

THE CONSEQUENCES OF SMALL FARM MECHANIZATION ON RURAL EMPLOYMENT, INCOMES AND PRODUCTION IN SELECTED COUNTRIES OF ASIA

REPORT OF
A JOINT ADC-IRRI
WORKSHOP
14-18 September 1981



AGRICULTURAL ENGINEERING DEPARTMENT
The International Rice Research Institute
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INTRODUCTION

The United States Agency for International Development is funding a research project entitled "The Consequences of Small Farm Mechanization on Production, Incomes and Rural Employment in Selected Countries of Asia" (AID/ta-c-1466). The project has two components: one is administered by the Agricultural Development Council (A/D/C) and has supported a series of case studies on issues related to mechanization; the second is conducted by the International Rice Research Institute (IRRI) in collaboration with national researchers in Indonesia and Thailand.

A research planning workshop was held at IRPI, Los Baños, on 31 October and 1 November, 1977, to consider the initial proposal and develop the research design and methodology. In addition, the workshop participants considered countries to be included in the study, possible survey sites within countries, sampling, survey techniques, alternative modeling formats and the nature of the complimentary case studies that would contribute to overall project objectives. The research design evolved was incorporated into the revised project proposal.

A second workshop was held at IRRI from 11-13 September, 1978, to discuss and develop the specific research methods and design for the field component of the project. The major objectives were to review and finalize the research designs for field surveys and record-keeping activities, to review and refine the field survey and record-keeping data instruments, to review and propose strategies for implementation of field research activities and to identify and incorporate those technical studies to be associated with the field surveys. During the course of the workshop a minimum set of hypotheses to be tested at each site was specified.

A third workshop was held at IRRI from 1-4 October, 1979. With data collection well underway the participants concentrated on the following issues. First, the status of, and necessary modifications to, the data collection instruments were reviewed. Second, progress with development and implementation of an efficient data assembly and management system was considered. Third, procedures for data analysis were defined. Special attention was given to simple, field-based, analytical methods as well as more sophisticated computerized approaches. Finally some initial reports from the A/D/C funded studies were presented.

A fourth workshop was held at IRRI from 14-18 September 1981. This was jointly sponsored by A/D/C and IRRI. The objectives of the workshop were to present reports on the A/D/C funded projects, to present some initial analyses from the IRRI study and to review and consolidate plans for the final year of the study.

The proceedings of the workshop are summarized in this report, which is set out as a series of abstracts of the papers presented and summaries of discussion.

When reviewing the contents of this report it is necessary to keep in mind the two original objectives of the study. The first was to provide a better understanding of the effects of mechanization on small farmers. Emphasis was to be given to determining output, income and employment effects of small scale equipment. The second objective was to encourage more applied research on the effects of farm mechanization and improve the capacity of Asian scientists and institutions to undertake such research.

CONFERENCE PROCEEDINGS

I. The contribution of mechanization to development in Asian rice producing economies

Mechanization of Rice Production in Developing Asian Countries: Perspective, Evidence and Issues

R. W. Herdt^{1/}

A generalized sequence of mechanization of the Asian rice production process is developed, based on experience in Japan, Taiwan and Korea, countries which by 1978 had reached a relatively high level of mechanized rice land preparation. Labor force growth rates are contrasted across Asian countries. A net social benefits model for evaluating the desirability of mechanizing rice production is outlined and factors often neglected are identified. Available empirical evidence on some important factors is reviewed. In closing, the most critical issues for evaluating the economic consequences of mechanization are stated.

^{1/}Affiliations of authors are shown in the list of participants at the end of this report.

Mechanization Policy and the National Agricultural
Mechanization Council - Philippines

R. M. Lantin

This paper presents an overview of agricultural mechanization in the Philippines by discussing a brief history of the events that led to the realization of the need for a sound agricultural mechanization policy. It also briefly discusses the present status of the Philippine agricultural machinery industry, outlining the factors that contribute to the need for policies in this area and for a governing body to implement these policies. Results of the First Philippine Agricultural Mechanization Policy Workshop held on December 11-12, 1980, emphasizing the policies proposed in the workshop, are reported. The establishment of the National Agricultural Mechanization Council (NAMC), the governing body that will approve and implement the proposed and future policies on agricultural mechanization in the country is also discussed.

Farm Mechanization in Pakistan: Policy and Practice

B. Lockwood

This report consists of two parts. The first contains brief reviews of the Government of Pakistan's farm mechanization policy from 1975 to the present and of a World Bank study of 1975 which questions the suitability of this policy of rapid tractorization in the context of the typical farm size and production patterns of Pakistan agriculture. The second part presents some of the results of a study of farm mechanization in Punjab Province, Faisalabad in 1978-79. Data on the behavioral pattern of tractor farms generally support the findings of the 1975 World Bank study and its conclusion that while tractor-farmers earned good returns on their investments in tractors and attachments these private gains were at the expense of substantial social costs to rural society, particularly in terms of the transfer of farmland from tenants to tractor-farmers

and the loss of jobs and earnings for the rural landless community. This part of the report also examines data on tractor use, by farm size, operation, combination of attachments, and between owners' farm work and off-farm and contract work on other farms. The analysis shows clearly the recent growth in tractor-based hire services supplied by medium and small tractor-farms to a ready market of largely medium sized farms.

Summary of Reactions and Discussion

H. P. Binswanger

The papers confirm that mechanization is a complex issue particularly when one is dealing with a range of different physical environments and economic circumstances. However there are some important regularities:

Firstly, where there is a high population density it is hard to find convincing evidence that mechanization causes gains in cropping intensity.

Secondly, the research issues have remained largely the same over the past ten years despite the fact that much work has been carried out, and a large amount of information is available.

Thirdly, the methodological issue as to whether mechanization is a cause or an effect of intensity gains is not yet solved. Furthermore it cannot be solved using cross-sectional data but requires recall data related to the complete period of mechanization.

Fourthly, whenever real demand for machines has existed due either to an open land frontier or rapidly rising wages private industry is quite capable of responding satisfactorily. An example is Thailand where an increased mechanization demand arising out of expansion of cultivated area in the north and northeast plus increases in irrigated area in the central plains has been satisfied under a free trade regime which has allowed a competitive industry to respond vigorously.

Lockwood's paper describes a situation where intervention by policy makers has been less happy. Despite the fact of tenant evictions throughout the seventies and despite the doubts about the makers of tractors chosen by the government, the policies still continue.

One hopes that efforts in the Philippines described by Lantin are more successful in generating a national and engineering policy beneficial to all sections of the community.

The Total Factor Productivity Growth of the Three-Digit Manufacturing Industries in Thailand

P. Wiboonchutikula

The paper estimates and analyzes the total factor productivity growth of the manufacturing industries in Thailand. It consists of two parts: one is on the three-digit-BSIC manufacturing industries using aggregate data, and the other is on the farm machinery industry using data at the firm level collected from our own surveys and interviews. The results show that even though the rates of total factor productivity growth of most industries are small compared to developed countries, they are increasing and moreover, the role of total factor productivity as a source of growth of real output becomes greater in significance over time.

A General Equilibrium Analysis of the Effects of Rice Farm Mechanization in the Philippines

C. S. Ahammed and R. W. Herdt

A macroeconomic model, with semi-closed input-output relations, is used to compare employment, income distribution, and resource utilization effects of producing additional rice using alternative rice farm mechanization systems. Aggregate net effects are computed by incorporating 'factor intensity', 'distribution', 'consumption', and 'import substitution' effects. A methodological step involved disaggregation of the conglomerate production vector for rice and agricultural machinery sectors into sub-sectors depending on water control-topography-technology mix and individual machine groups respectively. Five household classes are distinguished to provide some variation in consumption, savings and import behaviour. The simulations consider m subsets of the final demand vector for rice. Results indicate the effects of mechanization vary widely among four water-topographical regimes considered in the model. While increasing intensities of mechanization in a given water regime is found to worsen employment and income distribution problems, a comparison among water regimes indicate positive results of increasing water control.

Technology Change in the Philippine Agricultural Machinery Industry

K. W. Mikkelsen and N. N. Langam

Preliminary analysis has been done on a survey sample of 47 Philippine agricultural machinery manufacturers to investigate the nature of product changes made and to determine the characteristics of innovative firms. A wide variety of changes have been instituted showing considerable product differentiation and adaptation to local agricultural conditions. Several measures of direct and indirect technical change activity were found to be correlated with the number of product changes made.

Energy Use in Alternative Rice Production Systems in Nueva Ecija, Central Luzon, Philippines

D. Boughton

This study investigates the significance of rising fossil energy prices for the development of rice production technology, particularly in the field of mechanization. The use and productivity of resources employed on rainfed and irrigated farms in the Philippines are measured in energy as well as financial terms. Fertilizer use on all farms and water supply on pump irrigated accounted for the largest shares of fossil energy use and cash expenditure. When expected increases in real prices of chemical inputs are added to existing costs of production they represent 25% of current returns above variable costs per hectare on rainfed and 16% on gravity irrigated farms. In a decade of rising input prices and growing demand for rice mechanical innovations are needed which both increase yields, and simultaneously improve the productivity of resources that are becoming scarce relative to demand. This role of mechanization is illustrated by an ex-ante analysis of a hand powered machine for deep placement of fertilizer.

Summary of Reactions and Discussion

J. Lingard

Wiboonchutikula's paper reported an ambitious study attempting to measure total factor productivity growth for the agricultural machinery industry in Thailand between 1963-76. The assumptions involved in using Solow's model when applied to a somewhat inadequate Thai data base were thought to invalidate the results although other discussants felt that such studies were necessary. Confusion was expressed at a reported productivity growth of -1.36% in table 2 which appeared to contradict a figure of +5.33% in table 3. Paitoon replied that the sample differences accounted for different results.

Ahmed's paper described an input-output model tracing the backward and forward linkages of agricultural mechanization. Thirteen alternate rice systems were evaluated in terms of their overall resource use change in response to a 1% assumed increase in rice demand which must be met from one of the systems. Substitution between systems is not permitted, the land resource somewhat unrealistically is unconstrained and questions were raised as to the non-zero quasi elasticities of systems not using some inputs (e.g. threshers). The need for further runs to test the robustness of presented results was stressed and despite data frailties the general equilibrium approach adopted was thought to have much potential.

Mikkelsen/Langam's paper reported on the preliminary results of a survey of 47 agricultural machinery manufacturers in the Philippines investigating product changes and innovation in machinery designs. Discussion stressed the need for multivariate analysis of the data and asked whether TRRI should play a coordinating/updating role in disseminating manufacturers' improvements to its designs.

Boughton's paper outlined the positive role of energy analysis for different rice systems but stressed that energy ratios have little normative significance. Mechanization in the form of a deep fertilizer applicator could be an appropriate way to change the technology in the event of rising oil and fertilizer prices.

II.1 Land Preparation

Financial Analysis of Power Tiller Ownership in Mariuk Village, West Java, Indonesia

A. Hurun

A study on the profitability of owning a tiller was conducted in Mariuk Village, West Java, Indonesia, during the wet season, 1980. The objectives were to estimate the profitability of owning tillers, to describe the credit system in the area, to identify the reasons influencing farmers in purchasing a tiller, and to identify any technical problems that might influence the profitability of ownership. The results show that the B/C ratio for the gasoline tiller was 1.14 in the wet season and 0.9 in the dry season, and for the diesel tiller was 0.3 in wet season, 0.6 in dry season. The internal financial rate of return was 7.2% for the gasoline tiller and below 1% for the diesel tiller. The breakeven points were 11.3 and 9.7 in wet and dry season for the gasoline tiller, while for the diesel tiller they were 19.3 and 18.6 in wet and dry season. Technical problems included difficulties in finding spare parts and the high cost of replacement parts.

Economic, Technical and Social Aspects of Tractor Operation and Use in South Sulawesi, Indonesia

J. Hafsa and R. H. Bernstein

Mini-tractors have been introduced into South Sulawesi in order to provide additional land preparation power in this relatively sparsely populated province. To better understand the impact of this program, ten individuals in Sidrap and Pinrang Districts who bought mini-tractors in each of the past five years (1975-1979) were interviewed. Information was collected about socio-economic characteristics and various aspects of tractor operations. These data showed that tractor ownership was not economically viable, due to breakdowns and a shorter than expected useful life. Also, utilized capacity of new tractors during their first year of use has declined each year since 1975. This suggests that annual increases in the tractor population has made it more difficult for owners to achieve the capacity utilization level required to cover variable and fixed costs.

A Comparative Analysis of Tractor Contract Operations
in Nueva Ecija, Philippines, 1972 and 1980

C. L. Maranan

Changes in tractor contract operations in Nueva Ecija between 1972 and 1980 were analyzed. Benefit-cost ratios were calculated for two-wheel and four-wheel tractors. The areas serviced for both tractor types were parameterized to determine the level of operation required to break-even. Results showed that, at current contract rates and with current utilization patterns, two-wheel tractor ownership from a purely profit-oriented viewpoint, is not viable. All two-wheel tractor owners were farmers with a main concern to prepare their own lands. Hence, there were many non-pecuniary interests not included in the benefit-cost analysis. No significant difference were noted between the 1972 and 1980 operations. The benefit-cost ratios for four-wheel tractors decreased from 1.24 in 1972 to 0.89 in 1979-80 but remained constant at approximately 0.66 for two-wheel tractors.

Analysis of the Demand for Farm Power
for Small-Rice Farm Agriculture in Nueva Ecija, Philippines

V. Monge and J. B. Duff

The paper attempts to estimate the demand for tractor and power tiller services in Nueva Ecija, Philippines by examining rice farms using mechanized power alone or in combination with draft animals. Estimates of the demand for tractor and power tiller services were elastic which implies that exogenously enforced prices above the market determined rates would result in a substantial decrease in the employment of this input.

Summary of Reactions and Discussion

G. J. Gill

1. Opening remarks

These four papers are thematically quite similar. My comments aim to trace such themes rather than deal with individual presentations. These criticisms should not obscure the papers' many positive features.

Many important policy issues were bypassed or, at best, touched on peripherally. Production aspects of tractorization are only alluded to. The direct labour displacement effects received some attention, although apparently conflicting statements sometimes appear.

Excess capacity in the custom hiring business is widely reported in the papers, but the indirect employment implications are not explored. These implications follow because farmers who own machines may increase utilization by expanding their operated areas through the displacement of tenants, sharecroppers and smallholders.

The papers tend to resemble market research, since they are largely confined to an evaluation of tractor performance and (private) profitability. The evidence presented suggests rather poor performance in these respects. But if this is so, it is curious that farmers should continue to invest in tractors. The following three hypotheses are advanced as possible explanations for this apparent contradiction.

1. Even with overall excess capacity there will be peak periods when demand for ploughing services exceeds supply. The tractor owners, being farmers, will tend to cultivate their own land before putting their machines up for hire. By then, the hire rate will have dropped. To use this latter rate as an estimate of the opportunity cost to the farmer of ploughing his own land first may produce serious underestimates of the benefits of tractor ownership.

2. Seasonal variations in hire rates are usual in Bangladesh, as are seasonal fluctuations in the power tillers' working day. In the peak season power tillers work 20-22 hours per day on a three-shift system. If this also applies in the Philippines and Indonesia, and the peak period working day is longer than that assumed in the four studies (one paper suggests 10 hours per day), again the benefits will have been under-estimated.

3. The evaluation of reports provided by tractor owners may have been insufficiently skeptical. These far from disinterested respondents may have tended to overstate difficulties and costs while understating solutions and revenues.

A final comment concerns Mr. Monge's econometric model. This is an ambitious exercise, but the impression is gained that the data base is

perhaps insufficiently firm. Some of the reported elasticity coefficients, for example, are positive when economic theory would predict negative values.

2. General Discussion

It was pointed out that the Indonesian papers dealt only with certain aspects of a large study. Papers dealing with other aspects would be presented later in the week. It was noted that the papers did not contain a comparison of traditional and tractorized land preparation costs. Several speakers commented on the finding that the West Java sample was evidently located in a labour deficit area, to which it was replied that the Survey Area was fairly unusual in this respect. With regard to profitability, it was noted that defaults on tractor loans were at a high level and that sales had recently begun to fall. Another discussant said that the larger farmers were often the last to repay their loans.

It was noted that benefits and costs had been calculated seasonally in one paper rather than through a complete benefit-cost analysis using shadow prices.

One contributor wondered if the tractors had been "dumped" on the farmers, and noted that farmers are often extremely adept at increasing the profitability of their equipment, by for example using their tractors for non-agricultural purposes. It was observed that farmers were sometimes subjected to political pressures to buy tractors.

It was explained that in South Sulawesi only family labour is displaced by tractorization. The apparent contradiction contained in the relevant paper was due to farmers' perception of a theoretical advantage of tractors. Other discussants agreed with this.

In response to a question as to why, with benefit-cost ratios as low as 0.6, mechanization is still occurring in Central Luzon, it was noted that the rate of adoption of mechanization is declining.

The Impact of Power tillers on Productivity, Employment,
and Income Distribution: A Case Study of Bangladesh

A. H. M. Mahbudul Alam

The impact of power tillers on productivity and employment in Bangladesh Agriculture is studied. There are two main hypotheses. First, the use of power tiller in Bangladesh will increase the per hectare output in

the agricultural sector. Second, the use of power tiller will not reduce the present level of per hectare labour utilization. In order to test the hypotheses data from a sample survey of 120 farm households (user and non-user of power tiller) is used. Results indicate no significant differences in yields comparing the two methods of cultivation. Power tiller cultivation can increase yields by 3 to 5 percent compared to the best draught animal treatment. A total of 17 man-days per hectare were saved if power tiller was used instead of a pair of bullocks in land preparation. Thus the application of power tiller in land preparation has demonstrated a capacity to displace labour (both landless and marginal).

Tractor Use and Changes in Agrarian Structure: An Empirical Inquiry in West Godavari District of Andhra Pradesh, India - Presentation of Preliminary Results

V. Abraham and N. Desinga Rao

A survey was conducted of 8 villages, covering 4 zones, in the West Godavari, District of Andhra Pradesh. This was a follow up of a survey conducted in 1972. Results of the two surveys were compared. These indicated a large increase in tractor use in all zones, and a trend towards increase in ownership of holdings. Use of bullocks and employment of permanent from laborers declined. Occupational shifts away from cultivation were also observed. Associations were found between tractor use and costs in delta villages and tractor use and literacy in upland villages. Farm size affected tractor use in both situations.

An Evaluation of the Farmers' Decision-Making
for Investment in Farm Machinery

M. Munir

Results are derived from a survey of eighty-eight tractor owning farmers in Faisalabad, Pakistan. The study highlights decision-making at the farm level in terms of selection and purchase of farm machinery. The majority of the sample farmers were large land-owners. Investment decisions were made predominantly on the basis of economic factors, but non-economic factors such as expected leisure and prestige attached with tractor ownership also played a vital role. No economic analysis or financial justification was formalized and the perception of benefits frequently led to miscalculation of expected gains. The investment decision turned out incorrect for 18 farmers. Joint ownership was rare and mainly confined to close relatives. Priorities for purchase of the tractor implements and attachments were fixed by visualizing round-the-year use, cost and custom services market. Most of the tractor replacements resulted in increased H.P. Choices of farm machinery were most commonly based on the experience and advice of fellow farmers.

Causes and Consequences of Power Tiller Utilization
in Two Areas of Bangladesh

M. A. Jabbar, Md. S. R. Bhuiyan and
A. K. Maksudul Bari

Causes and consequences of power tiller utilization were examined with data collected from a sample of 63 tiller owners and 56 non-owners. Timely and quick cultivation, difficulty in managing large numbers of animals, low cost, better quality tillage and shortage of animals

were reported as the main reasons for purchasing tillers. Cost was low because of distortions in the prices of tillers and fuel. Unavailability of spare parts and lack of repair facilities were reported as major problems. Tiller use significantly increased the size of cultivated holding, decreased regular labour, evicted tenants, changed tenure status, increased cropping intensity and increased machine orientation of farmers in both of the selected areas. The findings indicated that mechanization of tillage would largely benefit rich farmers at the expense of small and marginal farmers.

Summary of Reactions and Discussion

J. B. Duff

1. Reactions

The four papers presented in this session are in contrast to those given in the preceding one. The content in general provided a good profile of tractor ownership and use pattern in Bangladesh, India and Pakistan. All studies provided a consensus on the following issues:

- 1) There has been a substantial increase in the number of machines over the past decade (highly localized in Bangladesh).
- 2) The evidence indicates little increase in output ascribable to these machines.
- 3) The most apparent direct impact has been a sizeable decrease in the number of animals employed on the farms.
- 4) Direct employment in land preparation has declined in all cases.
- 5) There has been a measurable displacement of tenants from those farms which have introduced tractors in all three countries.
- 6) In all four studies, the provision of credit has had an impact on the number of machines sold and the type of owner acquiring them.

- 7) Maintenance problems attributed to the lack of spare parts appeared to be the most serious technical problem confronting tractor owners.
- 8) Adoption and use of tractors was highly correlated with the availability of assured irrigation supplies.

None of the papers contained an economic analysis of machine use. Extension to include this component would add to their usefulness. Also, in examining the impact of machines on output and employment, no attempt was made to dissect the confounding effects of irrigation, improved varietal adoption and use of fertilizers.

2. Discussion

Discussion first centered upon the fact that bullocks and buffalo continue to be used long after the introduction of mechanization into an area. This may be because farmers wish to avoid the risk of breakdowns, or because the tasks carried out by the machines do not cover all operations (planning, levelling, etc). Furthermore in some areas the cost of maintaining a few cattle is low since many are fed on byproducts or graze non-productive land. The situation varies also with the availability of repair facilities.

Participants then discussed the importance of educating farmers in the costs and benefits of mechanization. This was one area of government activity which should be encouraged. Some programs were clearly inefficient and farmers had suffered. Another area which governments could assist included training of mechanics and machine operators.

Finally discussion centered around the tractor rental market which seemed to be related to increasing farm size. Machine owners are often aware that increased utilization led to more repairs and maintenance with the risk of delays due to lack of spare parts. In some areas farmers travel long distances to get hire customers, whereas in others where there is no excess capacity machines are not rented out.

II. 2 Postharvest

A Comparative Analysis of Thresher Adoption and Use in Thailand and the Philippines

F. Juarez and R. Pathnopoulos

*This paper provides a cross country comparison
of thresher adoption and use in Thailand and*

Philippines. It attempts to trace the history of thresher adoption and diffusion, determine the factors affecting adoption, and measure the private costs and benefits. It is found that factors like irrigation, high yielding rice varieties, farm size and credit facilities affect adoption. However, it is the net positive benefits that induces rapid adoption. Past and future investments were analysed and it is found that benefits are generally positive for owners and users.

**A Technical and Economic Evaluation of Village
Rice Mills in West Java, Indonesia**

H. Siswosumarto

In the past ten years rice milling technology in Indonesia has changed from traditional to mechanized methods. A study was conducted in the Subang and Indramayu Districts of West Java to evaluate the technical and economic aspects of the rice milling sector. The units surveyed typically consisted of a mill, rice huller and a polisher. Ninety-six percent of the rice mills were privately owned. Seventy percent had a capacity of less than 5 quintals/hr and 30 % greater. Small mills operated 190 working days per annum and milled 395 tons of paddy. Large mills operated 214 days and milled 503 tons. Net revenue per ton was US\$5.78 for small mills and US\$3.97 for large. Investment appraisal revealed a breakeven requirement of 362 tons of paddy/year for small mills and 639 for large, together with an internal rate of return of 40% for small mills and 22% for large.

Labour Use Pattern and Mechanization of Paddy
Postharvest Processing in Bangladesh

J. U. Ahmed

In Bangladesh, the economic necessity for small-scale mechanization of paddy processing at farm level does not appear to be strong. This may be attributed to the already low labor requirement in most of the traditional methods of paddy processing, extensive use of low-cost female family labor, and the existing low level of postharvest loss. As a particular case, the analysis reveals that the average of food loss per farm due to wet season drying constraints was much below the level at which the costs of using small-scale driers would equal the gains from saving food by supplementary mechanical drying. Contrarily, custom hullers enjoy commercial demand among farmer users mainly due to their high labor productivity. The custom hullers, however, were found to have caused some employment and income imbalances among the rural poor which may be alleviated by pro-poor development programmes.

Summary of Reactions and Discussion

J. A. Wicks

1. Reactions

Although presenting a common theme of post-harvest activities these studies used widely differing types of analyses. The papers by Pathnopas and Juarez, and Handaka both demonstrated the continuing private profitability of threshers. The reader may be overwhelmed by the mass of results presented and the failure to focus into a few conclusions. Both papers were concerned with the profitability of threshers although note was made of the importance of the social welfare issue.

The paper by Ahmed presented a broader view of postharvest operations but was less analytical. The details of inflow and disposal of paddy for various groups of society clearly demonstrated the discrepancies between rich and poor in Bangladesh. The results clearly suggest that rice mills have resulted in declines in employment, wage rate and net income of the poorer sectors. Alternative activities such as paddy processing and livestock production are suggested for generating income for these people. However,

the capacity of these activities to provide work for the rural poor is not evaluated.

2. Discussion

During the discussion it was suggested that, in Java, the main factor causing the switch from hand milling to rice hullers was to save costs. Now the problem is one of too many mills in the villages. The existence of studies of displaced labor was queried. It was suggested that little is known of this since, with any technological change, some gain and some lose. The losers tend to reduce their consumption whilst remaining in the village. Since they are not conspicuous it is difficult to trace them in order to determine the impact of the technological change. Those who gain are the owners of scarce resources and perhaps policy makers should assist the landless class in obtaining these scarce resources.

Some doubt was expressed about the low post-harvest losses recorded in the Bangladesh study. With the shift towards early harvesting the need for dryers becomes more critical. However, it was pointed out that poorer people have more time to check their stores and can often avoid losses by continuous checking and re-drying before losses become too severe.

II.3 Employment and the landless laborer

The Impact of Handtractors on Income and Employment Opportunities of Migrant Laborers in Java

J. M. Colter

Rice production in Mariuk and Tambakdahan villages, Subang, West Java is becoming increasingly mechanized. This has led to concern over the welfare of migrant laborers. A survey of 125 farmers and 66 migrant laborers was undertaken to determine the current situation. Results indicated that 28% of the labor used in rice production in Mariuk was migrant labor and 20% in Tambakdahan. The migrants tended to be relatively young (average 28 years) with little education and small families. Although mechanization has reduced employment opportunities there still appears to be a labor shortage during the peak period of wet season harvest, dry season planting. The average annual income of migrant laborers was RP81,200, at which RP18,500 came from farm labor outside their home village. Most migrant laborers came from marginal areas in West Java.

The Potential for Agricultural Mechanization
and Labor Markets in East Java

K. Santoso

Primary and secondary data were collected from 120 Kampung in 24 villages in 3 Kabupatens of East Java in order to estimate the need for mechanization. This need was quantified on the basis of a ranking between villages for each of 13 variables. The amount of power currently available for land cultivation and of land to be cultivated was also compared. Results indicated potential for mechanization in most areas. The cost of land preparation by hand tractors was often cheaper than by traditional methods and the time required was less. Finally it was concluded the development of agricultural mechanization will cause little unemployment because of opportunities outside the agricultural sector.

Improved Cropping Patterns, Labor Absorption and
Small Farm Mechanization in Indonesia

W. Collier

Summary of Reactions and Discussion

J.P.G. Webster

1. Reactions

One of the major possible impacts of mechanization is upon the income of landless laborers. If there is a labour-displacing effect it is socially desirable that those displaced have alternative means of support. Without a means of support the consequences to a country of large numbers of unemployed may be serious. So these papers relating to Java, an island with a very high population density and with relatively small farms, are of particular interest.

The three papers are to some extent complementary. Colter's looks at migrant workers, Santoso applies a simple technique for assessing the potential for mechanization whilst Collier adds the essential element of historical perspective to the discussion.

Taking them in order:

Colter first calculated peak labour requirements and showed how migrant laborers enabled these to be satisfied. But my major interest surrounded his Table 6 in which the sources of income of the migrants are listed. Firstly using the average figures given, we can see that about 43% of income comes from agricultural work. This is the income which would be at risk if mechanization took place. Secondly these average figures hide considerable variability. We are told that income varies from 17 to 250 thousands rupiahs - by a factor of 15 or so. Thirdly we are also told that 60% of these people have no land (Annex 4) which means, presumably, that they have zero farm income. Thus it is no easy task to generalize the income-destroying effect for these people of the mechanization of land preparation and harvesting. Some of them would be affected only slightly but others would lose most of their income. This latter group must be followed up if estimates of the social costs of mechanization are to be gained.

Santoso applied a method of appraising mechanization potential in an area. It consisted of two steps. The first one was the calculation of potential area cultivable with comparison of this figure with the actual area to be cultivated. The second was the calculation of a series of indices whose values were ranked. The rankings were then added together to give a final index to each of the areas under study. The magnitudes of the final indices plus the earlier comparison give the indication of potential for mechanization.

The method is subject to a number of serious problems which are listed in the paper. The indices and their treatment is largely empirical and there seemed to be little evidence of the validation of these criteria. Obviously some will be highly correlated and other workers might feel that different weights should be used.

Collier reminds us in an interestedly discursive paper of the time dimension in the mechanization of Indonesian agriculture. He traces through recent history and finishes with a projection of an Indonesian farm using the array of IRRI implements. This reviewer detected a note of optimism. However the improvements seemed to be dependent on fortunate weather and on good conditions in the non-agricultural sector of the economy. The question naturally arises as to whether the change is vulnerable to outside influences. It seemed that Collier was suggesting there were private benefits to mechanization, but also that social costs might not be high in the sense that jobs were being created in the non-agricultural sector. The question then arises as to whether this state

of affairs is likely to last long enough for further mechanization to take place without serious disruption.

2. Discussion

During the discussion there seemed to be agreement that opportunities for off-farm labour in Indonesia had improved. It was pointed out however that 63% of the population was in agriculture and that the expansion of the non-agricultural sector would have to be very large to cope with both the natural increase in population as well as labour displaced by any mechanization. It seems that real wages have risen throughout the economy and the increased consumer demand has led to higher wage employment in the service sector and other non-agricultural sectors. Thus if there is a slowdown of consumer demand or if agricultural incomes suffer, the worst hit will be the landless labourers who form between 20% and 80% of the population of most rural villages. It was also pointed out that agricultural progress tends to go in spurts, so that the perhaps undue pessimism subsequent on poor results in the early '70's should not be followed by undue optimism subsequent upon a few good years.

In reaction to Santoso's paper it was pointed out that job mobility in agriculture is highly important in all regions of Java and Bali, so that the results of the described technique will be inadequate if migrant workers are ignored. Indeed the Indonesian government was reported to be encouraging schemes which provide better knowledge of jobs available for migrant workers.

One participant said that the reported concern for jobs lost if the reaper were widely adopted in Thailand was misplaced. He felt that the non-agricultural industries plus the growing agricultural machinery industry would be well able to absorb any labour displaced.

II.4 Irrigation

The Economics of Pump Irrigation in Eastern Nepal

M. R. Khoju

The impact of pump-irrigation on cropping intensity, resource use and crop yields is investigated, and the profitability of pump irrigation ownership assessed. Data were collected from 189 farms in the terai of the Eastern Development Region of Nepal. Results suggest that pump-irrigation has promoted higher cropping intensity, higher levels of resource-use and higher crop yields. More than 79 percent of the increase in improved paddy, local paddy and wheat yields is attributable to irrigation. Similarly, for 34 percent increase in cropping intensity. Pump-

irrigation also increased employment through increase in labor input per crop and increase in cropping intensity. Net farm income for a 4.54 hectare pump-irrigated farm was estimated at Rs6532 as compared to Rs4003 for a similar sized rainfed farm. The results of the study support the current expansion program for pump-irrigation in the terai of Eastern Nepal.

The Effect of Tubewell on Income and Employment:
A Case Study in Three Villages in Kediri,
East Java, Indonesia

T. Sudaryanto

Indonesia is developing ground water sources for agricultural purposes through the use of tubewells. The effects on farm income and employment, as well as the feasibility of tubewell investment, are investigated. Data were collected from 66 tubewell users, 55 non-users and 30 farm laborers. Users were categorized according to the years of operation. Farm analyses were completed for two alternative cropping systems. Findings were that the introduction of tubewells generated increases in cropping intensity, production and farm income. Increase in income varied with the length of tubewell operation. Financially rice-rice-soybean is better than rice-rice-corn, yet economically the reverse is true. The use of tubewells was financially and economically feasible. Tubewells generated increases in employment and income for laborers. Sensitivity analysis showed that the program would still be profitable to farmers even if paying the whole cost of the environment. Users were categorized according to the years of operation. Farm analyses were completed for two alternative cropping systems.

Economics of Pumpsets in East Java

K. Santoso

A survey of 64 farmer respondents, 8 from each of 8 villages in East Java, was conducted to investigate the impact of the introduction of tubewells. All respondents were adopters and the analysis was conducted on a before compared to after basis. The results indicated that cropping intensity increased after adoption of water pumps, as did the average wages of family and non-family labor. Labor use increased, although the composition altered, there being more male and less female labor employed. Water pump projects were found to be financially feasible with an Internal Rate of Return at approximately 40% for individual farmer and co-operative (KUD) owned pumps and 18% for village managed pumps.

Summary of Reactions and Discussion

P. E. Church

1. Reactions

The three papers on irrigation technology draw on data for analysis from well-designed projects to introduce a specific power pump technology in a specific geographic area to a particular group of users.

The advantage of using data from project evaluations resides in the fact that the study area is often well defined and well documented for the research thus providing a good ready made data base. Also the research can often count on good local cooperation in gathering further data.

The shortcomings of project evaluations derive from the fact that they are often not representative of the target group. Care must also be taken as to when the data is collected to assure the full benefits of the new technology are accounted for.

The three papers serve to illustrate the potential and pitfalls of using project evaluation.

All three authors found that power irrigation pumps has a positive impact on land use intensity, employment and incomes. Two papers also found positive benefits as regards farm labor wages. All three authors, recommended expansion of power pump irrigation in their areas; one took care to qualify his recommendation with suggestions as to how to support better pump irrigation expansion.

Unfortunately, I feel that the authors' conclusions and recommendations cannot be accepted without reservation.

The first reservation concerns the representativeness of the data. The irrigation project in the Khoju study appeared to ignore the large majority of small farmers that make up Nepalese agriculture. The Santoso study had little to say about how representative were the farmer participants though did specify three types of user organization: owners, cooperatives and village association. The Sudaryanto study selected a project site where there was the greatest concentration of pump users but did not seek to determine whether the group was representative.

A second reservation must be raised with regard the phase of development during which the evaluations were conducted and the data were analyzed.

2. Discussion

It was felt that since users go through a learning curve, the point in time at which such studies are carried out will inevitably influence the results. Sudaryanto suggested an eight year period before full production is carried out. Khoju avoided the problem by selecting early adopters. But Sudaryanto and Santoso were perhaps both handicapped by the newness of their wells.

In addition since it appears that all the projects were undertaken in protected economic environments, it is not possible to judge whether or not the projects should be replicated on the basis of the illustrated internal rates of return. Further analysis of the social costs and benefits is needed and even a description of the subsidy and pricing policy would aid the reader. However Sudaryanto does attempt to deal with some of these issues in his sensitivity analyses.

III. Major Studies of the Impact of Mechanization

III.1 Central Luzon

Consequences of Farm Mechanization Project
Site Description: Philippines

P. Moran and E. Camacho

A brief description of the sample areas and villages selected for the Consequences of Farm Mechanization study in the Philippines is presented. Data came from the household census in March 1979 and household surveys in the 1979 wet season and 1980 dry season. Results show that there were no significant differences across villages in the demographic characteristics of households, average farm area and land use. Marked differences were seen when villages were compared in terms of irrigated area, cropping intensity, land tenure, degree of mechanization and assets. The degree of mechanization, measured in terms of area plowed by machine, was found to be closely associated with irrigation, cropping intensity and assets.

Effects of Mechanization on Intensity
of Land Use

A. Generalla and A. M. Aguilar

Use of land under different types of farm was analyzed. Farming activities of 42 Farm Record Keeping Cooperators were gathered for two cropping seasons. The farms were characterized as to topography and soil type, source of water supply, farm size, average area cultivated and production. Farm machines and draft animal ownership and tenure status of the farm operators were determined under the farm classifications. The findings revealed that rice-rice is the dominant pattern in the gravity irrigated areas. The cropping pattern for the rainfed and pump irrigated farms is still rice-rice but the dominant pattern is rice-fallow because only those who have access to supplementary irrigation from creeks grow second rice crop. Cropping intensity was found to be significantly different between the mechanized and non-mechanized farms at 1% probability level. Mechanized farms when grouped together regardless of the source of water supply gave an almost similar turnaround time to that of the non-mechanized farms.

Production Effects of Mechanization

Y. Tan and J. A. Wicks

The impact of farm mechanization on output was assessed using decomposition analyses. An arithmetic decomposition technique was employed to disaggregate output differences, between mechanized and non-mechanized farms, yield, price, area and cropping intensity components. Results showed the most important factors were cropping intensity and yield. The yield effect of mechanization was then investigated by using a decomposition technique derived from a production function framework. Total yield differences were decomposed into the effects of neutral technological change, non-neutral technological change, and change in the use of inputs component. The results of the analysis showed that the major source of yield differences between the two farm types was brought about by non-neutral technical change, i.e., shift in the slope coefficients of the production functions. The cropping intensity effect of mechanization was further investigated using covariance analysis. Results of the test showed that this was modified by the impact of irrigation and credit availability. Even so mechanization increased cropping intensity significantly.

Farm Labor Utilization and Employment in Two Selected Municipalities in Nueva Ecija - - A Preliminary Analysis

J. F. Sison and P. B. Moran

Mechanization of small rice farms may be assessed in terms of its impact on land preparation labor requirements. Although it is difficult to solely attribute the findings to mechanization, the study shows that farms using two-wheel tractors exhibited significant reductions in labor use for land preparation as well as for all other farm operations. This decline implies that no offsetting effects in labor utilization in other operations, such as post-production were evident in spite of higher yields produced by mechanized farms. However, it is inappropriate to ascribe this yield-difference to mechanized land preparation since a variety of factors, including higher levels of chemical and fertilizer application by mechanized farms, may account for this difference. In spite of its analytical weaknesses, the study provides important information regarding differences in labor utilization and employment between mechanized and non-mechanized farms.

Summary of Reactions and Discussion

R. S. Fieldson

1. Reactions

These four papers provide a detailed analysis of mechanization in Central Luzon but would benefit from a broader methodological approach. Cross-sectional analysis of survey results inevitably encounters the problem of isolating the effect of mechanization from those of other factors, especially where multicollinearity or specification problems prevent their complete elimination in multivariate analysis. Other approaches may therefore be useful, e.g. case studies, unstructured discussions with groups of farmers, and full consideration of technical factors.

For example, agronomic and agricultural engineering trials have provided little evidence of any link between mechanization and yields. Nor is mechanization likely to influence cropping intensity unless it reduces turnaround time, which Generalla and Aguilar show is not the case. So the suggested relationships between mechanization and yields and cropping intensity may well be spurious.

The need for a broader view of the social context of mechanization is emphasized by the findings of a recent major farm power study of Sri Lanka. For instance, it showed that tractor owners tend to be the most influential members of society, able to obtain land near the headworks of irrigation schemes. Poorer farmers at the tail end are more likely to be buffalo-users, and also to suffer from water shortages. Hence, yield differences appeared to result from differences in water reliability rather than power source. The findings of Sison and Moran largely concur with those of similar work in Sri Lanka, especially that predominantly family labour is displaced by mechanization.

A broader analysis of the economics of mechanization is necessary if results are to be relevant to policy-makers, and a social benefit-cost approach is advocated.

2. Discussion

Miss Tan pointed out that her first decomposition model permits the quantification of the various contributions towards higher output. The technique was supported as an accounting method of identifying the areas which require closer investigation.

The need to examine changes over time in variables such as farm size and cropping intensity was emphasized. Such recall information was in fact collected during the survey, but excluded from the analysis because

of doubts over its reliability. There followed a discussion on the feasibility of obtaining reliable recall data in survey work, group interviews and informal discussion were advocated.

It was suggested that even if turnaround time is not reduced by mechanization, it may ensure better land preparation and so give the crop a better start resulting in earlier harvest. Certain data was questioned in Sison and Moran's paper, which showed that mechanized farms have 40% higher yields but 20% lower post-production labour input.

Mr. Sison attributed this apparent anomaly to differences in thresher ownership between the groups, and went on to clarify how the mechanized and non-mechanized groups were defined.

It was asked why a price effect was included in Tah and Wicks' analysis of output changes, and Miss Tan explained that this was intended to pick up any differences in prices to farmers resulting from differences in their distance from the market.

III.2. Thailand

Consequences of Small Farm Mechanization Project Site Description: Thailand

L. Niyomvit and S. Sukharomana

The details in this description come from the household census in December 1978 and survey data for wet season 1979. The results show that demographic characteristics were no significant different. Average farm size per household was about 4.95 hectares. Rice cropping area and average yield per hectare for all rice varieties in the irrigated area were higher than rainfed area. High correlation was found between machine using and the level of water control. Among the seven village sites, Plubplachai, village 3, is the highest average employment and income from off- and non-farm.

Effect of Mechanization on Intensity of Land Use: Thailand

L. Niyomvit and S. Sukharomana

Average farm size was found to be higher in mechanized farm than non-mechanized one, both in irrigated and non-irrigated areas. The cropping pattern was not affected by mechanization under either conditions. The major reasons for using machine in land preparation were to plant on time, no human/animal labour available and to save time.

Effects of Mechanization on Employment
and Intensity of Labor Use

A. Wongsangaroon Sri

The objective of this study is to investigate the effects of mechanization on output and farm employment in Thailand. Observed output difference between mechanized farms and non-mechanized farms were disaggregated into their respective elements namely planting method, yield effects and interaction terms, using decomposition techniques. The results show that the differences were mainly due to the planting method. Secondly, farm employment was investigated using graphical analysis. Results show that the introduction of tractors in rainfed areas decreased farm employment but in the irrigated areas the analysis was inconclusive.

Summary of Reactions and Discussion

W. Chancellor

1. Reactions

The papers serve as a particularly clear illustration of how difficult it is to describe with words and tables an agricultural environment with a great deal of physical variation - both from place to place and from one year or season to another.

The data are presented for the wet season only, because of severe drought during the dry season which prevented any significant agricultural activity. Such droughts must be considered in farmers' decision-making. How can we represent such realities in our work?

There appear sometimes to be tenfold variations in yield, even in the wet season. In some low yield cases the farmers barely obtained yield equal to the seed they used. Are such occurrences usual? Do farmers have alternatives? Do tractors or pumps permit the avoidance of these low-yield occurrences, or do low yields keep farmers from being able to afford or utilize improved inputs?

These large variations associated with the production scene tend to dominate the response indicators of the analytical techniques used - analysis of variance and decomposition. In these techniques the effects of different varieties and of various levels of fertilizer use are not considered simultaneously with planting method, mechanization and irrigation.

It would be of interest to know more about the farmers' decision-making process with respect to variety selection, fertilizer use, planting method selection, tractor use, irrigation facilities water availability and field conditions - all of which he must consider simultaneously. Case studies of representative individual farm development would be of much help in interpreting the data reported.

2. Discussion

Although a very small percentage of farmers made changes in cropping patterns it was thought to be of interest to know the nature of those changes. The most common type of cropping pattern change was for the farmer on rainfed land to substitute some upland crop for rice when it was found that the principal seasonal rains were one month late.

A comment was made about the unusually diverse nature of agriculture in Thailand and the difficulty of bringing out the features of development change using only the data sought in the multi-country questionnaire. The development of a historical statement for the area covering the development period under consideration was thought to be a way to augment the data obtained so that interpretation might be more easily made.

III.3 West Java

Consequences of Small Farm Mechanization Project Site Description: West Java

Y. Saefudin

Subang and Indramayu Districts West Java were selected for the survey because of the extent of rice production and the presence of a significant number of tractors. Initial results indicate that the villages are homogeneous with almost all of the land irrigated and growing modern rice varieties. By mechanization category, minor differences only were found for social characteristics and rice yield. The major differences between groups were that mechanized farms are much larger and include a higher percentage of owner occupied land than the non-mechanized farms.

Effects of Mechanization on Intensity of Land Use, West Java, Indonesia

H. Siswosumarto

Increasing cropping intensity makes it possible to raise total production on a fixed land base. The mechanization of land preparation is often suggested as a means by which this goal can be achieved. Over 250 farmers who prepared their fields using men, animals and power tillers were interviewed in Subang and Indramayu District, West Java, Indonesia in 1979-80 to evaluate the relationship between power source and cropping intensity. Analysis of the data showed that mechanized farmers had only slightly higher cropping indices than non-mechanized and that non-mechanized farmers prepared their fields more rapidly in the wet season, but slower in the dry season than mechanized farmers.

The Effect of Mechanization on Productivity in West Java

R. S. Sinaga

The mechanization of land preparation has been expected to increase rice yield/ha. A study was undertaken in West Java in 1979-81 to evaluate the impact of mechanization on yields. Results of this research showed that after adjusting for crop failure and differences in fertilizer application there was no evidence to support the expectation that mechanization increases yield.

The Impact of Mechanization on Production and Employment in Rice Areas of West Java

A. Sri Bagyo and J. Lingard

The effects of mechanization on production and rural employment in the rice areas of West Java were analysed using three different methods. A t test indicated that fertilizer use was higher on mechanized farms. In contrast, mechanized farms used less pesticides than non-mechanized farms. Although labor use per hectare per season was lower on mechanized farms, the total annual labor use per farm was higher due to big area differences. Mechanized farms had a lower cropping intensity. Decomposition analysis was used to investigate the impact of mechanization on production and total labor use. Results showed the most important explanator to be area, while yield and cropping intensity had only minor effects. The area effect also gave the highest percentage contribution to the total labor use. Regression analysis was used to further determine whether yield differences were mainly due to mechanization or to other factors. Results again showed farm size and fertilizer use were the main explanators, mechanization dummies were small and insignificant and pesticide use was both significant and negative.

Summary of Reactions and Discussion

L. A. Gonzales

1. Reactions

I feel that the Saefuddin paper should have provided more policy background information concerning mechanization. There must be some policies in Indonesia that more led to this massive adoption of machines despite their low benefit-cost ratios as discussed earlier. Saefuddin however does describe the sites within the context of the Indonesian economy.

The Sinaga paper is a very simple analysis of whether mechanization adoption significantly increases yield. His conclusion, using the survey data was that mechanization adoption has no effect on yield. His analysis however does suffer from methodological flaws. One is his assumption that the fertilizer responses are the same (i.e., 1 kg of fertilizer = 10 kg of paddy) for both mechanized and non-mechanized farms. With different levels of fertilizer use, and with a common (non-linear) fertilizer response function, mechanized and non-mechanized farms are bound to have different responses. Furthermore his assumptions imply that land qualities for both are the same.

The Handaka paper demonstrated that cropping intensities of mechanized farms are relatively low. I think the definition of cropping intensity could be cleared. One reason perhaps why it appears low may be that secondary crops were not included. Table 4 is not very clear. He should specify "percent of what" under the area prepared. He however provide data on the cropping pattern during the period covered by the survey.

Finally, the Sri Bagyo paper is a refinement in both classification of mechanized farms as well as techniques in analyzing the impact of mechanization. He used three different techniques - t-test, decomposition analysis and production function - which gave differing results but nevertheless shed some light on the controversial mechanization issues. I hope that he continues this type of methodological experimentation until some real indicators for policy formulation emerge.

The Sri Bagyo paper does not appear to reconcile with those of Sinaga, Saefudin and Handaka. Particular attention should be focused to his analysis of the 1980 dry season data where he affirmed the non-existence of pest and infestation. The other papers which analyzed the same data all showed that during the same period, stemborers and rat infestation destroyed 24% of crops.

2. Discussion

Discussions during this session were directed to the question of why there were low cropping intensities in the areas (particularly West Java) where tillers and tractors were introduced. The assumption of the government that farmers would grow a third rice crop when tillers and tractors are available, does not hold for several reasons. One reason was to the inadequacy of irrigation water. A second was due to the incidence of rat infestations in the survey areas. A third was the lack of seedlings.

The issue of methodology was also touched. Whereas it was important to do simple analysis when interacting with policy makers, several methods (e.g., t-test, decomposition analysis, production function, etc.) should likewise be encouraged to evolve a consistent set of findings for policy decision making. The analyst must be able to interpret the results of his research.

The consensus was that there appeared to be no impact of power tillers and tractors on yield. The critical issue upon which there was agreement was the economic undesirability of tractor and tiller adoption in an area where the man-land ratio is very high.

III. 4. South Sulawesi

Consequences of Small Farm Mechanization Project Site Description: South Sulawesi

Y. Maamun

The objective in this paper is to provide information of the site selection of the Consequences of Mechanization Study. A combination of random and purposive sampling procedure was used to determine the representative sites in South Sulawesi.

Eight villages were selected in two districts for the research which involved an extensive survey, farm recordkeeping, case studies and price and wage monitoring. Data were collected from 1979 (wet season) through 1980/81 (dry season) for more than 300 households in mechanized and non-mechanized farms and in two different environments, irrigated and rainfed.

Effect of Mechanization on Intensity of Land Use
South Sulawesi, Indonesia

I.G.P. Sarasutha and P. Bernsten

Increasing cropping intensity is one way to increase production on a fixed land base. Mechanized land preparation may contribute to this objective. During 1979-81 over 250 farmers in Sidrap and Pinrang Districts, South Sulawesi, were surveyed and farm activity records were maintained on 70 respondents, stratified to represent the major non-mechanized and mechanized land preparation techniques used. The data indicated that mechanized rainfed farmers had higher cropping intensities than the non-mechanized, but for irrigated farmers there was no difference. In the wet season, non-mechanized farmers generally prepared their fields more rapidly than those using a mini-tractor. For the districts as a whole, the increase in mini-tractor numbers did not cause an observable increase in cropping intensity.

The Effect of Mechanization on Productivity in
South Sulawesi

R. S. Sinaga

The mechanization of land preparation has been expected to increase rice yield per hectare. A study was undertaken in South Sulawesi in 1979-81 to evaluate the impact of mechanization on yields. Results of this research showed that after adjusting for crop failure and differences in fertilizer application there was no evidence to support the expectation that mechanization increases yield.

Effects of Mini-Tractor Mechanization on
Employment and Labor Use Intensity, Sidrap and
Pinrang, South Sulawesi, Indonesia

R. H. Bernstein

The mechanization of land preparation can be expected to reduce labor requirement/rice crop. In order to evaluate the magnitude and nature of this impact, a farmer survey was conducted during 1979-81 in Sidrap and Pinrang District, South Sulawesi. Respondents included non-mechanized and mechanized farmers in rainfed and irrigated environments. The data showed that while mechanization reduces human/animal land preparation labor requirements, this is primarily family labor. Consequently, mechanization improves farmers welfare by freeing family labor for alternative work opportunities or leisure activities.

Summary of Reactions and Discussion

B. Lockwood

1. Reactions

The four papers present some results from the South Sulawesi component where the main types of machinery were mini-tractor plus a few power tillers.

The first paper described the study site and outlined the sampling methods. I felt that there could have been more information given about the Sidrap villages since there was considerable variation (20 to 90) in the percentage of farm households. Village TT in Sidrap seemed to be rather unique and since it provided almost all the mechanized dryland farms some further description seemed warranted. In addition there was confusion between the total population of households (9719), the "total sample" in table 7 (1794) and the "sample survey" (290). Again, some clarification appeared necessary.

The machines are only used for land preparation and they appear to halve the labour input required. There appears to be little effect on the cropped area. I am surprised that the tractors are not used more with trailers.

The results concerning intensity of land use seemed clear enough. But those relating to productivity appeared to raise many issues. The tractor users also used larger amounts of other inputs but after accounting for fertilizer and crop failures they get lower rice yields than the non-mechanized farms. Why should this be so? Finally, why were the mechanized farms less subject to crop losses?

2. Discussion

During the discussion it was emphasized that the area as a whole had a relatively low population density with a land frontier in the neighbouring region. Questions raised included whether labourers can get new land, whether the main contribution of tractors was in expansion of the area in regional terms, and the suggestion was made that further analysis be made concerning labour supply available to the farmers. The point was made that tractors in S. Sulawesi replace family labour whilst in Java they replace hired labour. If children are hired their time may be devoted to schooling if not all the family has to contribute to household income in order to keep it above subsistence levels.

IV. Industry Studies

The Impact of Economics Upon the Design of Machinery at IRRI

C. W. Bockhop and M. L. Nafziger

Research has shown the need for mechanization to optimize the production of the small farmer. However, serious constraints face the designer of farm machinery in developing machines that are economical for the farmer and can be produced by the small entrepreneur in the developing country.

Machines provide the farmer the means to produce beyond his own needs. However, there are severe restrictions on the designer to develop effective, easy to operate, easy to maintain machines which will provide a return on his investment. The economic constraints extend to the design of the machine elements. The result is a large number of individual design decisions, all of which have an economic element, culminating in a machine which will do the task effectively yet at a low cost.

The designers decisions also determine whether or not a machine can be economically produced by the manufacturer who may be limited in his production capabilities but must also reap a reasonable return on his investment.

The Domestic Resource Costs of Agricultural Mechanization in Thailand

S. Sukharomana

Farm mechanization, especially expansion of labor displacing technologies within rice production, will simultaneously reduce the use of domestic resources and increase the demand for imported input such as fuel oil, power engine, spare and parts of machine. The effects of farm mechanization on domestic resource of earning is less than the effects of yield and the opportunity cost of land. Mechanization has a tendency to generate profits for society even though it increases the demand for imports of machinery related items.

Economic Analysis of Farm Machinery Industry and Tractor Contractor Business in Thailand

S. Wattanutchariya

The purpose of this paper is to add information on farm mechanization in Thailand by looking at the local farm machinery industry and the economics of using farm machinery in the case of hired service. The local farm

machinery industry, developed during the past two decades, is now facing high competition both within the country and from abroad. It is the duty of the government to decide whether this industry should be truly supported in order to develop its potential and to provide farmers with low-cost machinery. The tractor contractor has generated farm mechanization throughout the country. The study showed some profitability among contractors. However, due to increase in operating cost and competition, the contractor is making less profit while the farmers still have to pay high custom rate.

An Assessment of Capacity of Workshops and Farmers
to Repair and Maintain Farm Machinery in
District Faisalabad:

Summary of Major Findings and Policy Recommendations

K. A. Hussain

Facilities for repair and maintenance of farm machinery, in District Faisalabad, were evaluated. Machinery breakdowns were concluded to be caused predominantly by improper use and ability to maintain machines was found to be poor. Forty-seven repair shops, employing a total of 211 persons, were surveyed. This provided the basis for a set of recommendations on the need for farmer training in the operation and maintenance of machines, improved training for mechanics and improvements to the capacity of workshops and supply of spare parts.

Summary of Reactions and Discussion

V. R. Reddy

These four papers deal with design and development work at IRRI, farm machinery developments in Thailand; its domestic resource costs, and lastly the adequacy of repair and workshop facilities for farm machinery in Pakistan.

The IRRI farm equipment technology presently caters for farms of up to 10 hectares. The machines can be built and repaired by small workshops located in the semi-urban towns of many developing countries. However, IRRI is now addressing itself to develop manual and animal operated equipment suitable for one to two hectares of cropland. IRRI should also develop alternative energy sources using animal and crop wastes, etc., and also investigate such problems as the establishment of plants with minimum tillage deserve intensive research efforts.

The second paper is concerned with the indigenous farm machinery industry in Thailand. It traces the impressive growth over last two decades. Presently, however, there are signs of a slower growth rate in this industry mainly due to increases in fuel price and competition. The author could perhaps have compared the costs of land preparation and of threshing using carabao and difference in traditional and mechanical means.

By using a set of earlier published data, the author of the third paper comes to the conclusion that the best alternatives for Thailand are the locally made 4-wheel tractors and threshers.

The fourth paper, a study of repair facilities in Faisalabad, Pakistan, makes a series of recommendations to decrease the downtime of farm machinery due to inadequate repairs and maintenance facilities. The problem is aggravated especially when several brands and sizes are imported from different countries and are dispersed widely. The solution lies in the use of local technology as far as possible and the standardization, through government policies, of sizes and brands of imported items. It is observed that in the case of motorcycles and automobiles (which are imported into most third world countries) the repair and maintenance facilities seem to develop, even in remote areas, as demand increases.

Evaluating the Sectoral Impact of Mechanization on Employment
and Rice Production in the Philippines:
A Simulation Analysis

L. A. Gonzales, R. W. Herdt and J. P. Webster

The paper reviewed three existing Philippine mechanization policy instruments, namely, credit subsidy, tax/tariff and fuel subsidy and analyzed their impact on the sales of five types of machines. These policy instruments are presently incorporated in a policy analysis model being developed at IRRI to evaluate their impact on production, employment and income distribution in the rice sector.

V. Current Status and Future Plans for Consequences of Mechanization Project.

Data Management for Analyzing the Consequences of Mechanization

J. A. Wicks and M. Sumiran

Data management provides the link between the raw data set and the analytical process. With the complex sets collected in the Consequences project data management is not an easy process. In this paper we review the various basic requirements for effective data management and then examine the alternative approaches from raw data storage through to specific data handling packages. It is proposed that the best way to handle the data in order to satisfy project requirements is to simultaneously run FMDCAS and develop more complex systems.

An Evaluation of Mechanization Data Using the FAO's Management Data Collection and Analysis System (FMDCAS)

J. P. G. Webster

This paper has two major purposes. For readers directly concerned with the 'Consequences of Mechanization' project the aim is to provide a critical commentary on the strengths and weaknesses of information produced by the FMDCAS. The appendices contain some detail about the operation of the programs. Secondly, for readers outside the project the aim is to provide a record of the implementation of FMDCAS in the 'Consequences of Mechanization' project at IRRI; to give an idea of the modifications which were adopted and their consequences upon the use of the system. The paper opens with a brief introduction to the FMDCAS system. There follows an outline of the modifications, together with a discussion of some of the problems encountered in their implementation at IRRI. Finally there is discussion of the strengths and weaknesses of the FMDCAS in relation to the study of the consequences of mechanization upon small rice farms.

Measuring the Impact of Mechanization on Output

J. Lingard

The impact of agricultural mechanization on output will vary with the form of machine, the on-farm resource situation, season, region, soil type, etc. and the institutional structure (pricing conditions) of agriculture. The primary impact of mechanization will manifest itself in a changed farm input structure leading to possible output differences between mechanized and non-mechanized farms. Attributing that part of the output difference due to mechanization alone is however difficult for there are many confounding factors. A production function approach using covariance analysis (dummy variables) is described and this is applied to Philippine survey data and initial results presented. Linear isoquants showing rates of substitution between animal and machines during land preparation operations are also estimated. A power tiller day substitutes for 2.5 carabao days whilst a tractor day is equivalent to 4.6 carabao days.

Summary of Reactions and Discussion

R. Bernstein

These papers dealt with the strategy being used to process and evaluate the large survey data sets collected by cooperators in Indonesia, Thailand and the Philippines.

Wicks and Sumiran outline the desirable characteristics of a data management and analysis system, followed by a description of the approaches being used at IRRI. Since there are many potential data users residing in several countries, the paper gives the impression that IRRI should design a generalized system that meets the needs of all potential users.

Most of the immediate analysis will be done at IRRI in conjunction with graduate students from the cooperating countries. Consequently, available programming resources should be directed at developing a system that will permit immediate access and analysis of the most important variables by Los Baños - based investigators. In part, this will be achieved when the FMDCAS system is fully operational.

Webster's paper provides a detailed description of the FMDCAS system, including difficulties that have been encountered in modifying the programs to generate the output required for analyzing consequences survey data. These insights will be invaluable to other researchers who have an interest in adopting FAO's general survey questionnaire and analytical package.

Lingard emphasizes that in future analysis, investigators must focus on developing multivariate models to untangle the numerous related factors that affect variability in cropping intensity, labor use and production. Introducing dummy variables is proposed as a particularly appropriate way to measure the independent contribution of mechanization. Several models are presented and it is suggested that these could be estimated for each data set to generate initial cross-site comparative results. While this strategy is sound, the models estimated include only dummies for power source and 2-3 additional independent variables. Given the number of variables for which data was collected, it seems that the models should be specified in more detail. This is necessary to control for a wide variety of variables associated with power source whose influence is now captured in the dummy variables.

Summary of Reports of Working Groups

J. Lingard^{2/}

The 4 site groups reported back separately on their deliberations although several common points emerged. A general case was made for:

1. Documentation of all significant crop year events so that data files can be both used and interpreted correctly in future research. The necessary background and milieu studies should be fully written up in the near future for reference purposes. A mechanism should be set up to contact enumerators should they be needed.
2. Individual site studies to emphasize the unique advantages of the chosen sites; for example, S. Sulawesi should focus on aspects dealing with land use at the frontier in relation to its low population density and Thailand on issues connected to its relatively advanced form of machinery adoption.

^{2/} This section is a synopsis of the reports of discussion groups presented by D. Boughton, P. Church, R. Fieldson and K. Mikkelsen, together with the final discussion of these reports.

3. Careful coordination of the project from the centre particularly with regard to work covered by the various student theses. Where possible, duplication of effort should be avoided and the necessary gaps plugged by additional studies.

The specific site recommendations are summarized below although it was recognized that many suggestions for further work were not within the capacity of the current project and priorities would have to be set in the near future to match the available resources to the specified objectives.

Thailand

Two major points were stressed for this site:

- i) The continuing 2nd survey means that some redesign is still possible.
- ii) Mechanization is already well advanced therefore with/without comparisons are not too easy nor particularly relevant.

The primary focus of the 81/82 survey and analysis of the 79/80 data should be on the effects of mechanization on different participants in the process rather than on the differences between participants and non-participants. Recall data should be collected to determine what mechanized farmers did prior to adoption and to determine the short term effects on the participants in the mechanization process.

Hypotheses thought to be important were:

- a) Employment - investigate the impact viz hired/family, crop/noncrop, children/women, wages and non-farm linkages.
- b) Production - look at cropping patterns (over time), the issue of losses and the role of timely input supply.
- c) Income - examine the costs of production and off-farm income

It was thought particularly appropriate to examine the machinery manufacturing and service industry with respect to its

1. Evolution - many manufacturers come from farm background
2. Interface - how responsive is the supply of manufacturers to demands by the farm sector
3. Macro policy - finance; tax and tariffs; quality control and standardization; small vs. large manufacture;

How would one evaluate the role of macro policy in the industry's development?

4. Energy - development of alternative sources

S. Sulawesi

Output related hypotheses were thought to be most important, employment aspects less so. Of high priority are hypotheses concerning the effect of mechanization on yield (via reduced losses due to late season drought) and on cultivated area arising from land reclamation over time. Does the proportion of farmland cropped increase with the level of mechanization? Income related hypotheses covering both the average costs of production and farm household income are of high priority.

The effect of mechanization on labour use in machinery manufacture and service support should be investigated, and further investigation of the constraints to tractor profitability are of immediate concern. Tractor hire enterprises appear to have potential benefits for the area but profitability is low and an investigation into factors impairing the viability of tractor hire services, drawing on both the completed case study and supplementary information from policy makers should be included in the report.

West Java

It was felt that there is currently a need for detailed descriptive work of the survey area based on the experience of the field-workers, so as to provide a social, cultural, and physical background to quantitative work. "Scenarios" giving the researchers' perceptions of the main changes facing typical mechanizing farmers and laborers formerly employed by mechanizing farmers are required.

Income effects have been neglected so far, and there are no data on landless labor with respect to those displaced by mechanization or on workers out of the site area.

Employment effects are of particular concern in a high population region such as West Java, and other issues to be investigated are resource-use and productivity and wage levels. Post-harvest operations and linkage effects are very important but it was felt that such aspects are inadequately covered in the present data set.

Other points included the need for due attention to land-tenure.

Philippines

Two main points were thought to be of special importance.

1. A Mechanization Policy Body now being set up would direct requests for information to IRRRI groups although the consequences study work is recognized to be of limited generality to the Philippines as a whole. IRRRI would play an important role liaising with the new Policy Council.
2. A characteristics study of the site is now required to allow more general conclusions to be drawn.

Future work on employment should be expanded beyond the machine or task level to the farm/community level.

More emphasis on threshers and not just tillers is required.

Timeliness issues should be developed in cooperation with agronomists; what are the costs of delays?

It was also felt that the census results and the experiences of survey personnel have been largely untapped.

Future Plans

Assignment of future responsibilities was discussed along with the questions of who will put the results together and how? Analytical resource constraints were continuously stressed particularly the shortage of country coordinating personnel.

Finally the question was posed as to who is the client of report? - USAID or Country Ministers? Different audiences perhaps require different reports.

The immediate short term need is for the quick establishment of a production line for 'numbers' to perform multivariate analysis. The FAO program was nearly ready and work on establishing an SAS data base should proceed immediately. Report writing will flow from the analysis and as time progresses any emerging gaps in the above areas filled. The future presents a challenge!

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