PN-AAQ-949
ISN 36468

THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

Working Paper No. 94

AN00
6732

EFFECTS OF AGRICULTURAL MECHANIZATION ON RICE FARM INCOME PATTERNS IN THE PHILIPPINES

by

Pilar C. Lim
The International Rice Research Institute
Los Baños, Laguna

December 1983

The Consequences of Small Rice Farm Mechanization Project is supported by the United States Agency for International Development under Contract tac-1466 and Grant No. 931-1026.01 and is being implemented by the International Rice Research Institute and the Agricultural Development Council, Inc.

EFFECTS OF AGRICULTURAL MECHANIZATION ON RICE FARM INCOME PATTERNS IN THE PHILIPPINES*

Pilar C. Lim**

ABSTRACT

The paper explores income differences across several dimensions including irrigation and mechanization using cross-section results from the Consequences of Small Rice Farm Mechanization survey. To isolate the mechanization effect on income, an analysis of covariance model was used where the effect of confounding factors such as household size, cropping intensity, farm size, and non-farm earnings are removed. The results show that mechanization has had an effect on income variation. Aside from the observed size effect, cropping intensity, household size, and non-farm earnings significantly contribute to income variability.

---

*Paper presented at a workshop on the Consequences of Small Farm Mechanization in the Philippines held at Development Academy of the Philippines, Tagaytay City, December 1-2, 1983.

**Senior Research Assistant, Economics Section, Agricultural Engineering, The International Rice Research Institute, Los Baños.

EFFECTS OF AGRICULTURAL MECHANIZATION ON FARM INCOME PATTERNS*

Pilar C. Lim**

INTRODUCTION

The introduction of new agricultural strategies has brought changes in the level and composition of resource use. Among these inputs is agricultural machinery. Mechanization of agricultural land has grown rapidly in the Philippines since the 1970s, particularly in the major rice producing areas such as Central Luzon and Laguna. Increased use of mechanical land preparation and threshing attests to the farm-level profitability of such new technology. It is important to determine the impact of mechanization on the overall level of living and welfare in these rural areas.

Some claim that mechanization, along with other new technology, has induced an upward shift in the production function by increasing output and decreasing costs. Furthermore, the cost of producing and using tractors and threshers has been reduced thus encouraging higher adoption rates. The overall effect of increased production and reduced costs is to increase incomes, assuming output prices remain constant on rice.

---

*Paper presented at a workshop on the Consequences of Small Farm Mechanization in the Philippines, December 1 - 2, 1983, held at Development Academy of the Philippines, Tagaytay City.

**Senior Research Assistant, Economics, IRRI Agricultural Engineering Department.

In contrast others allege that mechanization by its capital intensive nature has been divisive in its impact. Although incomes have increased in general, the large farmers and owners of mechanical power have been the prime beneficiaries. This, together with inequality in rates of adoption, has tended to produce greater inequality in the distribution of income.

The present study is an attempt to measure the importance of mechanization as a source of income variation using cross-sectional results from the Consequences of Small Rice Farm Mechanization survey. In particular, it explores income differences across several dimensions including irrigation and mechanization. To permit a systematic analysis of the income impact of mechanization, the effect of confounding factors must be removed.

The group of interest is a stratified sample of 320 rice farm households from 8 villages in Cabanatuan and Guimba. Stratification is by irrigation (rainfed, irrigated one-crop, irrigated two-crop) and mechanization (animal, 2-wheel tractor, and 4-wheel tractor). Irrigation is based on the type of water control. Mechanization is based on the type of power used for plowing.

Owing to gross shifts in type of power used from the wet season 1979 to the dry season 1980, a post-stratification scheme was devised. For analysis by crop year, mechanization classes have been converted to the following: non-mechanized, partially mechanized, and fully mechanized. Rice farm households which used only animal power for the entire crop year were considered non-mechanized while those using only

machines for land preparation during the crop year were defined as fully mechanized. The partially mechanized households included those which shifted from animal to machine or vice-versa during the year. Irrigation levels are rainfed, pump, and gravity-irrigated. Pump irrigation is from deep wells and occurs in an otherwise rainfed area.

Tabular Analysis of Income

The income measure used in this study is total household income which is the sum of on-farm, off-farm and non-farm earnings. On-farm income represents returns to crop and livestock production on the farmer's own farm. Off-farm earnings include income derived from agricultural work on other farms. Non-farm earnings derive from non-agricultural work such as services, commerce and industry or the practice of a profession.

Design-unbiased estimation procedures were used in the calculation of cell means. The method considers the sampling design to correct for the bias that is a result of the shifting across cells and the post-survey stratification used. The procedure essentially involves estimating the total for a variable x in the subpopulation and the total number of units in the subpopulation. From the sample data, a conceptual population is constructed which approximates the original population. (See Lim, 1982.)

In the wet season, other things being equal, gross differentials indicate a 154% income advantage for mechanized over non-mechanized farms, a 2 to 1 ratio between partially mechanized and non-mechanized

farms and a slight advantage of P289 for mechanized over partially mechanized farms (Table 1). Using the irrigation strata, gravity-irrigated farms show an income superiority of P4020 compared with P1502 for rainfed and P2544 for pump-irrigated farms, respectively. Cross-classifying by irrigation, the incomes of mechanized farms are higher than the non-mechanized at any given level of irrigation.

Dry season incomes are generally higher than wet season incomes. Without cross-classifying, income differentials have the same trends as the wet season data, with mechanized farms having a 191% advantage over their non-mechanized counterparts. The incomes of the partially mechanized and mechanized classes are consistently higher than those of non-mechanized farms for the pump and gravity-irrigated farms though not for the rainfed class. This last result appears because only a single household belonged to the rainfed mechanized class after post-stratification. Hence, inferences regarding it are extremely hazardous.

The crop year income differences among the mechanization classes are even more pronounced. The mechanized farms show a 176% differential advantage over the non-mechanized farms. Though not significantly different from the mechanized farms, the partially mechanized farms earn less. At given levels of irrigation, the partially mechanized and fully mechanized households show consistently higher mean incomes than the non-mechanized farms. Comparing irrigation clases, as expected, the gravity-irrigated farms perform better than pump-irrigated and rainfed farms. The benefits of an assured water supply are clearly seen.

DISTRIBUTION OF INCOME

Tables 2 and 3 illustrate the differences in income inequality among the mechanization classes. Both household incomes and per capita incomes are distributed unequally. The modal household income bracket is P2000-3999 for both non-mechanized and partially mechanized households while the modal bracket for mechanized households appears to be P10000-11999. The bulk of the non-mechanized farm households are clustered in the three lowest income groups (Table 2). About 80% of the non-mechanized households have an annual per capita income less than 900 pesos while more than 60% of the mechanized households are characterized by an annual per capita income of over 1300 pesos (Table 3). Figure 1 shows the cumulative income distribution for each mechanization class. The vertical axis is the cumulative probability that household income is less than or equal to an amount indicated on the horizontal axis. The cumulative income distribution of the sampled population of non-mechanized households rises steeply, which is strongly indicative of income inequality. The flat portion of the non-mechanized curve implies that a small percentage of households receive the highest incomes. In comparison, the cumulative distributions of the partially mechanized and mechanized classes rise relatively uniformly denoting less income inequality.

The differences in income inequality can be explained by the fact that most mechanized farms are situated in Cabanatuan. Cabanatuan is predominantly irrigated and mostly mechanized. It has a wider resource

base and a host of suitable technologies that facilitate income generation. In contrast, non-mechanized households are located in Guimba which is predominantly rainfed and less well-endowed than Cabanatuan.

INCOME AND FARM SIZE

An asessment of the income impact of mechanization is not complete unless we consider the farm size issue. Rice farm households were allocated to farm size categories on the basis of area cultivated per season. The size classes used were: below 1.00 ha, 1.00- 2.49 ha, and 2.50 ha and over. Since there exists a fairly active land rental market, not all farms stay in the same farm-size category each season. Table 4 gives mean incomes by farm size and mechanization class. In both the wet and dry seasons, farms below 1.00 ha showed no significant differences among the mechanization classes. The distinction between '1.00-2.49 ha' farms and '2.50 ha and over' farms is accompanied by a significant difference between non-mechanized and their mechanized counterparts. No difference appears to exist between partially mechanized and fully mechanized households (Table 5). In general, increasing farm-size translates into higher incomes for all mechanization classes.

On a per capita basis (Tables 6, 7), the same mechanism is at work. For farm sizes over one ha, the partially mechanized and fully mechanized households retain a significant per capita income superiority of as much as 171% over the non-mechanized households. This suggests, among other things, that the effect of mechanization on income is

significant for fairly large farm sizes. There seem to exist economies of scale in the use of machines on these farms.

MULTIPLE COVARIANCE MODEL USING LOGARITHMS OF INCOME

Differences between household incomes are confounded by many factors. The analysis can be improved if these confounding factors can be partitioned out in advance. Analysis of covariance is suited for this purpose. It eliminates the effect of the confounding factors by regressing income levels against them and considering the residuals. If these residuals vary significantly from class to class, this is evidence of a mechanization effect distinct from the dependence of income on the confounding factor.

Apart from possible irrigation and mechanization effects, household income is likely to depend on factors such as household size. Ceteris paribus, one would suspect that households with large families would have higher incomes than those with smaller families. Cropping intensity may also explain income variation as it measures the number of times a parcel of land is planted during the year. Differences in area cultivated also must be considered. In general, larger farm size translates into higher income. Finally, non-farm earnings are included to take account of income variation resulting from non-agricultural activities. There is reason to believe non-farm earnings are not influenced by mechanization and may be an important source of inequality in income distribution.

It is also believed that the regression of income against factors within different irrigation and mechanization classes does not produce estimates of a common within-class regression. Hence the model used estimates separate slopes for the covariates within each level of class variables. The class variables for the analysis are irrigation and mechanization and the covariates are the factors cited above. The dependent variable in the study is the natural logarithm of household income expressed in pesos. The necessity for transforming the data arises because the income variable is nonnormal and nonnormality invalidates the standard tests of significance. We considered only farm households with positive incomes for the analysis.

Initially a main-effects model with interaction was used to decompose overall variance in the logarithms of income into irrigation and mechanization effects (Table 8). From this decomposition we can determine whether income inequality exists across irrigation and mechanization groups and whether these effects are independent of one another. The results show that only irrigation appears to be significant in explaining income variation and the overall predictive power of the model is very low at 9%. This supports the use of the multiple covariance model in isolating and evaluating the magnitude of the mechanization effect on income inequality.

Table 9 provides the results of the multiple covariance analysis for all farms. Significant irrigation and mechanization effects are evident after correcting for the effect of the covariates. Cropping intensity appears significant in explaining variation in the logarithms

of income and it interacts with mechanization. This indicates that the effect of cropping intensity on income is different for each mechanization class. The same can be said for irrigation. This is as expected since cropping intensity is closely related with irrigation.

Non-farm earnings also appear significant and the absence of interaction with either irrigation or mechanization suggests a parallel relationship between income and non-farm earnings from class to class. This relation exists because non-farm earnings are not influenced by mechanization.

Area cultivated, which here represents farm size, interacts significantly with irrigation and mechanization. The interaction suggests that the magnitude of the mechanization effect on income is not the same for farms of different sizes. This supports the hypothesis of economies-of-scale associated with mechanized farming. Tables 4 and 5 also indicate a similar result as no significant differences were detected across mechanization classes for small farm sizes. We conjecture that there are few mechanization effects for small farms and considerable mechanization effects for larger farms. This suggests a threshold level above which mechanization translates into greater profits or higher incomes. It is of interest to determine this threshold level which ensures mechanization is profitable. The interaction of area with irrigation also implies regions of significance and non-significance associated with irrigation. Gravity-irrigated farms are more superior to rainfed farms at all farm sizes included.

The household size component is also significant and interacts with mechanization and irrigation. Again the interaction with mechanization implies varying effects on income for different household sizes. Larger household sizes possibly denote more intensive employment of family labor in farm and off-farm activities. The presence of mechanization could enhance the income-generating capacity of a fairly large household. A mechanized farm would require very much less family labor as compared with a nonmechanized farm. Consider the mean household labor input shown in Table 10. If household size represents the household labor available, less is required on mechanized than on non-mechanized households in both seasons and at a given irrigation level. An exception is noted in the rainfed-mechanized class, which is composed of only a single household which makes comparisons with any other classes very dubious. It also suggests the possibility that mechanization requires fewer labor inputs, and hence releases labor to be used for other work. The extent of the latter effect is not measurable directly.

Considering the irrigation dimension, a multiple covariance analysis was performed for each irrigation class. The results are given in Table 9. Caution must be used in interpreting the results for each irrigation class. For rainfed farms, the comparison is between non-mechanized and partially mechanized farms since there is only one fully mechanized household in the class. For pump-irrigated farms, there are no fully mechanized households and the comparison is limited to non-mechanized and partially mechanized. The three mechanization

classes are present in the gravity-irrigated class but the mechanized households are very limited.

Mechanization was not found to have a significant effect distinct from the effect of the covariates in the case of rainfed farms (Table 9). Cropping intensity is significant but fails to interact significantly with mechanization implying that the effect of cropping intensity on income is the same for each mechanization class. Farm size and nonfarm earnings also contribute significantly in explaining log-income variation but do not interact with mechanization. Household size interacts with mechanization so that income relates to household size differently for each mechanization class. The proportion of log-variance explained by the model is 0.44. The overall F-test is significant at confidence levels in excess of 0.999.

Mechanization significantly affects the logarithms of incomes of pump-irrigated farms after freeing it from the effect of the covariates (Table 9). Farm size and cropping intensity both interact with mechanization. The same is true for household size. Again, non-farm earnings contribute significantly to income variation but fail to interact with mechanization. The overall explanatory power of the model is quite high at 89%.

For gravity-irrigated farms, mechanization was found to affect incomes significantly (Table 9). Non-farm earnings and farm size were the only significant effects outside of the observed mechanization effect. The R^2 value of 0.40 is substantially lower compared to the R^2 for the pump-irrigated farms though quite similar to the R^2 of

rainfed farms. The apparent reason is the strong correlation among the variables in the case of the pump-irrigated farms. Intuitively, we would expect this since the incomes of the rainfed class are less dependent on mechanization. The gravity-irrigated farms, on the other hand, are less homogenous and, being situated close to Cabanatuan City, would have other sources of income not related to echanization.

Table 11 shows the marginal F-values for evaluating the individual predictive power of each effect based on the reduction in sums of squares attributed to the covariate after the removal of the other effects. While many of the values show significance, farm size appears to be the most important. This is expected since farm size is really a proxy for wealth and is also a management variable. Size is followed closely by non-farm earnings, household size, and cropping intensity.

The predictive value of non-farm earnings is high for all irrigation classes. Household size is important for rainfed and pump-irrigated farms but not for gravity-irrigated farms. Farm size is most effective for pump-irrigated farms. Cropping intensity loses its predictive power when we standardize for irrigation technique as seen in the nonsignificant F-values (Table 10). This is because, within an irrigation class, cropping intensities are fairly uniform. Gravity irrigated farms have a cropping intensity of 2, rainfed farms have a cropping intensity of 1, while that of pump-irrigated farms lie in between.

Finally, after removing the confounding effect of variables that affect incomes singly and together, income differences are still

substantial since our model has only accounted for 71% of the variability in the logarithms of income. The remaining portion unaccounted for by the model could arise from any one of a number of reasons: Differences could reflect price variations since prices of inputs and other goods are, in general, higher in Guimba than in Cabanatuan. Although similar wages are paid for similar services so that the labor market appears in approximate equilibrium, wages in Cabanatuan are a little higher than in Guimba. Lastly, measurement errors in addition to purely stochastic variability could have been contained in the residuals.

To quote from Lipton: "Income data are notoriously difficult to collect, and are not very reliable unless gathered during a considerable period of residence in the village over a time-span which allows for seasonal fluctuations. Few village surveys take such precautions, hence the value of much income information is severely reduced."

SUMMARY AND CONCLUSIONS

The paper presents statistical results to evaluate the income impact of mechanization.

The findings have policy implications. The present research supports the view that mechanization has had an effect on income variation. At the micro level, the effects are confined to certain levels of farm size and certain classes such as the pump-irrigated and gravity-irrigated farms. Household size as a gauge of family labor input interacts with mechanization in its income effect. Mechanization

requires fewer labor inputs and presents the potential for releasing labor which can be used for other work. Cropping intensity contributes significantly in explaining income variation across the sample of farms but fails to do so when standardized for irrigation technique. Farm size as a proxy for wealth is most important. The significant farm size/mechanization interaction suggests that beyond a certain farm size, mechanization effects are more pronounced. To make mechanization profitable, farmers may have to consolidate land holdings or cooperatives may have to be formed to realize the economies of machinery.

The low income levels, especially in the case of the nonmechanized households, exacerbate the problem of lack of access to credit, a major constraint in the adoption of new technologies particularly capital intensive inputs such as most farm machines. An attempt should be made to supply new production inputs plus credit, marketing, extension, and education relating to new technologies particularly in less well-endowed areas. This would enable small farmers to benefit as well from new technology, thereby reducing income inequality.

The analysis as presented here is only exploratory. To proceed to definite policy prescriptions requires a more dynamic model of income. In place of the conventional univariate analysis of income, a more realistic insight concerning income inequality could be gained with the use of multivariate analysis employing several dependent variables such as production and employment variables aside from income. Multivariate analysis would utilize the relationship among the dependent variables and incorporate this in the analysis of possible mechanization effects.

Another direction for research on the income issue might include factor share analysis to take account of the distribution of ownership within each mechanization class of land, labor, and capital in addition to intermediate inputs.

References

Cornell, J. and Michael Lipton. "Village Surveys bearing on Labour Utilization: Scopes and Aims" in Assessing Village Labor Situations in Developing Countries, Delhi: Oxford University Press, 1977.

Lim, P. C. "Estimation and Significance Test Concerning a Subpopulation Mean Using Survey Data." A paper presented at the Third National Convention on Statistics, December 13-14, 1982, Philippine International Convention Center, Manila.

Yotopoulos, P. and J. Nugent. "Income Distribution, Poverty and Dualism," in Economics of Development, New York: Harper and Row, Publishers, 1976.

Table 1. Mean household income (in pesos) by farm type and season. Rice farm households in 8 villages of Cabanatuan and Guimba.

Irrigation		Mechanization class			
		Non-Mechanized	Partially-mechanized	Mechanized	
Rainfed	WS	1302	1910	3951	1502
	DS	1885	2301	673	2007
	WS-DS	3187	4211	4623	3509
Pump	WS	2018	3655	-	2544
	DS	3110	4762	-	3641
	WS-DS	5128	8417	-	6185
Gravity	WS	1821	4474	3732	4020
	DS	3521	7277	6485	6752
	WS-DS	5342	11751	10217	10772
Mean	WS	1469	3446	3735	2662
	DS	2204	5185	6415	4151
	WS-DS	3673	8631	10150	6813

Source: Consequences of Small Rice Farm Mechanization (CSRFM) Data.

Table 2. Distribution (in %) of rice farm households across annual household income groups by mechanization class in eight villages of Cabanatuan and Guimba. Wet Season 1979, Dry Season, 1980.

Annual household income group (In P)	Mechanization class		
	Non-mechanized	Partially Mechanized	Mechanized
Below 0	7.0	1.8	3.1
0 - 1999	28.3	16.2	13.6
2000-3999	33.9*	20.3*	6.8
4000-5999	11.2	13.0	9.3
6000-7999	8.6	8.9	7.4
8000-9999	3.0	8.8	11.1
10000-11999	3.7	6.2	19.1*
12000-13999	1.9	4.7	7.4
14000-15999	0.5	6.8	3.1
16000-17999	1.3	4.1	6.8
18000-19999	0.0	2.9	1.2
20000 & over	0.5	6.2	11.1

*Modal income bracket.

Source: CSRFM Data.

Table 3. Distribution (in %) of rice farm households across annual per capita income groups by mechanization class in eight villages of Cabanatuan and Guimba. Wet Season 1979 - Dry Season, 1980.

Annual per capita income group (inP)	Mechanization Class		
	Non-mechanized	Partially mechanized	Mechanized
Below 100	13.3	5.3	9.1
100-299	19.4	15.6	7.9
300-499	23.7	8.5	6.1
500-699	9.3	8.5	2.4
700-899	13.6	5.9	0.0
900-1099	5.1	14.1	3.0
1100-1299	4.2	9.1	7.3
1300-1499	4.8	5.6	10.9
1500-1899	2.1	7.1	14.5
1900-2299	2.4	6.8	12.7
2300-2799	0.5	4.7	12.7
2800-3199	0.3	0.6	5.4
3200 & over	1.3	8.2	7.9

Source: CSRFM Data.

Table 4. Mean household income (in pesos) by farm size, mechanization class and season. Rice farm households in eight villages of Cabanatuan and Guimba.

Farm size	Mechanization class					
	Non-mechanized		Part. mechanized		Mechanized	
	Wet	Dry	Wet	Dry	Wet	Dry
Below 1.00 ha	1470	1868	1320	2225	962	1790
1.00 -2.49 ha	883	3150	2695	4825	2417	4256
2.50 ha & over	2320	3748	4844	10847	5336	9172

Source: CSRFM Data.

Table 5. Mean annual household income (in pesos) by farm size and mechanization class. Rice farm households in eight villages of Cabanatuan and Guimba. Wet season 1979 - Dry season, 1980.

Farm size class	Mechanization class		
	Non-mechanized	Partially mechanized	Mechanized
Below 2.00 ha	2828	3274	2924
2.00-4.99 ha	3907	6615	6620
5.00 & over	5930	15970	14309

Source: CSRFM Data

Table 6. Mean per capita income (in pesos) by farm size, mechanization class, and season. Rice farm households in eight villages of Cabanatuan and Guimba.

Farm size class	Mechanization class					
	Non-mechanized		Part-mechanized		Mechanized	
	Wet	Dry	Wet	Dry	Wet	Dry
Below 1.00 ha	280	308	226	348	262	515
1.00-2.49 ha	167	542	468	791	450	795
2.50 ha & over	371	576	744	1298	840	1562

Source: CSRFM Data.

Table 7. Mean annual per capita income (in pesos) by farm size and mechanization class. Rice farm households in eight villages of Cabanatuan and Guimba. Wet season 1979, Dry Season 1980.

Farm size class	Mechanization class		
	Non-mechanized	Part. mechanized	Mechanized
Below 2.00 ha	501	545	844
2.00-4.99	618	1049	1240
5.00 & over	1076	2265	2365

Source: CSRFM Data.

Table 8. Analysis of variance of the natural logarithms of income. Rice farm households in 8 villages of Cabanatuan and Guimba, Wet season 1979- dry season, 1980.

Source of variation	df	Sum of squares	F-value
Irrigation (I)	2		10.08***
Mechanization (M)	2		2.78
I*M	3		1.72
Model	7	509.0267	4.27**
Error	292	4973.1729	
Total corrected	299	5482.1996	

Proportion of log-variance explained

$R^2 = 0.09$

Note: ** Significant at 1% level.

*** Significant at 0.01% level.

Source: CSRFM Data.

Table 9. Multiple covariance analysis of the natural logarithms of income. Rice farm households in 8 villages of Cabanatuan and Guimba. Wet Season 1979 - Dry Season, 1980.

Source of variation	F-values			
	All	Rainfed	Pump	Gravity
Irrigation (I)	29.55***			
Mechanization (M)	6.68**	< 1	15.35**	3.22*
Cropping intensity (CI)	217.18***	4.85*	164.17***	1.63
CI*M	49.81***	< 1	102.14***	< 1
CI*I	18.13***			
Farm size (FSIZE)	95.38***	10.36**	15.07**	49.37***
FSIZE*M	2.90+	< 1	9.27**	1.09
FSIZE*I	3.67*			
Non-farm earnings (NF)	71.62***	44.66**	15.24**	17.81**
NF*I	2.26			
NF*M	< 1	< 1	1.00	< 1
Household size (HHSIZE)	36.30***	17.37***	6.41*	< 1
HHSIZE*M	3.14*	5.11*	7.46**	< 1
HHSIZE*I	7.69**			
Model	27.85***	8.32**	37.35**	5.72***
Number of farms included	300	115	51	134
Proportion of log-variance explained				
R^2	0.71	0.44	0.89	0.40

Note: + Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.
**** Significant at 0.01% level.

Table 10. Household labor input (Mandays/ha) by season and farm type. Rice farm households in 8 villages of Cabanatuan and Guimba.

Irrigation	Season							
	Wet season				Dry season			
	NM[a]	PM	FM[b]	All	NM	PM	FM	All
Rainfed	29	20	63	27	39	40	105	40
Pump	28	16	-	24	37	26	-	33
Gravity	57	9	8	11	68	9	8	11
	30	14	9		41	16	9	

[a] NM,PM,FM, designate non-mechanized, partially mechanized, and fully mechanized, respectively.

[b] The rainfed-mechanized class consists ofonly one observation.

Source: CSRFM Data.

Table 11. Marginal F-values for multiple copvariance analysis on the natural logarithms of income, rice farm households in 8 villages of Cabanatuan and Guimba. Wet Season, 1979 - Dry season, 1980.

Source of variation	F-values			
	All	Rainfed	Pump	Gravity
Irrigation (I)	3.54*			
Mechanization (M)	11.64*	2.32	16.30**	2.43+
Cropping intensity (CI)	4.29*	1.68	<1	<1
CI*M	2.15	<1	1.42	2.19
CI*I	<1			
Farm size (FSIZE)	28.98**	<1	22.01***	1.25
FSIZE*M	6.22**	<1	10.42**	1.16
FSIZE*I	13.41**			
Household size (HHSIZE)	15.14**	3.72+	13.49**	<1
HHSIZE*M	4.68**	5.11	7.46**	<1
HHSIZE*I	7.37**			
Non-farm earnings (NF)	24.10**	17.17**	2.92+	6.55**
NF*M	2.04	<1	<1	<1
NF*I	<1			

Note: + Significant at the 10% level.
* Significant at the 5% level.
** Significant at the 1% level.
*** Significant at the 0.01% level.

Source: CSRFM Data.

Table 12. Estimated population sizes by farm type. Rice farm households in 8 villages of Cabanatuan and Guimba.

	Non-mechanized	Partially mechanized	Mechanized	
Rainfed	282 (78)	126 (45)	2 (1)	410 (124)
Pump	76 (40)	36 (15)	-	112 (55)
Gravity	16 (7)	181 (76)	163 (54)	360 (137)
	374 (125)	343 (136)	165 (55)	882 (316)

Figures in parentheses are sample sizes.

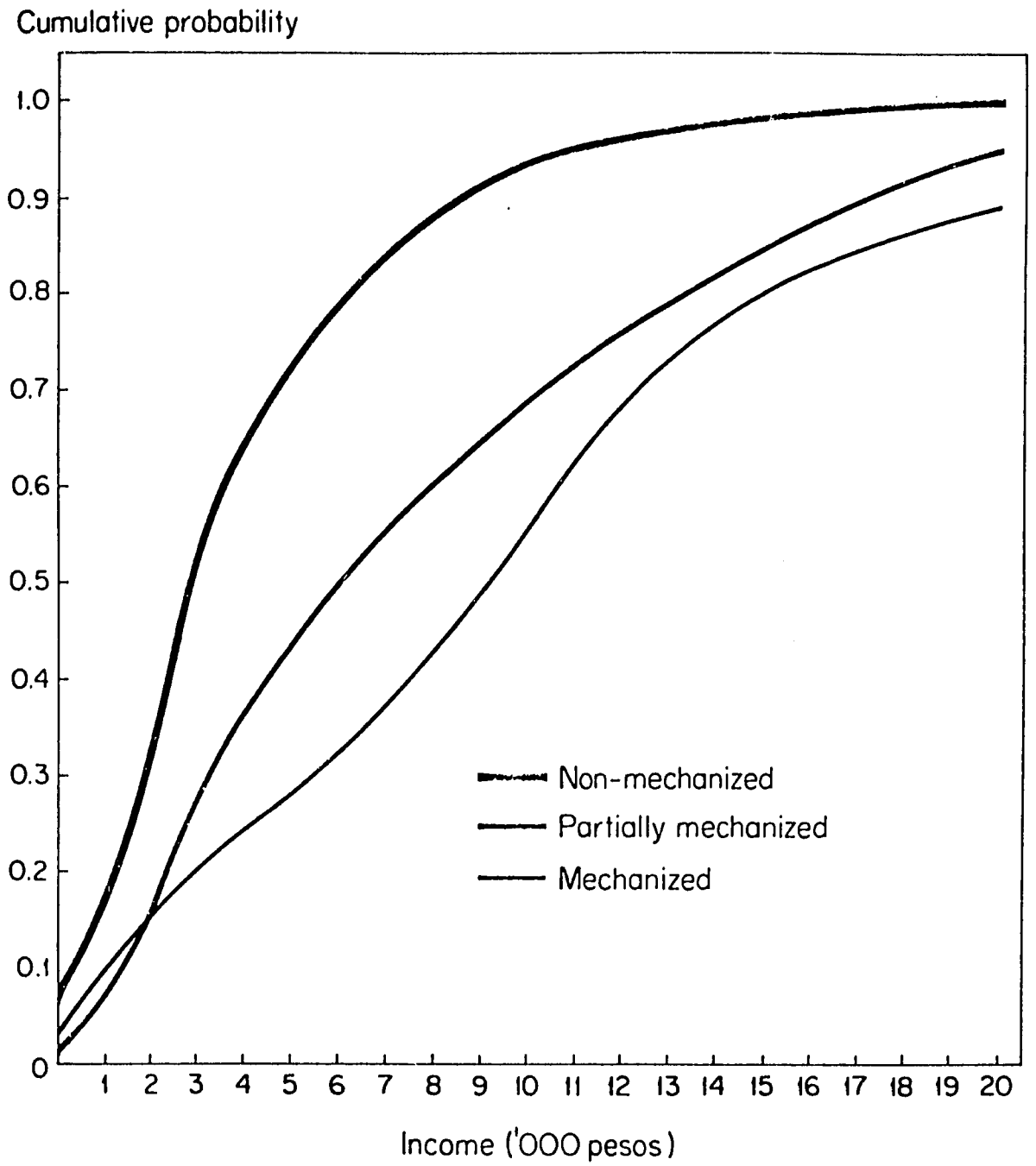

Figure 1. Cumulative income distribution by mechanization class.