PN-AAY-187
50315

IRRI RESEARCH PAPER SERIES
NUMBER 121 DECEMBER 1986

LANDFORMS AND MODERN RICE VARIETIES

R.A. Morris, J.H. Kim, and J.B. Valera

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

LANDFORMS AND MODERN RICE VARIETIES

R. A. Morris,[1] J. H. Kim,[2] and J.B. Valera[3]

ABSTRACT

Although modern rice varieties (MVs) are widely grown in tropical Asia, many farmers continue to cultivate traditional rice varieties. A study was conducted during 1983-84 wet season in the Cagayan Valley, Philippines, to identify factors that contribute to MV adoption. Two hundred parcels were sampled from 14 tracts of rainfed rice in a 25- × 45-km^2 area. The tracts were located on 5 landforms — alluvial fan (AF), interhill miniplain (IP), interfluve (IF), alluvial terrace (AT), and recent river terrace (RT). Data were collected to characterize farmers and their parcels with respect to personal (PC), economic (EC), and land (LC) attributes. Indicators of MV adoption (AAV) by farmers were determined. Data were obtained by field observation, crop cutting, and interviews to solicit farmer perceptions of MVs.

Canonical correlations between AAV and LC were stronger than between AAV and PC or AAV and EC. As a predictor of MV adoption, LC attributes were better than PC or EC attributes when used separately. When combinations of PC, EC, and LC attributes were used, two land variables (water reliability index and land suitability class), one personal variable (frequency of extension contact), and one economic variable (average N fertilizer use) predicted adopters and nonadopters with 95% accuracy.

The study demonstrated the importance of including land characteristics in research on rice variety adoption. Water reliability was the single most important land characteristic contributing to MV adoption. Farmers' perceptions of the drought hazard differences among landforms were associated with MV adoption and with observations of field hydrology.

[1]Agronomist and head, Multiple Cropping Department, International Rice Research Institute, P. O. Box 933, Manila, Philippines. [2]Chief, Evaluation Section, Rural Guidance Section, Rural Development Administration, Suweon 170, Republic of Korea. [3]Chairman, Department of Agricultural Education and Rural Studies, University of the Philippines at Los Baños, College, Laguna, Philippines.

13
PN-AAX-157
50315

LANDFORMS AND MODERN RICE VARIETIES

Farmers in many ecological niches in tropical Asia have adopted modern rice varieties (MVs)[4]. Farmers in other niches, however, persistently cultivate traditional rice varieties (TVs). An example of this persistence was observed in a research project initiated in 1980 in the Cagayan Valley, Luzon, Philippines. Agronomic factors contributing to persistent cultivation of photoperiod-sensitive TVs were reported by Gines et al (13). The research project in this valley focused on one landform (alluvial terrace), where only TVs were cultivated. By 1982, it was obvious that farmers cultivating fields on the alluvial terrace had little interest in the three MVs included in on-farm tests, even though their mean yield was slightly higher than yields from farmers' TVs (19). Two of these MVs (IR46 and IR52) had been released for rainfed lowland environments. The third (IR36) was the single most widely cultivated variety in tropical Asia. Table 1 outlines the main characteristics of these varieties.

Although MVs are seldom cultivated on rainfed alluvial terraces in the Cagayan Valley, they are commonly cultivated on other rainfed landforms adjacent to alluvial terraces. This study was undertaken to identify factors contributing to farmers' choice of rice varieties for the five landforms.

METHODOLOGY

Research area

The area in which the landforms are located extends approximately 45 km from north to south and 25 km from east to west in the central part of the valley. The study area is relatively compact and distant from major mountain ranges. Mean rainfall during the rice cultivation season (August-January) is relatively uniform across the research area (Table 2). During the season in which this study was conducted (1983-84), rainfall was below the 30-yr mean (1,133 mm) reported by Gines et al (13).

Sampling

Fourteen tracts containing representative landforms were delineated on a map drawn by Bruce and Morris (5). Characteristics of five landforms on which rainfed rice is grown are summarized in Table 3.

The total area in the 14 tracts was 5,890 ha. Reconnaisance visits were made with key informants. For each tract, a map was drawn at a 1:10,000 scale. Ricefields totaling 3,176 ha were identified. After several follow-up visits, 3,179 intensive data parcels (IDPs) were identified and used as the population from which 200 IDPs were drawn. (In this study, IDPs were the observational units. The IDP concept is explained more fully by De Datta et al [6]. IDPs were the units of observation because a farmer chooses the rice variety and field operations that are compatible with field characteristics.) Forty IDPs per landform were selected by stratified random sampling with provision for equal sample size (20).

Field observations were restricted to IDPs. Moreover, unless general information about the farm was sought, responses to questions about field characteristics, fertilizer use, varieties, and yields were solicited only for the IDP. Before the series of interviews started, visits to IDPs were made by enumerators and farmers to avoid confusion about location. Farmer interviews and observations on IDPs were conducted over a 6-mo period (September 1983 to February 1984).

Data

Five sets of data were collected. The variables in these sets were selected to reflect relevant differences in personal characteristics of farmers (PC), economic characteristics of farms (EC), land characteristics of IDPs (LC), the inclination of farmers toward MV acceptance, and the degree to which farmers have adopted MVs. The set of MV acceptance and adoption variables was designated by AAV.

[4]"High yielding variety" is a term widely used to describe many rice varieties developed during the past two decades. However, "modern variety" is a more appropriate term because a variety may be adopted not because it is responsive to improved agronomic practices but because it is early maturing and/or resistant to insect pests and diseases. Traditional varieties are commonly photoperiod sensitive, late maturing, and not highly responsive to improved agronomic practices.

Table 1. Characteristics of three modern varieties tested in a cropping systems research project on the alluvial terrace landform.

Variety	Year released	Target environment	Duration (d)	Height (cm)	Reaction[a] to								
					Tungro	Grassy stunt	Blast	BPH			Stem borer	Drought	Submergence
								1	2	3			
IR36	1976	Irrigated, favorable rainfed lowland	110	85	R	R	R	R	R	S	MR	MT	S
IR46	1978	Rainfed lowland	130	110	R	S	R	R	S	R	MR	MT	S
IR52	1980	Rainfed lowland	115	95	R	R	MR	R	R	S	MR	T	S

[a]R = resistant, MR = moderately resistant, S = susceptible. T = tolerant, MT = moderately tolerant.

Table 2. Mean monthly rainfall on each landform,[a] by month (means across 3 yr) and by year (totals across growing season).

Time period	Mean monthly rainfall (mm)				
	AT	RT	IF	IP	AF
August	134	126	141	159	151
September	165	164	174	166	134
October	234	230	212	218	187
November	165	200	170	196	187
December	67	70	45	49	63
January	31	24	7	11	29
1981	852	943	903	870	827
1982	1014	879	732	837	733
1983	522	621	615	690	692
Mean	796	814	749	799	751

[a]AT = alluvial terrace, RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan.

Seven data collection methods were used, including farm surveys and crop cuts from simple field experiments. The different methods and sources presented opportunities to cross-check many variables for reliability (18).

Analyses

Three statistical procedures were used to analyze the data: the Mann-Whitney U test (24), canonical correlation (1, 16), and binary logit analysis (14, 21).

A full description of data collection and analytical methods is given by Kim (18). SAS procedures were used for the analyses (23).

RESULTS

MV adoption, farmers' perceptions, and yields

Acceptance and adoption variable (AAV) codes and methods of determination are summarized in Table 4. Degree of adoption (DA) was a measure of MV adoption over a given time and area. Two measurement aspects were considered: adoption rate and measurement precision. For the 1983-84 season, measurement precision was achieved by direct observation. However, data for this single season did not reflect adoption rate. Therefore, farmer recall was used to determine adoption rate. Using the concept of an equally appealing interval scale as described by Kidder (17), the following scale was used:

1 MVs were not used in the last 5 growing seasons
2 1-25% use in time × area
3 26-50% use in time × area
4 51-75% use in time × area
5 76-100% use in time × area

Time × area, where time is five growing seasons and area is in hectares, is the total hectarage that could have been planted during the five growing seasons.

A Mann-Whitney U test showed that adoption patterns differed among the five landforms (Table 5). Trends are presented by landform in Figure 1. Farmers with adoption on 76% or more of their riceland in 1983 ranged from 3% on the alluvial terrace (AT) to 60% on the alluvial fan (AF).

Acceptance variables compare attributes a farmer might consider when choosing a variety for a field (in this case an IDP). Four of these were:

- perceived extra yield (PEY) = perceived yield from MVs – perceived yield from TVs;
- perceived extra return (PER) = perceived return from MVs – perceived return from TRVs;
- expected extra yield (EEY) = experimental MV yield – experimental TV yield; and
- expected extra return (EER) = experimental return from MV – experimental TV return.

PER and PEY were solicited from farmers. EEY and EER were computed from IDP crop cut data and from estimated prices and costs of production.

Adoption intention, ADPINT, is also listed in Table 4. It was measured on a five-point scale with a provision that favorable weather will prevail:

1 Only TVs planted
2 TV area > MV area
3 TV area = MV area
4 MV area > TV area
5 Only MVs planted

ADPINT reflects a farmer's assessment of the suitability of an IDP when the risk of bad weather is removed. It can be regarded as the first step in the decision-making process. The next step requires estimates of probabilities that water will be insufficient or in excess at one or more

Table 3. Predominant characteristics of the 5 landforms, Cagayan Province, Philippines (5).[a]

Characteristic	AT	RT	IF	IP	AF
Topography	Old floodplains formed by Cagayan River and other major rivers, flat, generally constant slope	Close to Cagayan River; valley floor abandoned as river cut down to a lower base level; relatively narrow strips	Relatively level area between two valleys, of varying width and area, relatively level to slightly undulating along the river	Narrow valley floors between hills, emerges to alluvial terraces and between hills fringing alluvial terraces, sloping head downward	Convex deposits where rapid streams emerge from hills
Drainage	Somewhat poorly drained to moderately well drained	Moderately well drained	Moderately well drained	Somewhat poorly drained	Moderately well drained
Flooding	Common seasonal floods, extent depending on location with respect to local topography	Seasonally flooded, extent depending on elevation with respect to major rivers	None	None	None except at margins, where water may accumulate briefly

[a]AT = alluvial terrace, RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan.

Table 4. Codes for acceptance and adoption variables and determination method.

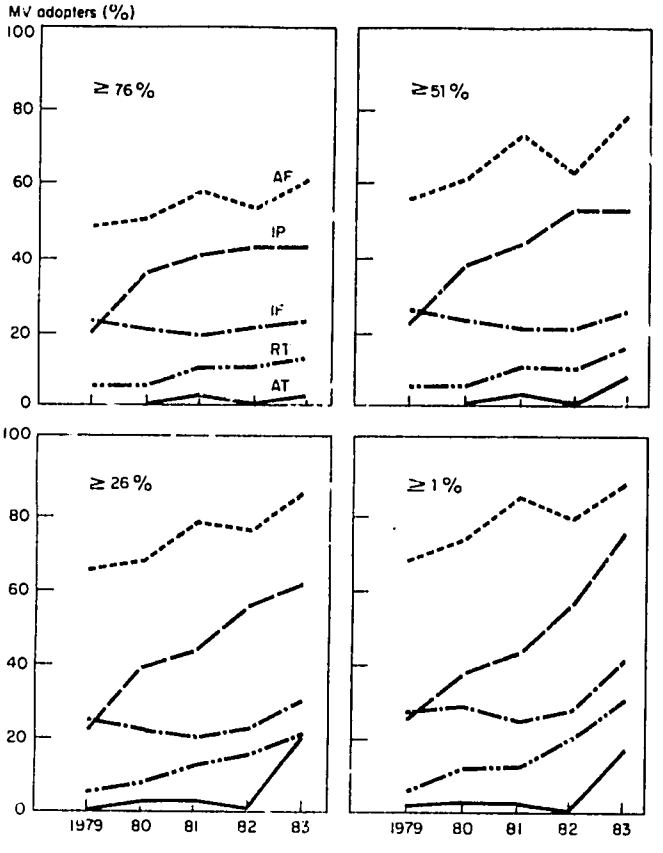
Code[a]	Variable	Determination method
PEY	Perceived extra yield	Farmer's ordering under alternative weather conditions
PER	Perceived extra return	Farmer's ranking of likelihood of greater returns from MVs
MLD, TLD	Modern, traditional variety yield	Field trials and crop-cut data[b]
EEY	Expected extra yield	Field trials and crop-cut data
EER	Expected extra return	Field trials and crop-cut data
DA	Adoption	1 = not adopted, 2 to 5 = in quartiles of time × area
ADPINT	Adoption intention	Adoption intention assuming favorable weather

[a]Some variables were transformed to log scales for analysis. [b]Enough MV seed was supplied to the farmer operating each IDP at the beginning of 1983 to plant 300 m². Farmers were asked to plant these seeds in the IDP, with a similar area for the TV of their choice if they planned to grow only MVs.

Table 5. Years from 1979 to 1983 in which MV adoption was significant in 5 landforms.[a]

RT	IF	IP	AF	
	1979, 1980, 1981, 1982, 1983, ADP	1979, 1980, 1981, 1982, 1983, ADP	1979, 1980, 1981, 1982, 1983, ADP	AT
	1979, 1980, ADP	1979, 1980, 1981, 1982, 1983, ADP	1979, 1980, 1981, 1982, 1983, ADP	RT
		1981, 1982, 1983, ADP	1979, 1980, 1981, 1982, 1983, ADP	IF
			1979, 1980, 1981, 1982, 1983, ADP	IP

[a]ADP = mean MV adoption in the last 5 yr. AT = alluvial terrace, RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan.



1. Patterns of MV adoption by farmers who averaged at least 76, 51, 26, and 1% MVs on their fields in 1979-83.

stages of crop development. Distributions of PEY, PER, and ADPINT are summarized by landform in Table 6.

A Mann-Whitney U test was applied to PEY, PER, ADPINT, and six additional indicators of farmers' perceptions hypothesized to be important in deciding to adopt MVs. ADPINT and PEY differed in all comparisons among landforms (Table 7). PER and another variable, farmer's perception of MV productivity relative

to TV but without restriction to IDP (PRDT), also differed in a majority of comparisons.

Mean yields from the 1983 tests, and extra yields and returns from MVs computed from yield data are summarized in Table 8. A Mann-Whitney U test was applied to these objective measures of variety performance. Of the 40 differences, 25 were statistically significant (Table 9).

Personal, economic, and land characteristics

Personal characteristic (PC) variable codes and methods of determination are summarized in Table 10. Table 11 gives mean personal characteristics of farmers cultivating IDPs on each landform. Of the 80 differences possible, 19 (24%) were statistically significant (Table 12). EXTN alone accounted for almost one-third of these differences.

Table 6. Perceived extra yields (PEY) and returns (PER) from MVs, and MV adoption intention (ADPINT) by farmers operating IDP on the 5 landforms.

Characteristic	AT	RT	IF	IP	AF
PEY					
Higher than TVs[a]	25	55	72	85	92
Equal to TVs	20	42	28	10	8
Lower than TVs	55	3	0	5	0
PER					
Higher than TVs[a]	25	55	58	75	55
Equal to TVs	13	37	32	10	38
Lower than TVs	62	8	10	15	8
ADPINT					
All MVs	28	42	32	68	52
Mostly MVs	0	0	8	5	5
Equal MVs and TVs	5	15	18	15	32
Mostly TVs	3	0	12	5	5
All TVs	65	42	30	8	5

[a]The PEY and PER scales have 5 values. In this table, values 1 and 2 are consolidated into "higher than TVs," and 4 and 5 into "lower than TVs" for brevity.

Table 7. Adoption intention, and acceptance and other adoption decision-influencing variables that were significantly different among the 5 landforms.[a]

RT	IF	IP	AF	
PEY, PER, FTOL,[b] ADPINT	PEY, PER, FTOL, ADPINT, PRDT	PEY, PER, PROFIT,[b] ADPINT, PRDT	PEY, PER, PRDT,[b] PRICE,[b] PROFIT, ADPINT	AT
		PEY, DTOL,[b] ADPINT	PEY, PRDT, PRICE, ADPINT	RT
		PEY, ADPINT	PEY, MARKET,[b] ADPINT	IF
				IP

[a]RT = recent river terrain, IF = interfluve, IP = interhill miniplain, AF = alluvial fan, AT = alluvial terrace. [b]In addition to farmers' perceptions of differences in yields and returns from MVs relative to TVs, perceptions of six other variables were solicited for general production environments, not for a farmer's specific IDP. The variables were FTOL (flood tolerance), PROFIT (profitability), PRDT (productivity), PRICE, DTOL (drought tolerance), and MARKET (marketability). Responses were solicited for MVs relative to TVs.

Economic characteristic (EC) variable codes and methods of determination are summarized in Table 13. Table 14 gives mean economic characteristics of farms. Of the 110 differences, 50 (45%) were statistically significant (Table 15). The variables most frequently differing among landforms were ELEC and TRNDST. Because of their physiographic positioning, AF landforms were most remote from major commercial centers. They are also the most difficult to supply with electricity. MV adoption, however, was highest on AF.

Table 8. Experimental yields in 1983 and computed extra yields and returns for IDPs on the 5 landforms.[a]

Characteristic	AT	RT	IF	IP	AF
MV (% failed)	45	8	18	0	18
Mean yield of nonfailed (t/ha)	0.6	0.9	0.9	1.8	1.3
TV (% failed)	25	8	18	0	18
Mean yield of nonfailed (t/ha)	0.7	0.8	0.9	1.4	1.0
EEY (t/ha)	−0.3	0.1	0.0	0.3	0.2
EER ($/ha)	−55	6	−9	37	14

[a]AT = alluvial terrace, RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan.

Table 9. Experimental yields from MVs and TVs, and extra yield and extra returns from MVs that were significantly different in experiments in the 1983 tests on the 5 landforms.[a]

RT	IF	IP	AF	
MLD, EEY, EER	MLD, EEY	MLD, TLD, EEY, EER	MLD, TLD, EEY, EER	AT
		MLD, TLD, EEY, EER		RT
		MLD, TLD, EEY, EER	EEY, EER	IF
			MLD, TLD	IP

[a]RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan, MLD = yield (t/ha) of MVs, TLD = yield (t/ha) of TVs, including 0 t/ha for the yield of failed crops.

Table 10. Codes for personal characteristics of farmers and determination method.

Code	Variable	Determination method
AGE	Operator's age	Interview
EDUC	No. of years of formal education	Interview
EXPR	No. of years in rice farming	Interview
SOPATN	Social participation	Interview
FAM	Family size	No. of family members in household at time of survey
EXTN	Frequency of extension contact in 1982-83	Interview
KNG	Knowledge of farming	Rated by a senior village official
ATD	Attitude toward MVs	Derived from a battery of questionnaire items

Table 11. Mean personal characteristics of farmers operating IDPs on the 5 landforms.[a]

Characteristic[b]	AT	RT	IF	IP	AF
AGE (yr)	49	50	44	43	48
EDUC (yr)	5	5	4	4	5
EXPR (yr)	29	25	23	24	28
FAM (no.)	7	6	6	6	6
SOPATN (frequency/yr)	6	5	10	8	4
EXTN (frequency/yr)	30	35	45	52	51
KNG (mean score)	6.6	5.9	5.4	6.2	6.3
ATD (mean score)	5.9	6.9	8.4	8.6	8.6

[a]AT = alluvial terrace, RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan. [b]See Table 10 for explanation of codes.

Table 12. Personal characteristics[a] of farmers that were significantly different on the 5 landforms.[b]

RT	IF	IP	AF	
SOPATN	EXPR EXTN KNG ATD	EXTN ATD	EXTN ATD	AT
	AGE SOPATN EXTN	AGE EXTN	EXPR SOPATN	RT
		KNG	EXTN KNG	IF
				IP

[a]See Table 10 for explanation of codes. [b]RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan, AT = alluvial terrace.

Table 13. Codes for economic characteristics of the farms, type of variable, and determination method.

Code	Variable	Determination method
FARMZ	Area of farm	Interview
MKTZ	Quantity of rice sold over past 5 yr	Interview
WELX1	Present value of capital items and land	Interview
WELX2	Present value of durable and nondurable goods in the household	Interview
TENURE	Tenure status	1 if farmer is owner-cultivator, 0 otherwise
TRNDST	Distance from farmhouse to nearest national road	From 1:50,000 scale map
CREDIT	Credit availability	1 if credit is easily available when needed, 0 otherwise
SEED	MV seed availability	1 if MV seed is easily available when needed, 0 otherwise
CAPITAL	Capital availability	1 if capital is easily available when needed, 0 otherwise
FERT	Average N fertilizer use in past 5 yr	Interview
FERPAT	Frequency of N fertilizer use in past 5 yr	Interview
ELEC	House electrification	Observation

Table 14. Mean economic characteristics of farms on the 5 landforms.[a]

Characteristic[b]	AT	RT	IF	IP	AF
FARMZ (ha)	2.5	2.6	3.3	2.7	2.2
MKTZ (100 kg)	9.5	10.5	35.0	40.5	26.0
TENURE (%)	78	70	100	75	83
SEED (% availability)	78	68	90	80	100
CREDIT (% availability)	42	45	40	47	20
CAPITAL (% availability)	65	60	42	60	78
ELEC (% serviced)	100	68	40	35	7
FERT (kg N/ha)	2.7	2.5	4.0	4.6	10.4
FERPAT					
% never	55	67	65	55	17
% always	0	3	5	5	32
TRNDST (km)	0.8	0.9	0.9	1.5	2.8
House size (m^2)	35	29	24	26	353
House value ($)	1272	715	374	659	353
Equipment value ($)	2083	1257	645	1114	830

[a]AT = alluvial terrace, RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan. [b]See Table 13 for explanation of codes.

Table 15. Economic characteristics[a] that were significantly different on the 5 landforms.[b]

RT	IF	IP	AF	
FARMZ, ELEC, WELX2	FARMZ, TENURE, WELX2 ELEC	MKTZ, WELX2, ELEC, TRNDST	MKTZ, WELX2, ELEC, SEED, TRNDST, FERTAV, FERPAT	AT
	MKTZ, TENURE, SEED, WELX2	MKTZ, SEED, ELEC, FARMZ, TRNDST	MKTZ, CREDIT, SEED, WELX2, ELEC, FARMZ, FERT, FERPAT, TRNDST	RT
		MKTZ, TENURE, TRNDST	TENURE, CAPITAL, ELEC, FERT, FERPAT, TRNDST	IF
			CREDIT, ELEC, FERT, FERPAT, TRNDST	IP

[a]See Table 13 for explanation of codes. [b]RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan, AT = alluvial terrace.

Land characteristic (LC) variable codes and methods of determination are summarized in Table 16. Table 17 gives mean land characteristics of IDP. Of the 110 differences,67 (61%) were statistically significant (Table 18). SEDAGE, an indirect indication of seasonal field hydrology, was different in all comparisons. WRI, PDR, PFL, and PDN, which are also indicators of field hydrology, differed frequently.

Percentage-wise, fewer differences were observed among the personal and economic variables used to characterize farmers operating the IDP than among the variables used to characterize the land attributes of the IDP. We did not expect to encounter major differences in

Table 16. Codes for land characteristics of IDPs and determination method.

Code	Variable	Determination method
LAND	Suitability class	From a Bureau of Soils report (22)
PDR	Perceived drought hazard	Farmer ranking
PFL	Perceived flood hazard	Farmer ranking
PDN	Perceived natural field drainage	Farmer ranking
PST	Perceived soil texture	Farmer ranking
WTSRCE	Water source	Direct observation: 0 if purely rainfed, 1 for peripheral water source
ST1, ST2	Surface and subsurface soil texture	Increasing value as clay content increases
WRI	Water reliability index	Scalogram analysis applied to periodic observations of water depth
DST	Distance from house to farm parcel	Odometer of motorcycle
SEDAGE	Seedling age in 1983	Difference between date of seeding and date of transplanting
CII	Cropping intensity index	Calculated from cultivation history

Table 17. Mean land characteristics of the IDPs of the 5 landforms.[a]

Characteristic[b]	AT	RT	IF	IP	AF
PDR	5.2	5.4	4.5	6.6	6
PFL	7.4	6.8	9.5	7.0	9.8
PDN	7.4	7.2	9.0	7.1	9.6
WTSRCE (% with peripheral source)	0	0	5	7	12
WRI (%)					
Very low	30	22	5	5	2
Low	60	42	52	20	12
Medium	10	35	35	48	55
High	0	0	8	28	30
SEDAGE (d)	80	93	62	48	40
CII	100	100	102	125	110
ST1 (%)					
Coarse	8	35	12	0	0
Medium	38	38	60	45	32
Fine	55	28	28	55	68
ST2 (%)					
Coarse	18	32	20	5	10
Medium	50	48	50	48	48
Fine	32	20	30	48	42
PST (%)					
Coarse	0	12	45	5	2
Medium	62	60	42	70	90
Fine	38	28	12	25	8
DST (km)	1.0	0.5	1.2	1.3	0.6

[a]AT = alluvial terrace, RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan. [b]See Table 16 for explanation of codes.

personal and economic characteristics of farmers with landforms because the 14 tracts were distributed over a relatively confined area in which farmers do not differ greatly in ethnic, cultural, and educational backgrounds. They also face similar economic environments (e.g., product and factor prices, input availability, and alternate employment opportunities).

Associations between sets of variables

Associations within the PC, EC, LC, and AAV sets of variables were examined by computing zero order correlations within the sets (Appendix Tables 1, 2, 3, and 4). Zero order correlations were also computed between AAV and each of the three other sets (Appendix Tables 5, 6, and 7).

Many correlations were significant. Canonical correlation procedures were used to establish the patterns of association within the AAV set and between variables in the AAV set and those in the PC, EC, and LC sets.

Associations between acceptance variables and adoption variables. The first canonical correlation coefficient between the 6 acceptance variables and the 2 adoption variables (DA and ADPINT) was 0.74 ($P<0.01$). Among the acceptance variables, loadings were highest on PEY and PER (Table 19). A heavier loading was found on ADPINT than on DA, indicating that the canonical variable was composed primarily of adoption intention. The higher loading also suggested that perception of extra yield or extra return contributed strongly to adoption intention, even though acceptance variables had moderate predictive power for both DA and ADPINT. The simple correlation between DA and ADPINT was moderate ($R = 0.46$, $P<0.01$).

Associations between personal, economic, and land characteristics and acceptance and adoption variables. The R, standard error, and F-ratio for significant canonical correlations between AAV and PC, EC, and LC are given in Table 20. Coefficients in Table 21 reveal that EXTN and KNG were the primary PC variables in the association, and the association was strongest with DA, LOGMLD, and LOGTLD. This correlation suggests that those farmers with more exposure to or better knowledge of improved rice cultivation practices produced above average yields of both MVs and TVs. The first correlation in Table 22 draws attention to an association between fertilizer use (LOGFERT and FERPAT) and MV adoption (DA) and perceived extra yield from MVs (PEY). A causal relationship cannot be argued for this association, because a farmer would typically exploit the yield potential of MVs by adopting MVs and fertilizer simultaneously. The second correlation suggests that farmers near markets produced higher-than-average yields of both MVs and TVs, and marketed a larger-than-average quantity of rice.

The first correlation in Table 23 shows that adoption and perceived extra yield were positively associated with five variables in the LC set (WRI, LAND, WTSRCE, PDR, SEDAGE) that reflect favorable field hydrology. The second correlation suggests that perceived extra returns from MVs were greater where fields were suitable for sequential cropping (double rice or mungbean followed by rice) and where drainage was favorable. MVs

Table 18. Land characteristics that were significantly different on the 5 landforms.[a]

RT	IF	IP	AF	
PFL, PST, WRI, DST, SEDAGE, CII	PDR, PFL, PDN, PST, WRI, SEDAGE	PDR, ST2, WRI, SEDAGE	WTSRCE, PRDR, PFL, PDN, PST, WRI, DST, SEDAGE	AT
	PDR, PFL, PDN, PST, DST, SEDAGE, CII	PDR, ST1, ST2, WRI, DST, SEDAGE	WTSRCE, PDR, PFL, PDN, PST, ST1 WRI, ST2, SEDAGE, CII	RT
		PDR, PFL, PDN, PST, ST1, ST2, WRI, SEDAGE, CII	PDR, ST1, WRI, DST, SEDAGE	IF
			PDR, PFL, PDN, DST, SEDAGE, CII	IP

[a]RT = recent river terrace, IF = interfluve, IP = interhill miniplain, AF = alluvial fan, AT = alluvial terrace.

Table 19. Loadings of the first vector from the canonical correlation between acceptance variables, and adoption intention and adoption.

Acceptance variable		Adoption intention and adoption	
PEY	0.95	ADPINT	0.70
PER	0.79	DA	0.58
LOGMLD	0.63		
LOGEEY	0.51		
LOGTLD	0.32		
LOGEER	0.17		

Table 20. Canonical R, standard error, and F-ratio for significant correlations[a] between personal, economic, and land sets of variables and acceptance and adoption variables.

Set of variables	No.	Canonical R	SE	F-ratio
Personal	1	0.69	0.04	2.71**
Economic	1	0.78	0.03	3.12***
	2	0.54	0.06	1.73***
Land	1	0.89	0.02	4.40***
	2	0.49	0.06	1.52**

[a]** = significant at the 1% level, *** = significant at the 0.1% level.

should be well adapted to such conditions and, in fact, double rice cropping would be virtually impossible under rainfed conditions if at least the first rice crop were not a photoperiod-insensitive, early maturing MV. The second canonical variable was poorly associated with actual adoption (DA), even though it was significantly associated with perceived extra returns.

Even though PC, EC, and LC canonical variables were significantly associated with MV acceptance and adoption, the first canonical PC and EC variables separately explained only 14% each and the LC variables only 24% of the variation in the set of MV acceptance and adoption

Table 21. Loadings of the first vector from the canonical correlation between personal variables and acceptance and adoption variables.

Personal variable		Acceptance and adoption variable	
EXTN	0.93	DA	0.77
KNG	0.90	LOGMLD	0.73
ATD	0.24	LOGTLD	0.64
EDUC	0.15	LOGEEY	0.49
LOGSOPATN	0.11	PEY	0.48
AGE	-0.03	ADPINT	0.38
EXPR	-0.05	LOGEER	0.32
FAM	-0.13	PER	0.30

variables. The second canonical PC variable was not retained, and the corresponding EC and LC variables accounted for only 6 and 4%, respectively. Nevertheless, these canonical correlations demonstrate that there exist significant associations between selected personal, economic, and land attributes on one hand and MV acceptance and adoption on the other. In the correlations of AAV with the PC, EC, and LC sets, DA consistently had the highest loading on each of the first canonical vectors of each of attributes. In the association between AAV and PC, extension (EXTN) and technical knowledge (KNG) were the dominant personal variables. In the PC association, fertilizer use (LOGFERT and FERPAT) was dominant in the first canonical correlation, although causality can be questioned. In the LC association, those variables that reflected field hydrology (WRI, LAND, WTSRCE, PDR, and SEDAGE) were dominant.

Adoption probabilities of MVs

Seven logit models in which MV adoption[5] was regressed on independent variables were developed by systematic-

[5]For binary logit analysis, farmers must be classified as adopters or nonadopters. A binary version of DA was used for the logit model. Adopters were farmers who averaged MV cultivation on more than half their IDPs in the last 5 yr. An adopter in this study was, therefore, a farmer who exhibited a high degree of sustained MV use. In terms of impact on production, sustained users are more important than trial adopters (9).

Table 22. Loadings of first and second vectors from the canonical correlation between economic variables and acceptance and adoption variables.

First				Second			
Economic variable		Acceptance and adoption variable		Economic variable		Acceptance and adoption variable	
LOGFERT	0.92	DA	0.96	LOGMKT	0.56	LOGMLD	0.69
FERPAT	0.89	PEY	0.58	SEED	0.17	LOGTLD	0.68
TRNDST	0.63	ADPINT	0.46	TENURE	0.10	PER	0.55
LOGMKTZ	0.42	LOGMLD	0.34	ELEC	0.01	ADPINT	0.43
SEED	0.39	PER	0.29	FARMZ	0.07	LOGEER	0.30
CAPITAL	0.35	LOGEEY	0.28	CAPITAL	0.06	PEY	0.27
CREDIT	0.22	LOGTLD	0.17	LOGFERT	-0.01	LOGEEY	0.25
FARMZ	0.06	LOGEER	-0.03	LOGWELZ1	-0.06	DA	0.19
TENURE	0.00			FERPAT	-0.09		
LOGDWELX1	-0.01			LOGWELX2	-0.14		
LOGDWELX2	-0.05			CREDIT	-0.39		
ELEC	-0.38			TRNDST	-0.52		

Table 23. Loadings of first and second vectors from the canonical correlation between land variables and acceptance and adoption variables.

First				Second			
Land variable		Acceptance and adoption variable		Land variable		Acceptance and adoption variable	
WRI	0.96	DA	0.97	CH	0.70	PER	0.71
LAND	0.68	PEY	0.64	DST	0.28	LOGEEY	0.45
WTSRCE	0.43	ADPINT	0.59	PFL	0.25	LOGEER	0.36
ST1	0.30	LOGMLD	0.50	SEDAGE	0.03	[illegible]INT	0.36
ST2	0.24	PER	0.47	WTSRCE	0.03		0.32
CH	0.22	LOGEEY	0.40	WRI	-0.01	LOGMLD	0.29
PDN	-0.07	LOGTLD	0.32	PDR	-0.02	LOGTLD	0.10
PFL	-0.15	LOGEER	0.09	LAND	-0.13	DA	-0.11
DST	-0.24			ST2	-0.13		
PDR	-0.50			ST1	-0.15		
SEDAGE	-0.62			PDN	-0.51		

Table 24. Logit models for MV adoption (DDA) regressed on sets of personal, economic, and land variables.

Model	Functional relationship[a]	χ^2	df	Correct prediction (%)
1	DDA = f (PC)	64**	4	78
2	DDA = f (EC)	104**	4	86
3	DDA = f (LC)	156**	3	90
4	DDA = f (PC+EC)	150**	5	89
5	DDA = f (PC+LC)	161**	3	93
6	DDA = f (EC+LC)	178**	3	95
7	DDA = f (PC+EC+LC)	181**	4	95

[a]DDA = binary variable for adoption of MVs, PC = personal variable set, EC = economic variable set, LC = land variable set.

Table 25. Partial regression coefficients, standard errors, and partial probabilities of Model 7 in Table 24.

Variable	Partial regression coefficient[a]	SE	Partial probability
INTERCEPT	-16.19**	3.01	–
LOGFERT	1.57**	0.39	0.117[b]
WRI	1.36**	0.34	0.274
LAND	0.67*	0.33	0.135
EXTN	0.04+	0.02	0.008

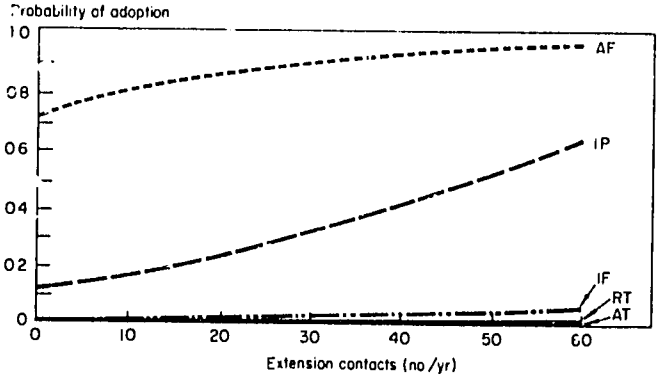
[a]+ = significant at the 10% level, * = 5%, ** = 1%. [b]Transformed from the log form ($0.317 \times e^{-1} = 0.117$).

ally combining the PC, EC, and LC sets of variables and selecting from combined sets by a backward elimination procedure. Table 24 summarizes results from this procedure. The last model was the most parsimonious and accurate. The model explained 73% of total variation and accurately predicted 95% of the MV adopters and non-adopters.

Table 25 shows the estimated partial regression coefficients, standard errors, and partial probabilities of the independent variables. Water reliability (WRI) contributed strongly to adoption probability. The partial probability for WRI was 0.274, with the following interpretation: a unit increase in WRI increased the probability of MV adoption 27%. However, WRI did not account for all the variability associated with the physical characteristics of the IDP. LAND, a suitability class variable, also accounted for a significant portion of the variability in adoption. (Suitability class refers to suitability for rice cultivation using criteria established by soils specialists [22]).

Using the final model in Table 24, the probabilities of MV adoption on the 5 landform units were estimated as a function of extension contact frequency. Mean values for WRI, LAND, and LOGFERT corresponding to each landform were substituted into Model 7. Values for EXTN were incremented from 0 to 60 contacts/yr.[6] The effects of extension contact frequency on adoption probabilities were not the same among the landforms (Fig. 2). The curve was steepest for the interhill miniplain (IP), implying that the impact of increased extension contact is greatest on that landform unit. Slopes of the RT and AT curves were close to zero, indicating that, regardless of contact frequency, extension activities in these landforms would bring about almost no increase in MV adoption. The greatest payoff for intensive extension activities appears to be not on landforms where modern varieties are well adapted (e.g., alluvial fans) or poorly adapted (e.g., alluvial terraces), but on landforms where adaptation is intermediate (e.g., interhill miniplains).

A second model selection series was run to select a model with LOGFERT and FERPAT deleted from the set of potential explanatory variables. Because fertilizer adoption was closely associated with MV adoption, these variables cannot realistically be used to identify *a priori* farmers who would most likely adopt MVs, although they may control for differences among farmers with respect to access to fertilizer and cash or credit to buy it. The final model in the second run was identical to Model 5 in Table 24. No economic variable entered the model. The independent variables were WRI ($b = 1.58$, $P<0.01$, partial probability = 0.332), LAND ($b = 0.84$, $P<0.01$, partial probability = 0.170), and KNG ($b = 0.95$, $P<0.05$, partial probability = 0.138). This model suggests that the probability of adoption was greatest among farmers possessing above average rice farming knowledge and operating land that is favored with respect to hydrology.



2. Predicted effects of extension contact on adoption probabilities of modern rice varieties, Cagayan, Philippines.

DISCUSSION

The canonical correlation analyses showed that MV adoption was more strongly associated with the physical characteristics of land than with the farmer's personal characteristics or economic characteristics of farms. Logit analysis demonstrated that, by incorporating land variables into an adoption model that is initially selected from only personal and economic variables, MV adoption can be predicted with an increased level of accuracy. Although patterns of social and economic characteristics were comparatively uniform among villages within the study area, personal and economic differences among farmers and farms within villages were large. Some PC and EC variables were associated with AAV and, independent of LC variables, explained a significant amount of the variability observed in MV adoption. Had we chosen to limit sampling to only the IP we may have found stronger associations between adoption and the personal attributes of farmers and economic attributes of farms. At the adoption extremes (i.e., within the AT where adoption was low or within the AF where adoption was high), the evidence would probably not be stronger for variables from either set of characteristics.

It is possible that personal and economic variables other than those examined in this study are more closely associated with MV adoption. However, landform variables alone explained two-thirds of the variability (Model 3), leaving only one-third to partition among personal and economic characteristics. While there may be scope to improve the measurement of personal and economic characteristics, the potential additional explanation from these improvements appears to be small.

The analyses suggest that land characteristics should be considered when an adoption study crosses landform boundaries. Significant landform differences often occur in close proximity and, therefore, land characteristics should probably be recognized in many studies. In the Cagayan Valley, boundaries between adjacent landforms are easy to locate. In other rice growing areas, the boundaries may be more gradual and boundaries between significantly different landforms harder to locate.

Other MV adoption studies

In a discussion of factors associated with MV adoption, Herdt and Capule (15) noted that "the literature on factors associated with new technology adoption has two broad themes: one focuses on the characteristics of individuals or groups making adoption decisions, and the second attempts to quantify the economic forces affecting

[6]A broad definition of extension contact was accepted in this study. A contact could range from an intense one-to-one discussion of modern rice cultivation practices, to an interview by an extension technician to gather data for a report to the provincial office, to a casual meeting of a partly social nature. Furthermore, extension technicians come from many different levels (village, town, provincial, regional, and integrated), commodity foci (e.g., food crops, livestock, cotton, tobacco), and organizations (government and nongovernment). Because of the complexity and uncertainty it would entail, attempts to discriminate contacts for technical content or by commodity were not made.

their production decisions." For the second theme, Herdt and Capule outlined a theory of varietal adoption that can be summarized simply: If MVs are economically advantageous, farmers will adopt them; otherwise they will not. They present evidence from macrolevel and microlevel studies to support this theory.

In pursuit of the first theme, scientists have sought an answer to the question: "What are the characteristics of farmers who find MVs more advantageous than TVs?" Although Herdt and Capule found reports of many significant associations between personal characteristics and MV adoption, no single subset of personal characteristics was consistently associated with MV adoption.

Until recently, the search for the characteristics of farmers who adopt MVs has virtually ignored the physical environment in the sets of variables examined. Farmers per se do not have physical environment variables, but the fields for which farmers make production decisions do. Thus, a second question should be asked about adopters and nonadopters: "What are the characteristics of the fields on which MVs give more advantage than TVs?" Herdt and Capule were aware of this lacuna and stated: "A third theme, seldom explored but perhaps of more importance, is the performance of the technology under local conditions. Unfortunately there is a lack of literature on this theme."

The Cagayan Valley study has demonstrated that farmers are keenly aware of differences in land characteristics and appear to consider these differences when deciding to adopt or reject MVs. Seasonal patterns of too much or too little water are most clearly the land characteristics perceived by farmers as influencing MV adaptation and, therefore, adoption. Similarly, Farmer (8) observed that modern rice adoption in South Asia was related to field hydrology.

Field hydrologies are important in target environment definitions on which rice varietal improvement programs focus. Although hydrologic differences are recognized in rice improvement programs, progress toward crop ideotypes that are superior to TVs for hydrologically disadvantaged environments has been less dramatic than progress toward ideotypes for hydrologically advantaged (i.e., irrigated) environments. A variety that is early maturing, fertilizer responsive, and disease and insect resistant, and has a high grain-to-straw ratio appeals to farmers cultivating land where hydrology is favorable. Such varieties lack traits that make them adaptable to hydrologically disadvantaged environments. It is not surprising that generations of farmers have selected varieties that are adapted to the modal hydrologic states found in disadvantaged environments but that have sufficient adaptability to cope with the adversity encountered in years when hydrologic states deviate in an undesirable direction from the mode. Few MVs have this adaptability.

Technical knowledge

In this study we found that technical knowledge and/or frequency of extension contact were important personal characteristics associated with MV adoption. Herdt and Capule (15) found that in three of the four studies that determined the contribution of either technical knowledge or frequency of extension contact on MV adoption, these variables were associated with adoption. They hypothesized that the greater knowledge needed to grow MVs represents a higher fixed cost for cultivating MVs relative to TVs, and that farmers who have this knowledge or access to it are more likely to find that MVs are economically advantageous. The Cagayan Valley study supports this hypothesis. KNG differed in only 3 of the 10 interlandform comparisons, yet it was a highly significant variable in the presence of land variables (Model 5). EXTN differed in more interlandform comparisons (6 of 10), which may reflect "ease of extension" on the part of extension technicians; however, as a significant independent variable in combination with two land variables in Model 7, it exhibited a reasonable effect on MV adoption differences among landforms.

Recent issues

We are aware of the current debate on the appropriateness of physical variables in studies of the adoption of modern technology (2, 3, 4, 10, 11, 12). The debate has increased awareness among scientists that rural people are aware of the physical domains suitable for modern technology, and that they take these into consideration when production decisions are made. The Cagayan Valley study demonstrates the effect of physical environment variables on modern technology adoption or, conversely, the limited range of modern technology adaptation.

We concur with Dunlap and Martin (7) that scientists should systematically include environmental variables in sociological and economic analyses. At the very least, the variables should help remove background noise. Their inclusion should also help scientists define domains of adaptation for modern technology, an important consideration when scarce managerial capability must guide agricultural development projects. To characterize physical environments effectively at any level (regional or field), however, an interdisciplinary effort may be required.

CONCLUSIONS

Land characteristics influence the adaptation of MVs most significantly by the way terrain features influence water reliability. Farmers are aware of the association between landforms and the hazards of drought and flooding. Land characteristics appear to be considered when a rice variety is chosen for a field. The significant associations between land characteristics and MV adop-

tion, and the improvements produced by the inclusion of land characteristics in a logit model to predict MV adopters and nonadopters, suggest that land attributes should be accorded greater prominence when factors contributing to MV adoption are sought. The analysis also suggests that rice breeders and agronomists should recognize the requirement for an increased level of adaptability or plasticity in rice varieties and cultural practices intended for rainfed terrain in which the hazards of too much or too little water or both are prevalent.

REFERENCES CITED

1. Anderson, T.W. 1966. An introduction to multivariate statistical analysis. John Wiley and Sons, New York.
2. Ashby, J.A. 1982. Technology and ecology: implications for innovation research in peasant agriculture. Rural Sociol. 47:234-250.
3. Ashby, J.A. 1983. "Armchair" agriculture or the sociology of agriculture. A rejoinder to Gartrell. Rural Sociol. 48:667-669.
4. Ashby, J.A., and E.W. Coward, Jr. 1980. Putting agriculture back into the study of farm practice innovation: comment on status, knowledge, and innovation. Rural Sociol. 45:520-523.
5. Bruce, R.C., and R.A. Morris. 1981. Landforms in the rice growing areas of the Cagayan River Basin. IRRI Res. Pap. Ser. 65. 28 p.
6. De Datta, S.K., K.A. Gomez, R.W. Herdt, and R. Barker. 1978. A handbook on the methodology for an integrated experiment-survey of rice yield constraints. International Rice Research Institute, P.O. Box 933, Manila, Philippines.
7. Dunlap, R.E., and K.E. Martin. 1983. Bring environment into the study of agriculture: observations and suggestions regarding the sociology of agriculture. Rural Sociol. 48:201-218.
8. Farmer, B.H. 1979. The green revolution in South Asian ricefields: environment and production. J. Dev. Stud. 15:304-319.
9. Feder, G., R.E. Just, and D. Zilberman. 1982. Adoption of agricultural innovation in developing countries: a survey. World Bank Staff Working Paper No. 542. World Bank, Washington, DC, USA.
10. Gartrell, C.D. 1983. The social ecology of innovation: a comment to Ashby. Rural Sociol. 48:661-666.
11. Gartrell, J.W., and C.D. Gartrell. 1979. Status, knowledge, and innovation. Rural Sociol. 44:73-94.
12. Gartrell, J.W., and C.D. Gartrell. 1980. Beyond earth, water, weather, and wind. Rural Sociol. 45:524-530.
13. Gines, H.C., R.G. Pernito, and R.A. Morris. 1985. The rationale of photoperiod-sensitive rice cultivars in rainfed rice-based cropping systems. Philipp. J. Crop Sci. 10:77-80.
14. Harrel, F.E. 1982. The logit procedure. *In* SAS user's guide: statistics. SAS Institute Inc., North Carolina, USA.
15. Herdt, R.W., and C. Capule. 1983. Adoption, spread, and production impact of modern rice varieties in Asia. International Rice Research Institute, P.O. Box 933, Manila, Philippines.
16. Kerlinger, F.N. 1973. Foundations of behavioral research. 2nd ed. Holt, Rinehart and Winston, Inc., New York.
17. Kidder, L.H. 1981. Research methods in social relations. 4th ed. Holt-Saunders, Japan, Ltd., Tokyo, Japan. 483 p.
18. Kim, J.H. 1985. Biophysical environments and adoption of modern rice varieties in rainfed lowland of Cagayan Province, Philippines. Unpublished Ph D dissertation, University of the Philippines at Los Baños, College, Laguna, Philippines.
19. Morris, R.A., A. Patanothai, A. Syarifuddin, and V.R. Carangal. 1986. Cropping systems for rainfed lowland rice environments. Pages 59-76 *in* Progress in rainfed lowland rice. The International Rice Research Institute, P.O. Box 933, Manila, Philippines.
20. Parel, C.P., G.C. Caldido, P.L. Ferrer, G.G. de Guzman, C.S. Sinsioco, and R.H. Tan. 1973. Sampling design and procedure. Agriculture Development Council, New York.
21. Pyndyck, R.S., and D.L. Rubinfeld. 1981. Econometric models and economic forecasts. 2nd ed. McGraw-Hill, Inc., New York.
22. Rianzonda, A.B., T.N. Reynaldo, A.O. Romeo, and R.R. Leonides. 1980. Soil and land capability map: Cagayan Province, Bureau of Soils, Ministry of Agriculture and Foods, Manila, Philippines. (unpubl.)
23. SAS Institute, Inc. 1982. SAS user's guide: statistics. North Carolina.
24. Siegel, S. 1956. Nonparametric statistics for the behavioral sciences, McGraw-Hill, New York.

Appendix Table 1. Correlations among personal characteristics.

	EXPR	EDUC	LOGSOPATN	FAM	EXTN	KNG	ATD
AGE	0.80**	-0.25**	-0.08	0.08	-0.08	0.15	-0.14
EXPR		-0.23**	-0.10	0.05	-0.06	0.12	-0.08
EDUC			0.08	0.02	0.19*	0.09	-0.02
LOGSOPATN				0.07	0.33**	0.21	-0.01
FAM					-0.04	0.07	0.02
EXTN						0.09	0.10
KNG							0.04

* = significant at the 5% level, ** = significant at the 1% level.

Appendix Table 2. Correlations among economic characteristics.

	LOGMKTZ	LOGWELX1	LOGWELX2	TRNDST	TENURE	CREDIT	SEED	CAPITAL	LOGFERT	FERPAT	ELEC
FARMZ	0.34**	0.14	0.23*	-0.03	0.08	-0.03	0.12	0.19*	0.06	0.13	-0.16
LOGMKTZ		0.02	0.11	0.20*	0.14	0.05	0.23*	0.29**	0.26**	0.29**	-0.12
LOGWELX1			0.52**	-0.13	0.25**	0.05	-0.07	0.14	0.11	0.07	0.42**
LOGWELX2				-0.04	0.26**	0.06	-0.06	0.12	0.09	0.07	0.42**
TRNDST					0.07	0.21*	0.22*	0.15	0.42**	0.46**	-0.49**
TENURE						-0.08	-0.10	0.12	0.06	0.09	0.24**
CREDIT							0.27**	0.22*	0.26**	0.20*	-0.04
SEED								0.20*	0.26**	0.21*	-0.21*
CAPITAL									0.29**	0.29**	-0.01
LOGFERT										0.90**	-0.10
FERPAT											-0.13

* = significant at the 5% level, ** = significant at the 1% level.

Appendix Table 3. Correlations among land characteristics.

	PDR	PFL	PDN	WTSRCE	ST1	ST2	WRI	DST	SEDAGE	CII
LAND	-0.29**	-0.37**	0.31**	0.22*	0.24**	0.19*	0.53**	-0.01	-0.56**	0.06
PDR		-0.27**	0.30**	-0.44**	-0.32**	-0.28**	-0.50**	0.15	0.34**	0.38**
PFL			-0.74**	-0.10	-0.04	0.04	-0.12	-0.16	0.15	0.25**
PDN				0.03	-0.15	-0.21*	-0.10	0.12	-0.11	-0.21*
WTSRCE					0.08	0.12	0.35**	-0.07	-0.21*	0.32**
ST1						0.70**	0.30**	0.12	-0.20*	-0.03
ST2							0.27**	0.05	-0.24*	-0.04
WRI								-0.14	-0.51**	0.17
DST									-0.02	-0.10
SEDAGE										-0.11

* = significant at the 5% level, ** = significant at the 1% level.

Appendix Table 4. Correlations among acceptance and adoption variables.

	PER	ADPINT	LOGMLD	LOGTLD	LOGEEY	LOGEER	DA
PEY	0.76**	0.68**	0.39**	0.18	0.36**	0.10	0.53**
PER		0.59**	0.35**	0.20*	0.26**	0.05	0.39**
ADPINT			0.43**	0.24*	0.32**	0.10	0.46**
LOGMLD				0.72**	0.54**	0.28*	0.39**
LOGTLD					-0.06	-0.16	0.18
LOGEEY						0.84**	0.37**
LOGEER							0.12

* = significant at the 5% level, ** = significant at the 1% level.

Appendix Table 5. Correlations between personal characteristics, and acceptance and adoption variables.

Personal characteristic	Acceptance and adoption variables							
	PEY	PER	ADPINT	LOGMLD	LOGTLD	LOGEEY	LOGEER	DA
AGE	-0.07	-0.10	-0.09	-0.07	0.05	-0.11	-0.04	-0.10
EXPR	-0.06	-0.13	-0.06	-0.07	0.00	-0.10	-0.07	-0.05
EDUC	0.10	0.06	0.11	0.10	0.10	0.01	-0.01	0.12
LOGSOPATN	0.07	0.04	0.03	-0.03	0.04	-0.03	0.06	0.06
FAM	-0.13	-0.07	0.02	-0.01	0.03	-0.08	-0.12	-0.08
EXTN	0.31**	0.09*	0.20*	0.43**	0.39**	0.32**	0.25**	0.48**
KNG	0.06	0.00	0.18	0.19*	0.27**	-0.07	-0.14	0.16
ATD	0.16	0.13	0.27**	0.16	0.04	0.20*	0.12	0.20*

* = significant at the 5% level, ** = significant at the 1% level.

Appendix Table 6. Correlations between economic characteristics, and acceptance and adoption variables.

Economic characteristic	Acceptance and adoption variables							
	PEY	PER	ADPINT	LOGMLD	LOGTLD	LOGEEY	LOGEER	DA
FARMZ	0.02	-0.03	0.01	0.08	0.07	0.03	0.03	0.04
LOGMKTZ	0.22*	0.17	0.23**	0.38**	0.31**	0.20*	0.12	0.36**
LOGWELX1	-0.11	-0.11	-0.03	-0.04	-0.02	0.02	0.05	-0.01
LOGWELX2	-0.13	-0.14	0.07	-0.11	-0.10	-0.08	-0.04	-0.06
TRNDST	0.19*	-0.08	0.11	0.03	-0.08	0.11	-0.06	0.41**
TENURE	-0.04	-0.01	0.11	0.05	0.02	0.10	0.07	0.02
CREDIT	0.15	0.01	0.05	-0.10	-0.10	-0.02	-0.06	0.11
SEED	0.36**	0.21*	0.40**	0.19*	0.12	0.18	0.05	0.26**
CAPITAL	0.10	0.03	0.14	0.09	0.12	-0.01	-0.06	0.26**
LOGFERT	0.41**	0.23*	0.36**	0.19*	0.09	0.17	-0.04	0.69**
FERPAT	0.37**	0.19*	0.30**	0.20*	0.08	0.18	-0.06	0.67**
ELEC	-0.23*	-0.08	-0.06	-0.14	-0.03	-0.12	-0.01	-0.27**

* = significant at the 5% level, ** = significant at the 1% level.

Appendix Table 7. Correlations between land characteristics, and acceptance and adoption variables.

Land characteristic	Acceptance and adoption variables							
	PEY	PER	ADPINT	LOGMLD	LOGTLD	LOGEEY	LOGEER	DA
LAND	0.50**	0.28**	0.34**	0.34**	0.18	0.26**	0.03	0.57**
PDR	-0.19*	-0.12	-0.30**	-0.31**	-0.26**	-0.22*	-0.11	-0.41**
PFL	-0.07	-0.03	0.08	0.12	0.12	0.04	0.08	-0.08
PDN	-0.05	-0.15	-0.19*	-0.19*	-0.15	-0.15	-0.12	-0.02
WTSRCE	0.16	0.13	0.23**	0.26**	0.18	0.20*	0.10	0.37**
ST1	0.10	0.05	0.16	0.21*	0.19*	0.06	-0.02	0.25**
ST2	0.09	0.04	0.13	0.23*	0.19	0.07	0.02	0.21*
WRI	0.51**	0.39**	0.50**	0.40**	0.25**	0.33**	0.08	0.83**
DST	-0.11	0.01	-0.09	0.02	0.02	-0.01	0.04	-0.22*
SEDAGE	-0.32**	-0.25**	-0.28**	-0.37**	-0.31**	-0.19*	-0.03	-0.53**
CH	0.23*	0.31**	0.27**	0.21*	0.11	0.25**	0.16	0.15

* = significant at the 5% level, ** = significant at the 1% level.

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

Stamp

Other papers in this series

ISSN 0115-3862

TITLES OF NUMBERS 1-45 ARE LISTED ON THE LAST PAGE OF NO. 46. THOSE OF NUMBERS 46-70 ARE ON THE LAST PAGE OF NO. 71-80.

No. 71 The development and diffusion of rice varieties in Indonesia
No. 72 Levels of resistance of rice varieties to biotypes of the brown planthopper, *Nilaparvata lugens*, in South and Southeast Asia
No. 73 Growing season analyses for rainfed wetland fields
No. 74 San Bartolome: beyond the green revolution
No. 75 Pathotypes of *Xanthomonas campestris* pv. *oryzae* in Asia
No. 76 Focusing field research on future constraints to rice production
No. 77 An international survey of methods used for evaluation of the cooking and eating qualities of milled rice
No. 78 Research on algae, blue-green algae, and phototrophic nitrogen fixation at the International Rice Research Institute (1963-81), summarization, problems, and prospects
No. 79 Seed-derived callus culture for selecting salt-tolerant rices
No. 80 Economic limitations to increasing shallow rainfed rice productivity in Bicol, Philippines
No. 81 Irrigation system management research and selected methodological issues
No. 82 Interdisciplinary challenges and opportunities in international agricultural research
No. 83 Comparative analysis of cropping systems: an exploratory study of 14 rainfed sites in the Philippines
No. 84 Rapid generation advance of rice at the International Rice Research Institute
No. 85 Physicochemical characterization of iron-toxic soils in some Asian countries
No. 86 New rice technology, intrarural migration, and institutional innovation in the Philippines
No. 87 RICEMOD: a physiologically based rice growth and yield model
No. 88 Sensitivity tests of the environmental variables in RICEMOD
No. 89 Sensitivity tests of the crop variables in RICEMOD
No. 90 New rice technology and labor absorption: comparative histories of two Philippine rice villages
No. 91 Calculating the private benefits of farm machinery: a microcomputer application
No. 92 Cropping systems research in the Pangasinan Project
No. 93 Estimating risk of fertilizer use in rainfed rice production
No. 94 Sensitivity tests of the enviromental variables in IRRIMOD
No. 95 Sensitivity tests of the crop and management variable in RICEMOD
No. 96 Fertilizer transfer to floodwater during deep placement
No. 97 Interaction between fertilizer and weed control methods in Philippine upland rice: estimates from farmers' fields
No. 98 Training needs of information services in agricultural research and educational organizations in Asia: a 9-country survey
No. 99 Soil sickness caused by continuous cropping of upland rice, mungbean, and other crops
No. 100 Changes in input use and grain yields in lowland rice farms in three Philippine provinces
No. 101 The economics of hybrid rice production in China
No. 102 Rice ratooning
No. 103 Growth and development of the deep water rice plant
No. 104 Faridpur: a computer-assisted instruction model for rainfed lowland rice
No. 105 A reading and listening comprehension test in English for nonnative speakers applying for training at IRRI
No. 106 Rice grassy stunt virus 2: a new strain of rice grassy stunt in the Philippines
No. 107 Physical losses and quality deterioration in rice postproduction systems
No. 108 Copublication of IRRI materials: a survey of translators and publishers
No. 109 Classification of Philippine rainfall patterns
No. 110 Contributions of modern rice varieties to nutrition in Asia
No. 111 Changes in rice breeding in 10 Asian countries: 1965-84
No. 112 Design parameters affecting the performance of the IRRI-designed axial-flow pump
No. 113 Boron toxicity in rice
No. 114 Energy analysis, rice production systems, and rice research
No. 115 Production risk and optimal fertilizer rates: an application of the random coefficient model
No. 116 Consumer demand for rice grain quality in Thailand, Indonesia, and the Philippines
No. 117 Morphological changes in rice panicle development: a review of literature
No. 118 IRRI-Korea collaborative project for the development of cold-tolerant lines through anther culture
No. 119 Problem soils as potential areas for adverse soils-tolerant rice varieties in South and Southeast Asia
No. 120 Changes in small-farm rice threshing technology in Thailand and the Philippines