irrigation System (Gibb 1974; Sanders 1979). Similar agricultural-led regional growth leading to low-level urbanization have been documented as in the case of the Muda Project in Malaysia (Bell and Hazell 1982) and the Punjab and Haryana experience in Northern India (Thapar 1971), among others.

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Appendix

DEFINITION OF VARIABLES USED IN THE LABOR DEMAND FUNCTION AND MIGRATION FUNCTION ESTIMATION

Variable Name	Definition
TLABOR	Sum of family, hired and exchange labor, and all farm activities in man-days
HLABOR	Sum of permanent and seasonal hired labor, and all farm activities in man-days
WAGE	Average daily wage (cash and non-cash equivalent)
PRICE	Price of palay per kilogram
AREA	Farm size in hectares
IRRIG	Proportion of farm area under irrigation
MV	Proportion of farm area planted to modern rice varieties
MECH	Proportion of farm area mechanized (use of tractor)
DSEED	Proportion of farm area under direct seeding
SAGOD	Proportion of farm area under *sagod* contract
SEASON	Dummy variable: 1 if wet season; 0 if otherwise

MAN-LAND	Population density: persons per square kilometer
INEQTY	Landownership inequality index; share of upper 10 percent of landowners
INMIG	In-migration rate defined as the number of in-migrants over a five-year period divided by initial year population