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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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THE IMPACT OF MECHANIZING SMALL SCALE RICE PRODUCTION IN THE PHILIPPINES, INDONESIA AND THAILAND: SOME EMPIRICAL EVIDENCE

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THE IMPACT OF MECHANIZING SMALL SCALE RICE PRODUCTION IN THE PHILIPPINES, INDONESIA AND THAILAND: SOME EMPIRICAL EVIDENCE*

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Considerable controversy exists about the desirability of farm mechanization in S.E. Asia. The issues involved are outlined and an ongoing project analyzing the economic and social consequences of mechanization at four sites in the Philippines, Indonesia (2) and Thailand described. Preliminary evidence is presented and tentative conclusions drawn.

Agricultural mechanization has brought far reaching changes in farming structure in all developed countries; its effects are now beginning to be felt in many developing countries. Within the former, mechanization has been associated with increasing farm size, migration of labor out of farming and the development of agriculture as a specialist commercial activity. New inputs of improved quality have been developed, modern management practices adopted and machinery inputs (capital) have substantially substituted for labor and animal-power inputs. The impact of farm mechanization results from its interaction with the institutional structure of agriculture however and introduction to the developing countries will not necessarily result in similar adjustments. Indeed one might argue that it is the duty of the developing countries to intervene and modify the impact of mechanization.

Before such intervention however it is necessary to understand the effects of mechanization on factors such as output, labor demand and cropping intensity. Equity considerations require an assessment of the impact on farm earnings along with the income effects on landless laborers. The problem is one of disentangling cause from effect and distinguishing between the factors which cause change and those which merely provide an <u>enabling</u> role. One view of mechanization holds that it is directly output increasing, another that it has little effect. This is an empirical issue and results are likely to be site specific. Farm structures, land-labor ratios, tenure patterns, soils, prices, irrigation networks and institutional arrangements vary from site to site and will both shift the underlying production function and shape the behavior of farmers.

The Issues

In his seminal work on tractors in the Indian sub-continent Binswanger (1978) outlined the two schools of thought in a recurrent debate. The substitution view holds that the switch from animal and human power to tractors and power tillers is guided by changing factor prices and is itself a market phenomenon. Correct timing of the switch in technique then becomes the efficiency issue of concern, society's welfare and private individuals profit maximizing behavior being

largely compatible, although income distribution aspects are as ever present. On the other hand, the net contribution view holds that the traditional power input is a binding constraint and the introduction of machinery may be expected to result in significant output increases. These might show up as increased yields, an extension in the area cultivated, a release of land and other inputs formerly allocated to draft animals and improved cropping intensity. Quality aspects associated with the new source of power input, such as deeper plowing, improved seed-bed preparation and faster operating times, would add to the effects of quantity increases. The net contributor view benevolently holds that mechanization will therefore contribute to increased output without necessarily displacing labor.

Measurement holds the key to this debate but is not easy. At the micro experimental plot level, individual machinery cultivation effects have been observed for a number of operations (see for example Orcino and Duff, 1974). However, at the whole farm level and for more aggregate data, such direct effects become masked by changing farmer behavior patterns and other qualitative influences. Indeed such factors as 'timeliness' and 'turnaround time' are extremely elusive concepts, difficult to define, observe and measure and impossible to relate to the broader aggregates of farm survey data. Therefore we are left with measuring differences in cropping intensity, the incidence of multiple-cropping etc. for which 'turnaround time' and 'timeliness' explanations are but two possible influences, along with water availability, soil-types, weather and many other factors not particularly related to mechanization. King (1974) reported that 84% of the increase in cropping intensity for tractor adopters in the Philippines was explained by associated changes in irrigation but no evidence supported the hypothesis of increased intensity from mechanized land preparation. Duff (1978), surveying recent evidence, concluded that the "actual impact of intensification through reductions in turnaround time is extremely hazy".

The question thus remains as to whether machinery is yield-increasing, output-increasing or quality-improving at the farm level. Are timeliness, increased power and other attributes of machinery technology actually used by farmers? Could not the same degree of timeliness be achieved by a combination of labor and traditional techniques? Does timeliness matter in any case? A whole series of issues arise and one must be careful not to attribute to machines the effects of other techniques or inputs.

The two alternate viewpoints are essentially different interpretations (and assertions) of the impact of mechanization. Such extreme positions are as unhelpful as painting the general agricultural development dilemma of, without new technology - no development; with new technology - inequitable distribution. Similarly it is our view that the considerable achievements on the theoretical analysis of technical change have done little to further understanding in the real farming

world. The current study was initiated in 1978 to generate a substantial body of information on the mechanization of rice farming in S.E. Asia and, recognizing the fallability of eclecticism (indiscriminate use of selective pieces of evidence), to permit a comprehensive standardized analysis.

The Consequences of Small Farm Mechanization.

A proposal was submitted to USAID for the funding of a project on "The Consequences of small rice farm mechanization on production, incomes and rural employment in selected countries of Asia" (IRRI, 1978) for which two major components were identified. The first was a series of major surveys, eventually located in the Philippines, Thailand and two sites in Indonesia, to be coordinated by IRRI. These involved collaborative research with selected government and university departments. The second component was a series of small case studies coordinated by A/D/C. The results reported in the present paper were derived from IRRI's component of the study.

Once suitable national cooperators had been identified they were requested to identify two districts from a single province in which there was sufficient mechanization to permit collection of a comprehensive set of with and without farm data covering both mechanization and irrigation states. The districts selected were Cabanatuan City and Guimba in Nueva Ecija, Philippines, Don Chedi and U-Thong in Supanburi, Thailand, Indramayu and Subang in West Java, Indonesia and Pinrang and Sidrap in South Sulawesi, Indonesia.[2] Up to four villages were selected from each of the districts.

The local staff conducted a household census in each of the villages in late 1978 and early 1979. For Nueva Ecija and Supanburi, where the villages were relatively small, the census enumerated all households. For West Java and South Sulawesi a partial census, comprising approximately 200 households in a single block in each village, was enumerated. Where there were insufficient households in a particular category, additional areas were enumerated.

The information gathered in the census was used initially to stratify by household (farmer or landless laborer), land preparation and irrigation type. Details varied between sites since not all categories were present, and some research teams felt that a particular category should be further sub-divided to reflect the specific nature of their site. A stratified random sample of 300-400 households was drawn for each site subject to the proviso that each category should contain a minimum of 30 observations.[3] These were used for farm surveys conducted over a period of 3-4 seasons, depending on site. Two survey rounds, one after land preparation and one after harvest, were accomplished each season.

Some Methodological Problems

Having obtained reliable data on mechanized and unmechanized farms the question arises as to how to isolate meaningfully the contribution of mechanization. The primary impact of mechanization is hypothesized to be changed farm input structure leading to output differences between mechanized and non-mechanized farms. Other factors, e.g. irrigation, contribute to those differences and identifying that part of observed output differences due to mechanization alone is difficult. Several approaches are being used to see if any pattern emerges.

At an initial level, using survey data, differences across villages in demographic characteristics, average farm size and land use were tabulated. Such tabular studies and site descriptions were performed for all sites. The effects of mechanization on land use intensity were also investigated. Although, such analyses are of limited value, and are essentially a precursor to more sophisticated multi-variate methods, they should reveal any large differences associated with mechanization.

More sophisticated methods have, as yet, consisted of limited use of multiple regression analysis, involving the judicious use of dummy variables (covariance analysis) for qualitative influences such as soils, region, irrigation, mechanization, etc. (Sison and Moran, 1981). We would argue that the potential advantages of tractors in rice farming are essentially qualitative (deeper cultivation, more timely tillage, etc.) and that an appropriate way to incorporate the state of mechanization into relationships is via dummy variables. Conventional significance tests may then be applied to the coefficients of the dummy variables or Chow tests performed. Relationships investigated in this way included cropping intensity, labor utilization and employment (broken down into hired or family and by sex), production functions and those concerned with animal-machine substitutability. Decomposition analysis has been used (Tan, 1981) to split observed output differences between farms 'with' and 'without' machines into yield, price, area and cropping intensity components. Interaction effects between the components have also been investigated. Labor use differences may likewise be decomposed into selected components.

The 'with-without' approach is subject to serious limitations since important institutional variables often cannot be incorporated. Interpretation of a large number of dummy variables becomes difficult particularly when interaction terms are introduced. The dummies capture the effects of a wide variety of influences and some of the important micro influences of power source may have been lost in the aggregation process. More disaggregated analysis may reveal further relationships. Also the approaches so far are essentially only sophisticated forms of correlation analysis and hence the chain of

causality is not readily apparent. Given the number of confounding influences at work at each of the sites, a healthy dose of cynicism/disbelief is necessary for interpreting our preliminary results.

Preliminary Evidence

Table 1 shows that, even after taking account of possible biases from the partial censuses conducted at the two Indonesian sites, there are very clear structural differences. The highest proportion of landless laborer households, as expected, is in West Java. However in Nueva Ecija there appears to be a substantial non-agricultural sector. Other than in West Java the areas censused contained both irrigated and rainfed parcels of land. Average farm size varied greatly between sites. Although the average size of farms in South Sulawesi was lower even than in Java, there were far fewer very small farms. Farms in Supanburi were the largest with most farms between 3 and 10 hectares. The predominant cropping pattern at all the sites was double cropped rice where irrigated and single cropped rice were rainfed. Small areas of non-rice crops were grown at each site, plus a significant area of sugar cane in Supanburi. However the current analysis relates solely to rice.

With two exceptions the results showed that mechanized farms produced, on average, at least as high a yield as the non-mechanized farms. However, fertilizer use was almost always higher on mechanized than non-mechanized farms. Sinaga (1981a and b) has suggested that, on average, the difference between farm types in fertilizer used accounts for yield differences even assuming relatively moderate response. It appears likely that a similar situation prevails at the other sites but more detailed analyses are required to yield any firm conclusions. Again there is little evidence of higher cropping intensity on mechanized farms, other than for deepwell irrigated farms in Nueva Ecija and rainfed farms in South Sulawesi. In these situations mechanization seems likely to be easing a bottleneck. Since cropping intensity at all sites is well below the technically feasible level, we tend to conclude other factors are limiting.

Other than for rainfed farms in South Sulawesi, total labor use was markedly less with mechanized land preparation (Table 2). However, it is also evident that the major displacement is of family labor. The largest decline in use of hired labor is in Java, where manual land preparation is still practiced.

Conclusions

The evidence presented in this paper is, by necessity, preliminary. However, the conclusions on yield and cropping intensity are in general agreement with other researchers (e.g. Binswanger, 1978; Roy and Blase, 1978; Agarwal, 1980). More detailed analyses are required.

Some preliminary insights have been made as to the impact of mechanization on employment distribution. Of the three sites studied West Java is the only one where mechanization appears to result in a large loss to landless laborers. Under such conditions one should not be influenced by the argument that mechanization reduces drudgery. If alternative employment opportunities are limited reduction in drudgery through mechanization will cause greater hardships as income will be transferred from laborers to machine owners. Such a transfer can in no way be considered as a Paretian welfare improvement. The many less clear situations require analysis of net social benefits to resolve the issue (Herdt, 1981).

In concluding it is evident that the consequences of mechanization in South and South East Asia present an emotional rather than empirical issue. Interest groups have tended to argue their positions on emotive grounds, whereas unbiased evaluation of the question requires empirical analysis with a firm theoretical underpinning.

Notes

* Contributed paper presented at the 18th International Conference of the Agricultural Economists, Jakarta, Indonesia, 24 August to 2 September, 1982.

1 Visiting Scientist and Associate Agricultural Economist, IRRI. We wish to acknowledge the contributions of Mr. B. Duff, Drs. R. Sinaga, R. Bernsten and D. Mongkolsmai and Ms. S. Dumngratana.

2 For convenience these sites are referred to as Nueva Ecija, Supanburi, West Java and South Sulawesi.

3 During the survey it became apparent that the mechanization process was extremely dynamic and farms changed classification frequently.

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Table 1. Characteristics of sample villages, household census data.

Characteristic	Site			
	Nueva Ecija	Supanburi	West Java	S. Sulawesi
Occupation (no.)				
Farm operator	1042	892	1021	1367 (9529)
Landless laborer	233	63	331	15
Non-ag. worker	401	75	19	197
Total	1676	1030	1371(22582)	1579 (13375)
Irrigation status (ha)				
Irrigated	1033	1813	2022(10397)	1465 (13596)
Rainfed	1112	2616	0 (943)	526 (1406)
Total	2144	4429	2022(11340)	1990 (15002)
Average farm size(ha)	2.06	4.96	1.98	1.46

[a]Numbers in parentheses are values for the entire village as derived from secondary data.

Table 2. Total and hired labor used in days/ha by farmers with mechanized and non-mechanized land preparation methods.

Area	Irrigation	Season	Total labor		Hired labor	
			Mech	Non-mech	Mech	Non-mech
Nueva Ecija, Philippines	All	Wet '79	472	592	360	375
		Dry '80	483	706	381	442
West Java Indonesia	All	Dry '79	513	532	n.a.	n.a.
		Wet '80	1061	1320	1005	1138
S. Sulawesi, Indonesia	Canal	Wet '79	828	830	602	398
		Wet '80	581	690	390	369
		Dry '80-81	606	638	414	426
	Rain-fed	Wet '79	1047	1027	681	574
		Wet '80	589	607	364	310
		Dry '80-81	633	630	369	396

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