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Armando Erguiza, Bart Duff,
and Concepcion Khan

The International Rice Research Institute
P.O. Box 933, 1099 Manila, Philippines

CHOICE OF RICE CROP ESTABLISHMENT TECHNIQUE: TRANSPLANTING vs WET SEEDING

Armando Erguiza, Bart Duff, and Concepcion Khan[1]

ABSTRACT

Wet seeding and transplanting are not separate technologies: they are different methods of establishing a rice crop at the same level of technical efficiency. Wet seeding does have a cost advantage over transplanting, due to its labor-saving bias. While adoption of wet seeding has been increasing, the majority of rice farmers still practice transplanting. In effect, farmers who transplant spend more to produce the same amount of rice. We used a probit probability model to identify the factors that influence a farmer's crop establishment choice. The analysis indicated that supervision of hired labor, cost of transplanting labor, use of credit, costs of fertilizer and herbicide, and selling price of rough rice are significant determinants of the crop establishment choice of irrigated rice farmers in Nueva Ecija, Philippines.

[1] Senior research assistant, agricultural economist, and research aide, respectively, Agricultural Economics Department, International Rice Research Institute, P.O. Box 933, Manila, Philippines.

CHOICE OF RICE CROP ESTABLISHMENT TECHNIQUE: TRANSPLANTING vs WET SEEDING

Expansion of irrigated area, availability of selective herbicides, introduction of early-maturing rice varieties, and improved fertilizer management, coupled with increasing costs of transplanting and declining profitability of rice production, have encouraged many Filipino rice farmers to switch from transplanting to wet seeding (De Datta 1986, De Datta and Flinn 1986). In Central Luzon, where traditionally rice has been transplanted, adoption of wet seeding has been relatively rapid, from less than 2% of the rice area in 1979 to 16% in 1982 (Moody and Cordova 1985). The rapid adoption rate has focused attention on the equity and efficiency implications of a shift from a labor-intensive to a labor-saving technology.

Even though wet seeding (broadcasting pregerminated seed) requires substantially less labor than transplanting, its adoption does not necessarily imply an increase in the technical efficiency of rice production (Coxhead 1984). Moreover, in an environment of labor abundance and limited off-farm and nonfarm employment opportunities, the labor-saving bias of wet seeding does not appear to be socially optimal. However, wet seeding is a rational response of rice farmers to relative factor price changes, to maximize their private profitability.

If there is no difference in technical efficiency between transplanting and wet seeding, and wet seeding is the privately optimal alternative, why do farmers continue to practice transplanting? We examined some determinants of a farmer's choice of crop establishment technique.

DETERMINANTS OF CROP ESTABLISHMENT METHOD

Coxhead (1984) used the theory of induced innovation to explain the shift to wet seeding for crop establishment on irrigated farms in Nueva Ecija. He found that substitution of capital for labor was only a change in factor proportions along a common production function. It was a response to changing relative factor prices, not to any technical superiority of wet seeding. Wet seeding and transplanting are not separate technologies; they are merely different crop establishment methods that have essentially the same level of technical efficiency. A farmer's decision to replace transplanting with wet seeding is a choice of technique conditioned by relative factor prices.

Mandac et al (1982) noted that wet seeding is not a recent response to labor shortages or to higher labor costs; it has been practiced in the Bicol Region since pre-Hispanic times. They hypothesized that the decision to establish a rice crop by wet seeding or by transplanting in that rainfed environment is determined principally by biophysical, not economic parameters. Mandac and Flinn (1983) supported this argument in their study of rainfed farmers in the same region. They found two cropping patterns: two consecutive transplanted rice crops on the lower portions of the landscape and two consecutive wet seeded rice crops on the upper portions.

Smith (1984) suggested a different approach in analyzing farmers' choices among different techniques. She focused on the issue of moral hazards inherent in casual labor contracts. Moral hazards arise because two parties to a contract have unequal access to information (i.e., the farmer has less information than the laborer on the quality and quantity of work actually carried out). This situation provides an opportunity for the laborer to maximize payment per unit of effort by actually operating on a lower marginal product curve, by practicing "shirking."

Shirking increases the need for supervision services. For small farms, the transaction costs per unit area of using the labor market to generate supervision services are very high. This constrains the use of paid supervisors. Family supervision services have low transaction costs because the family's well-being results from successful production, guaranteeing trustworthiness and providing an incentive to manage the farm well. The supply of family supervisors is, however, limited.

Supervision constraints encourage farmers to adopt techniques or innovations that reduce the opportunity for shirking and reduce the need for supervision. An example is the choice of technique for threshing. Smith (1984) reported widespread adoption of mechanized threshing in Laguna, even in the absence of a distinct cost advantage. She said that clearly implies the importance of supervision costs in a farmer's choice of technique. Mechanized threshing reduces supervision requirements by reducing the number of laborers and the laborers' control over harvesting and threshing operations.

Ramachandran (1986) used data from a cross section of 318 rice-farming households in Nueva Ecija to establish a probability model. The model showed that supervision costs of hired labor are an important determinant in decisions to adopt labor-saving innovations. The model was tested on two major farm activities—land preparation and harvesting/threshing. Farms facing high supervision costs and a limited supply of family supervision services appeared to be good candidates for mechanization.

Although wet seeding does not require mechanization, a parallel can be drawn between the adoption of mechanization and wet seeding in response to supervision constraints.

OBJECTIVE OF THIS STUDY

This study incorporated the concept of supervision constraints and induced-innovation theory into a single model. The effects of biophysical factors could not be tested because of limited data and the homogeneity of the farms sampled.The time-series nature of the data, however, permitted examination of the effects of factor prices on adoption decisions.

We hypothesized that changes in relative factor prices would influence a farmer's choice of crop establishment method. Farmers will maximize the private profitability of rice farming by substituting relatively cheaper inputs for more expensive inputs. If labor costs increase relative to other inputs (all other factors held constant), farmers will adopt labor-saving crop establishment techniques (i.e., wet seeding).

Equally important is the supervision cost associated with the use of alternate techniques. If the wage rate for transplanting relative to the wage rate for similar farm activities goes down, that creates an incentive for transplanters to shirk. Shirking enables transplanters to maximize, or at least maintain, established pay per unit of effort. This puts pressure on the farm household to supervise transplanters so as to minimize, if not eliminate, shirking. Supervision constraints on small farms are minimal and are mitigated by family supervisors. Use of hired supervision services is relevant primarily to large farms. We hypothesized that farm households experiencing supervision constraints will substitute wet seeding for transplanting.

DATA

Data from the 1979-80 Consequences of Small Rice Farm Mechanization Project survey and from a 1985-86 resurvey (Lucas 1984, Moran and Unson 1980, Novenario 1985) were used. The 1979-80 survey covered 320 farm households in eight villages of Cabanatuan and Guimba, Nueva Ecija, Philippines. The 1985-86 resurvey included 265 households from the original sample. Data had been collected for wet and dry season rice crops in both surveys. We analyzed a subset made up of irrigated farms that had used wet seeding in any of the four seasons included in 1979-80 and 1985-86.

Using data from the same panel of farmers allows analysis of responses to change in socioeconomic factors over time. Wet seeding was used as the selection criteria because it is a relatively new method in the area: there are relatively few adopters. Moreover, farmers' knowledge of the merits of both transplanting and wet seeding was required in understanding farmers' choice of technique. The concentration on irrigated farms eliminated variables that could have complicated the analysis.

Table 1. Farms used for probit analysis.[a]

Farm type	Farms (no.)	
	Pooled wet season	Pooled dry season
Transplanted rice farms	108	55
Wet seeded rice farms	26	80
Not planted	10	9
Total	144	144

[a]The few farms that used a combination of transplanting and wet seeding were categorized as wet seeded.

A total of 72 rice farm households per cropping season were selected for the regression analysis. A breakdown of the sample by crop establishment method is given in Table 1.

THE MODEL

A farmer's decision to transplant or wet-seed rice is a classic example of binary choice, in which an individual chooses between only two alternatives. The dependent variable assumes a value of 1 if the first option is chosen, 0 if the second option is chosen. One class of binary-choice models is the probit probability model, which is a constrained version of the linear probability model (see Pindyck and Rubinfeld 1981, for a detailed description).

We used the probit model to analyze the determinants of wet seeding adoption by Nueva Ecija farmers. The use of a combination of cross-section and time-series data allowed the model to capture the effects of both farm-specific attributes and real-price variability. The model is specified as:

$$Z = \alpha + \beta X_1 + \delta X_2 + \ldots\ldots + \sigma X_n$$

The dependent variable Z takes the value of 1 if wet seeding is chosen and 0 if transplanting is chosen. X corresponds to the explanatory variables hypothesized to influence choice of crop establishment technique. The intercept is represented by α; β, δ, and σ correspond to the estimated parameter coefficients.

The explanatory variables used were family supervision services, cropped area, wage for family labor, herbicide cost, transplanting wage, fertilizer cost, credit, and rough rice price.

Family supervision services

The market for hired supervision services on small farms is limited, and a suitable proxy variable must be used to reflect the cost of supervision services. The availability of family supervision services was used to establish the degree of supervision constraint. The variable is defined as the ratio of the required transplanting labor per unit area to the number of adult household workers. The village mean was used to compute the required transplanting labor per household. For wet seeded rice farms, this represents the amount of labor that would be required if transplanting were used. Using the

village mean assumes that the time required to transplant a hectare of rice is the same for all farms in the village.

It is hypothesized that as the family supervision constraint increases, farmers will shift to wet seeding to reduce the need for hired labor and the demand for family supervision. The family supervision variable, therefore, should have a positive sign.

Cropped area

The area to be transplanted determines the demand for supervision services. Large farms are expected to adopt wet seeding because of the larger number of hired laborers required for transplanting. More hired labor increases supervision requirements, which on larger farms may exceed family resources.

Wage for family labor

The family labor wage represents the opportunity cost of time given by household members to supervision. It was computed as the daily off-farm and nonfarm income earned by adult household members. (In the original survey, adults were defined as those 10 years of age and older.)

Herbicide cost

Because of similarities in the age and morphological characteristics of grassy weeds and rice seedlings, weed competition has been a major constraint to wide adoption of wet seeding (Moody and Cordova 1985). Herbicides are required for cost-efficient weed control, particularly because hand weeding is difficult in broadcast rice (Chang and De Datta 1974). De Datta and Bernasor (1988) estimated that 150 labor hours are required to weed 1 ha of transplanted rice twice; 450 labor hours are needed to weed 1 ha of wet seeded rice once. A decline in herbicide costs should increase the probability of the adoption of wet seeding.

Transplanting wage

The primary difference between wet seeding and transplanting is the amount of labor used for crop establishment. Lower planting cost is the most explicit advantage of wet seeding (De Datta 1986). Because wet seeding is a labor-saving technique, we would expect this method to be adopted if wages, particularly for transplanting, increase. Transplanting wage was defined as the cost per hectare of hired transplanting labor. This definition accounts for changes in transplanting cost due to changes in the wage rate and in costs associated with shirking, taking into account the possibility that transplanting costs could increase even with a declining wage rate.

Fertilizer cost

Higher fertilizer inputs may be necessary for wet seeded rice (in the farmer's experience, if not in experiments) to support a larger plant population and to promote germination and growth of otherwise poorly rooted seedlings (Coxhead 1984). Adoption of wet seeding should, therefore, be negatively correlated with the price of fertilizer.

Credit

Transplanting requires large amounts of labor. Traditionally, laborers are paid in cash upon completion of the work. The availability of cash or credit before the planting season largely determines if a farmer transplants or does wet seeding. If cash is scarce and credit unavailable, farmers are more likely to do wet seeding: the method can be handled entirely by family labor. The sign of the credit variable is expected to be negative.

Rough rice price

A decline in the real price of rice, if other prices are held constant, will encourage farmers to adopt cost-saving innovations to sustain farm profits. Wet seeding provides a low-cost alternative to transplanting by reducing crop establishment costs. Adoption of wet seeding is expected to increase as the real price of rice falls.

ADOPTION OF WET SEEDING

Water control is an important prerequisite for wet seeding in flooded fields (De Datta 1986). This explains the higher adoption rate for wet seeding in the dry season (Table 2). Adoption of wet seeding increased between 1979 and 1986 for both wet and dry seasons, although the percentage of adopters in the dry season was higher. In 1985-86, wet seeding adopters represented 36% of the total dry season sample but only 12% of the wet season sample.

Adoption appears to be earlier and more complete in Cabanatuan than in Guimba. As early as the 1980 dry season, the adoption rate was 12% in Cabanatuan but only 2% in Guimba. By the 1986 dry season, Cabanatuan had an adoption rate of 38%, Guimba 32%. The different adoption rates may be a consequence of type of irrigation. The main irrigation source in Cabanatuan is a gravity system; Guimba relies primarily on government and privately owned irrigation pumps. (A follow-up survey showed that pumps were a less reliable source of water, due to frequent breakdowns and power interruptions.)

Table 3 shows the adoption behavior of sample farmers. In the 1979 wet season, 86% of the farmers were continuing to transplant. Only 10% had switched to wet seeding (a small number practiced a combination of transplanting and wet seeding within the same cropping season.) In the 1986 dry

Table 2. Farms adopting wet seeding by municipality and season, Nueva Ecija, Philippines, 1979-80 and 1985-86.[a]

Location of farms	1979 wet	1980 dry	1985 wet	1986 dry
Cabanatuan	3 (2)	17 (12)	18 (16)	43(38)
sample size	136 (100)	137 (100)	114 (100)	112(100)
Guimba	2 (3)	1 (2)	3 (5)	19(32)
sample size	79 (100)	61 (100)	55 (100)	60(100)
All farms	5 (2)	18 (9)	21 (12)	62(36)
sample size	215 (100)	198 (100)	169 (100)	172(100)

[a] Values in parentheses are percentages.

Table 3. Changes in crop establishment patterns of sample farms, Nueva Ecija, Philippines, 1979-80 and 1985-86.[a]

Crop establishment method	1979 wet season to 1985 wet season	1980 dry season to 1986 dry season
WSR to TPR	1 (nil)	5 (4)
TPR to WSR	26 (10)	39 (27)
TPR to Mix	5 (2)	2 (1)
Mix to WSR	1 (nil)	6 (4)
Mix to TPR	1 (nil)	3 (2)
TPR to TPR	214 (86)	87 (61)
WSR to WSR	2 (1)	1 (1)
Mix to Mix	- (0)	- (0)
Total	250 (100)	143 (100)

[a] Values in parentheses are percentages. TPR = transplanting, WSR = wet seeding. Mix refers to a combination of transplanting and wet seeding.

season, 27% of the farmers were found to have switched to wet seeding. The majority still transplanted their crop. Those who were practicing a combination of transplanting and wet seeding in 1980 tended in 1986 to have shifted to wet seeding only.

FACTORS INFLUENCING CHOICE

We compared factors likely to influence the choice of crop establishment method. To eliminate extraneous variables (e.g., technological change, weather, etc.), mean differences were determined for only one cropping season, the 1986 dry season (which had the highest number of wet seeding adopters). The sample included 172 irrigated rice farmers, 62 of them using wet seeding.

Socioeconomic characteristics

No significant differences in age, formal education, and farming experience of the household head were found between the two groups (Table 4). The number of household workers and average family wage also were not significantly different. Tenure, however, was significantly different, with wet seeded rice farms cultivating a higher percentage of rented land. A slightly higher percentage (56%) of the transplanting farmers used production loans, but the average amount borrowed by farmers in each group did not significantly differ.

Cropped area and yield

Cropped area did not differ significantly. Average area planted to rice in the dry season was 1.8 ha for transplanted farms and 1.7 ha for wet seeded farms. Mean yields also did not differ significantly (Table 4).

Seeding rate

Farmers who wet-seed use higher seeding rates to compensate for uneven seed distribution, losses to rat and bird attacks, and uneven land preparation, and to control weeds (Coxhead 1984, Flinn and Mandac 1986, Moody and Cordova 1985). Seeding rate was significantly higher for wet seeded farms (Table 5).

Table 4. Socioeconomic characteristics of sample farmers, Nueva Ecija, Philippines, 1986 dry season.

Item	Transplanted	Wet seeded	Difference[a]
Education (yr)[b]	4.8	4.7	0.1
Age (yr)[b]	51.6	52.6	1.0
Farming experience (yr)[b]	25.4	25.5	0.1
Household workers (no.)	4.8	5.2	0.4
Family wage rate ($/day)[c]	0.93	1.05	0.12
Crop area (ha)	1.79	1.74	0.05
Area rented (%)[d]	41	56	15*
Production credit			
Farmers using (%)	56	53	3
Amount borrowed ($/ha)	314	312	1.50
Yield (kg/ha)	4266	4080	186
Sample size	110	62	

[a] * = difference significant at the 10% level, based on *t*-test of means.
[b] Refers to household head.
[c] Includes on-farm and off-farm income of all household members.
[d] Area rented as percentage of total area planted. US$ = ₱20.39.

Table 5. Material and power input used per hectare by crop establishment method, Nueva Ecija, Philippines, 1986 dry season.

Input	Transplanted	Wet seeded	Difference[a]
Seed (kg)	149.0	183.0	34.0 **
Fertilizer (kg NPK)	139.0	133.0	6.0
Herbicide (kg ai)	0.42	0.51	0.09 **
Insecticide (kg ai)	0.92	0.76	0.16
Power (d)			
Tractor	3.5	3.1	0.4
Animal	5.7	2.5	3.2 **
Farms (no.)	110	62	

[a] ** = difference significant at 5% level, based on *t-test* of means.

Fertilizer

Total fertilizer applied was higher for transplanted rice than for wet seeded rice, although the mean difference was not significant (Table 5). In effect, less fertilizer per plant was applied in wet seeded rice, which may be a rational decision since high fertilizer application increases lodging, particularly in a wet seeded crop with poor root establishment (Cia 1986).

Power

Transplanted farms used significantly more animal draft power for land preparation (Table 5). Tractor use did not differ significantly across farm types.

Herbicide

The amount of herbicide applied to wet seeded rice and transplanted rice differed significantly (Table 5). Farmers who used wet seeding relied more heavily on chemicals to control weeds than did farmers who transplanted. Rates were 0.51 kg ai/ha for wet seeded rice and 0.42 kg ai/ha for transplanted rice.

Herbicides alone were used by 71% of the wet-seeding and 52% of the transplanting farmers. The remainder used manual

Table 6. Weed control practices by crop establishment method, Nueva Ecija, Philippines, 1986 dry season.[a]

Weed control method	Farms (no.)	
	Transplanted	Wet seeded
Manual only	9 (8)	0 (0)
Chemical only	57 (52)	44 (71)
Combination	37 (34)	17 (27)
None	7 (6)	1 (2)
Total	110 (100)	62 (100)

[a] Values in parentheses are percentages.

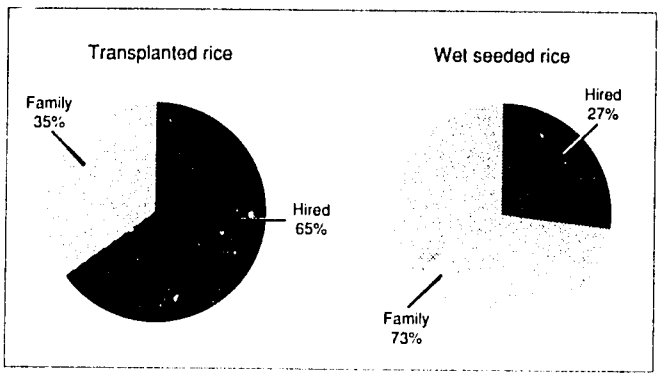
weeding, a combination of hand weeding and chemicals, or no control (Table 6).

Labor

Table 7 shows a significant difference in total preharvest labor required for transplanting and wet seeding. Transplanted rice required 34.9 d/ha more labor than did wet seeded rice. The difference is the high labor input required to grow and transplant seedlings. That accounts for 86% of the difference in total preharvest labor. Wet seeding reduces the labor needed for crop establishment by about 30 d/ha.

Crop care also shows a significant difference in labor use: transplanted rice used 3.2 d/ha more labor. Weeding required 6.3 d/ha for transplanted rice, 3.3 d/ha for wet seeded rice. The higher weeding labor for transplanted rice compensated for the lower herbicide rates used. Wet seeded rice farms used less weeding labor but higher herbicide rates.

Transplanted rice farms employ proportionately more hired labor than wet seeded rice farms. In transplanted rice, 65% of the total preharvest labor was hired. In wet seeded rice, hired labor was 27% of the total preharvest labor (Fig. 1). In absolute terms, transplanted rice used 6.1 d/ha more family labor and 28.8 d/ha more hired labor than wet seeded rice. When crop establishment labor is excluded, transplanted rice used 18.8 d/ha, wet seeded rice 13.9 d/ha. Although the



1. Sources of preharvest labor used in transplanted and wet seeded rice crops. Nueva Ecija, Philippines, 1986 dry season.

percentage shares of hired and family labor are almost the same, the absolute values for family labor differed significantly. Excluding crop establishment labor, preharvest labor for both transplanted and wet seeded rice was largely provided by the farm family. Transplanted rice used significantly more family labor (4.5 d/ha).

Transplanting and weeding represent the two main differences in labor use across farm types. The nature of labor displacement when farmers shift from transplanting to wet seeding can be discerned from these two activities (Table 8). Transplanting, which normally uses hired labor, is performed mostly by women (16 d/ha, 59% of the total transplanting labor). Participation of women in weeding is roughly equal to that of men (2.9 d/ha, 46% of total weeding labor). We hypothesize that as farmers shift from transplanting to wet seeding, proportionately more women will be displaced from the hired labor force. The sharp reduction in hired labor is the most significant effect of wet seeding technology.

Price trends

The real transplanting wage and the herbicide and rough rice prices are given in Table 9. The figures indicate a decline in both the price of rice and the transplanting wage rate and an

Table 7. Preharvest labor (d/ha) by crop establishment method, Nueva Ecija, Philippines, 1986 dry season.[a]

Activity	Transplanted			Wet seeded			Difference[b]		
	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total
Land preparation	6.3	1.0	7.3	4.3	1.3	5.6	2.0	0.3	1.7
Crop establishment	3.0	29.6	32.6	1.4	1.2	2.6	1.6***	28.4***	30.0***
Crop care	8.8	2.7	11.5	6.3	2.0	8.3	2.5*	0.7	3.2*
Weeding	4.7	1.6	6.3	2.0	1.3	3.3	2.7**	0.3	3.0*
Pesticide application	2.4	0.7	3.1	2.6	0.5	3.1	0.2	0.2	0.0
Fertilizer application	1.7	0.4	2.1	1.6	0.2	1.8	0.1	0.2**	0.3
Preharvest 1[c]	18.1	33.3	51.4	12.0	4.5	16.5	6.1**	28.8***	34.9***
	(35)	(65)	(100)	(73)	(27)	(100)			
Preharvest 2[d]	15.1	3.7	18.8	10.6	3.3	13.9	4.5**	0.4	4.9**
	(80)	(20)	(100)	(76)	(24)	(100)			

[a] Values in parentheses are percentages.
[b] ***, **, * = difference significant at the 1%, 5%, and 10% level, respectively, based on *t*-tests of means.
[c] Preharvest labor inclusive of crop establishment.
[d] Preharvest labor exclusive of crop establishment.

Table 8. Labor use (d/ha) for transplanting and weeding, by gender, on transplanted rice farms, Nueva Ecija, Philippines, 1986 dry season.[a]

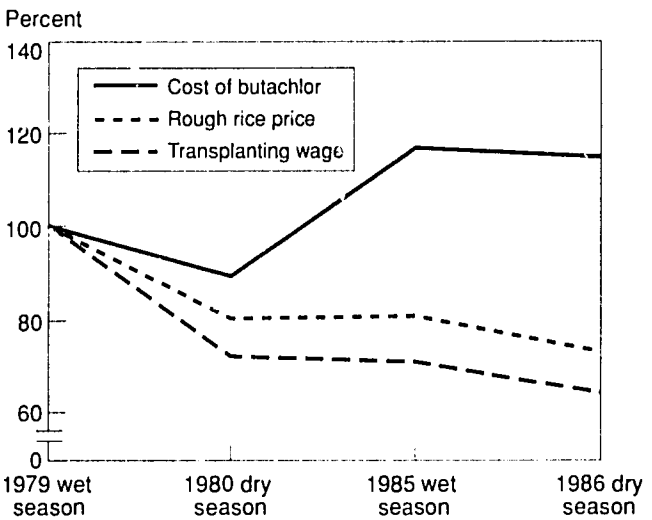
Activity and labor used	Male	Female	Difference[b]
Transplanting			
Hired labor	10.6 (40)	15.8 (60)	5.2***
Family labor	0.3 (60)	0.2 (40)	0.1
Total	10.9 (41)	16.0 (59)	5.1 ***
Weeding			
Hired labor	0.6 (37)	1.0 (63)	0.4
Family labor	2.8 (60)	1.9 (40)	0.9
Total	3.4 (54)	2.9 (46)	0.5

[a] Values in parentheses are percentages.
[b] *** = difference significant at 1% level, based on *t*-tests of means.

Table 9. Real wage rate and output and input prices by season, Nueva Ecija, Philippines, 1979-80 and 1985-86.[a]

Item	1979 wet	1980 dry	1985 wet	1986 dry
Price of rough rice ($/kg)	0.15	0.12	0.12	0.11
Price of butachlor ($/kg ai)	12.55	11.12	14.74	14.49
Transplanting wage ($/d)	1.07	0.85	0.74	0.76
Transplanting to crop care wage ratio [b]	0.72	0.52	0.51	0.46

[a] Values were deflated by Region III consumer price index and converted to US$ using constant 1979 exchange rate (US$ = P7.38).
[b] Computed by dividing transplanting wage by the wage rate for crop care labor like manual weeding.



2. Real wage and price indices by season, Nueva Ecija, Philippines, 1979-80 and 1985-86.

increase in the price of herbicides between 1979 and 1986 (Fig. 2).

The real price of rice fell from US$0.15 in 1979 to US$0.11 in 1986. Transplanting wage rates fell even more sharply, from US$1.07 to US$0.76. The transplanting wage rate fell faster than the wage rates for similar farm activities, as indicated by the declining transplanting to crop care wage ratio. The real price of butachlor, the most widely used herbicide, increased 15% between 1979 and 1986.

Table 10. Costs and returns of rice production by crop establishment method, Nueva Ecija, Philippines, 1986 dry season.

Item	TPR	WSR	Difference[a]
Revenue			
Yield (t/ha)	4.3	4.1	0.2
Net yield (t/ha)[b]	3.8	3.5	0.3
Rough rice price ($/kg)	0.14	0.14	0.0
Total revenue ($/ha)	518	486	32
Costs paid ($/ha)			
Material inputs	120	125	5
Seeds	26	32	6***
Fertilizer	66	65	1
Herbicides	7	9	2**
Other pesticides	21	19	2
Hired labor	25	8	27***
Land preparation	3	3	0
Crop establishment	28	1	27***
Crop care	5	4	1
Power	67	57	10
Machine	64	57	7
Animal	2	nil	2*
Total costs paid	222	191	31***
Gross margin ($/ha)	295	296	1

[a] ***, **, * = difference significant at the 1%, 5%, and 10% level, respectively, based on *t*-tests of means.
[b] Net of harvester/thresher share. US$ = P20.39.

Gross margin

The gross margin, computed by deducting paid-out costs from total revenue, is a measure of the profitability of an enterprise. Table 10 compares the gross margins for transplanted rice and wet seeded rice. The data indicate no significant differences in gross margins, but exhibit marked differences in paid-out costs.

Total paid-out costs were 16% higher for transplanted rice, largely due to the higher cost of hired labor for crop establishment. Transplanted farms spent US$28/ha for crop establishment, wet seeded farms US$1/ha. Material input costs were 4% higher for wet seeded rice, mainly because of higher seeding rates and herbicide application rates. Cost of seed was 23% higher, and herbicides 29% higher, for wet seeded farms.

Despite higher seed and herbicide costs, wet seeded rice had a cost advantage of US$31/ha, largely due to reduced crop establishment costs.

REGRESSION RESULTS

The results from applying the probit model to the data are summarized in Table 11. Pooled wet season, pooled dry season, and pooled wet and dry season data were used. We had little control over the sampling procedure, and the wet season

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Errata for

IRRI Research Paper Series, Number 139, February 1990

Choice of Rice Crop
Establishment Technique:
Transplanting vs
Wet Seeding

Page 9, Table 11.

...= difference significant at the 1,5... SHOULD READ
...= significant at the 1,5....

Page 9, Family labor wage

...Although the results show the expected negative sign,...
SHOULD READ ...Although the results show the expected
positive sign,....

Table 11. Pooled probit regression coefficients for determinants of crop establishment technique, dry season, Nueva Ecija, Philippines.

Variable	Coefficient[a]
Constant	-5.6048 **
Supervision	0.0390 **
Transplanting cost[b]	0.0319***
Credit	0.6151 *
Family wage rate	0.0042
Fertilizer price	-0.4547***
Herbicide price	0.0670 ***
Rough rice price	-2.5370 *
Log-likelihood	-61.42
Sample size	135

[a] ***,**,* = difference significant at the 1, 5, and 10% level, respectively.

[b] Hired labor for transplanting.

data included only 26 wet seeded farms (19% of the total). Given this limitation, only the pooled dry season results are discussed here.

Supervision constraints

Availability of family supervision services affects a farmer's choice of crop establishment method. The positive sign for this variable indicates that as the ratio of transplanting labor to available family supervisors increases, the probability of the adoption of wet seeding increases. Wet seeding reduces the supervision requirement by reducing the number of laborers. On the farms surveyed, transplanting took 32.6 d/ha for crop establishment; wet seeding used only 2.6 d/ha. Farmers who shift to wet seeding are able to reduce labor use by 30 d/ha. With only 2.6 labor d/ha needed, farmers who adopt wet seeding can hire labor that requires little supervision or can use family labor for more control of planting activities. This supports the hypothesis that supervision is an important constraint in the choice between a labor-saving and a labor-using crop establishment technique.

Transplanting cost

The cost of transplanting is another important determinant of the crop establishment method chosen. The variable has the expected positive sign, indicating that as transplanting costs rise, the probability of wet seeding adoption increases.

Credit

A dummy variable for credit was used to determine the effect of a cash constraint on choice of crop establishment method. It was hypothesized that farmers who used credit would transplant and that those who did not would adopt wet seeding. This was based on the lower crop establishment costs, with lower credit requirements, for wet seeding. The results, however, suggest the opposite relationship between credit and selection of crop establishment method. Credit use substantially increased the probability of wet seeding.

It is possible that farmers with sufficient cash are in a better position to transplant. Those using credit may intend to purchase material inputs instead of hiring labor.

Family labor wage

The family labor wage rate reflects the opportunity cost of family supervisory time. If the family wage is high, we expect a higher probability of wet seeding adoption. Although the results show the expected negative sign, the estimated coefficient is not significant. This may be due to the small degree of variability in off-farm and nonfarm income across farm types. It may also reflect the scarcity of off-farm and nonfarm employment opportunities in the area surveyed.

Price of fertilizer

The real price of fertilizer does affect the probability of wet seeding adoption. This suggests that farmers associate wet seeding with poor root penetration and higher plant populations, hence requiring a relatively higher fertilizer application rate. If the real price of fertilizer increases, farmers will be discouraged from adopting wet seeding.

Price of herbicide

The real price of herbicides is a highly significant determinant of crop establishment choice. The positive sign, however, runs counter to expectations. Since wet seeded rice depends heavily on chemicals for weed control, a negative relationship between adoption of wet seeding and the real price of herbicide was expected. The relationship found is possible if private profitability increases with wet seeding. In effect, farmers do not view increases in herbicide cost in isolation, but in relation to changes in other production costs with the shift in crop establishment technique. Increases in herbicide cost can be justified by savings in crop establishment and weeding costs. Therefore, there is an incentive to shift to wet seeding even with increasing herbicide prices.

Rice price

Among the nondichotomous variables in the model, the rough rice price coefficient had the highest significant absolute value. When other factors are held constant, the probability of wet seeding adoption increases as the real price of rice declines. Wet seeding is viewed as a rational response of farmers to falling output prices, to sustain farm profits.

Cropped area

The coefficient of this variable was insignificant in all regressions and was dropped. (Variability in cropped area across farm types was low.)

SUMMARY

Widespread adoption of wet seeding in recent years has been attributed to a range of biophysical and socioeconomic factors. We used data from a panel survey of farmers in six

irrigated rice villages of Nueva Ecija to analyze determinants of crop establishment choice in the dry season.

The analysis confirmed the hypothesis that supervision of hired labor is a significant determinant of a farmer's decision to transplant or to wet-seed. Insufficient family labor to supervise hired transplanters constrains farmers from transplanting. Shifting to wet seeding reduces the scope for hired labor shirking, reducing the need for supervision services.

An increasing trend in transplanting costs encourages farmers to adopt labor-saving crop establishment techniques. In effect, farmers substitute capital in the form of seed and herbicides for labor. The results also suggest that the labor cost advantage of wet seeding more than compensates for the increase in herbicide cost, and adoption is increasing even with increasing herbicide costs.

The results also suggest that farmers with low credit requirements are more likely to transplant. Household assets may be a more suitable proxy variable to reflect the household cash position.

An increase in fertilizer price discourages farmers from adopting wet seeding. Reduction in fertilizer application with increasing fertilizer prices may be more detrimental to wet seeded rice, which has higher plant population per unit area. Conversely, the declining trend in rice prices greatly increases the probability of wet seeding adoption, because it permits farmers to sustain farm profits.

Cropped area and family wage rate were not significant determinants of crop establishment choice. This may have been due to the lack of variation in these variables across farm types. The insignificant family labor wage variable may also reflect the lack of off-farm and nonfarm income opportunities in the villages surveyed.

The increasing adoption of wet seeding also may exacerbate the unemployment problem by releasing the labor that would have been used for transplanting. Women are more disadvantaged because of their greater participation in transplanting activities. How displaced labor is ultimately utilized will determine the equity implications of wet seeding technology.

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