Do agricultural technologies help or hurt poor farm women?

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With the advent of the Green Revolution, machinery use in rice production has increased across Asia, both for land preparation and for post harvest operations. The rapid spread of machines for these operations has led to a debate on their impact on rural poor and landless women. Debate centers on several propositions such as: a) poor and landless women have lost jobs and income earning opportunities; b) machines favor men more than women and traditional female tasks are taken over by men; c) at the same time proponents have argued for a reduction in drudgery. Despite this often emotional debate on the negative effects of engineering technologies on farm women and the need for labor enhancing technologies, there has been little research explicitly examining or reviewing the framework or conditions under which engineering technologies can help or hurt poor farm women.

Objectives of this paper are: a) to discuss the dilemmas in introducing engineering technologies to farm women; b) to present a framework for assessing their impact both positive and negative; and to c) identify the conditions under which engineering technologies can help poor farm women.

DILEMMAS IN ENGINEERING TECHNOLOGIES AND FARM WOMEN

Have poor and landless women lost jobs and income earning opportunities due to mechanization?

If an analysis of labor displacement is done for the one specific task for which the machine has been introduced the answer is always yes. That is almost by definition. For example, if hand threshing is replaced by a mechanical thresher one would observe a dramatic decline in threshing labor hours. Does this mean that the women formerly employed for threshing are no longer gainfully employed? The answer is no. Mechanical threshing has resulted in faster turn around time and therefore contributed to an increase in cropping intensities, the net result of which, has been an increase in employment of landless labor for transplanting, weeding, and harvesting activities. ***Therefore the net gain in income due to the introduction of a mechanical thresher has been positive under most circumstances.***

The few circumstances where there has been no net gain in employment have been those where social, cultural, or political restrictions have prevented displaced labor from being re-absorbed in other agricultural or non-agricultural tasks. For example, the story of the *dekhi* in Bangladesh is often cited as a case where mechanization had a negative effect on poor and landless women. While the

replacement of the *dekhi* with a mechanical rice mill resulted in substantial labor savings (and increased leisure) for women pounding grain for home consumption, it resulted in greater impoverishment of women whose income was dependent on hand pounding services. These women were culturally restricted from seeking employment outside the confines of their homesteads.

A similar replacement of the *dekhi* with a mechanical mill did not result in negative income effects in Indonesia, since the displaced women gradually moved to off-farm employment opportunities.

Assessment of implications of machinery on employment has to be done in a holistic sense rather than the marginal confines of the operation under question. People, especially poor households, are flexible. They move and adjust as market opportunities open up.

Do machines favor men more than women and are traditional female tasks taken over by men?

The transfer of traditional female tasks from women to men is not wrong per se. If we accept that "traditional" female tasks impose high levels of drudgery then a release from these tasks is beneficial. The question that needs to be asked is: Do the displaced women have alternative employment opportunities? Experiences with the mechanical thresher and the micro-mill in the Philippines are cases in point. In Iloilo, Philippines, the introduction of mechanical threshers had relieved men and women of the drudgery of manual threshing. The thresher also reduced the turnaround time and enabled rice farmers to grow a second crop of rice. The introduction of this technology led to an increase in total employment as there was a consequent increased demand for labor for transplanting, weeding, and harvesting (two crops instead of one). The net benefits of increased output, employment, and lower food prices were substantially greater than the small loss in manual labor opportunities for threshing. The micro-mill introduced in the remote upland areas in Eastern Visayas, Philippines relieved farm women of the monotonous and arduous time of handpounding grains (Alcober, 1993).

Is reduction in drudgery always a valid argument for promoting mechanization?

Empirical studies on the women in Asian agriculture revealed that rural women from resource poor families work longer hours than men in order to fulfill their dual productive and reproductive roles. Aside from providing physical labor in crop and animal production activities, they have to perform daily sustenance activities such as collecting water for domestic use and collecting fodder for the animals requiring them to spend long hours away from their homes. They perform these responsibilities with little or undervalued knowledge and poor, outdated tools and equipment. Thus, there had been a clamor from female advocates and scholars for agricultural engineers to spend more time and money on developing some technologies specifically to reduce the drudgery of women's work (Stephens, 1985).

Where machines can reduce time spent by women in food processing activities such as making rice flour, then the benefits are positive because time saved in manual methods of processing can be spent on more productive household activities, leisure or in market employment. However, there are laborious operations where mechanical substitutes may be available, but the net effect need not be positive. For example, in low wage countries, India or Nepal, the mechanization of transplanting, weeding, or

harvesting may result in a loss of employment while reducing drudgery at the same time. Once again, generalizations cannot be made without examining the complete picture.

CHANGING TRENDS WHICH AFFECT FARM MECHANIZATION

The demand for agricultural labor and therefore, demand for mechanical innovations are highly interlinked with global, regional, and national economic trends. The successful implementation of General Agreement on Tariffs and Trade (GATT) will have enormous implications on food production systems across Asia. As we plan for the future of mechanization we need to be cognizant of these trends and their implications for labor supply and the profitability of mechanization.

Declining agricultural labor supply and increasing wage rates in the rural areas due to urban migration.

As economic development takes place there is a general withdrawal of labor force from the agricultural sector to the industrial and urban sectors. This phenomenon is generally true across all developing regions of the World, although it is faster in some regions than in others. In the Association of Southeast Asian Nations (ASEAN) region for example, agricultural labor force will drop from 80% of total labor force in 1960 to less than 50% by the year 2000. Note decline in five major rice regions (Fig. 1).

With rapid industrialization and urbanization in the ASEAN regions, one should expect labor withdrawal from agriculture leading to an increase in real wages and an increase in the opportunity cost of family labor. This would be true in general but perhaps to a lesser extent in South Asia and China. Several of the East Asian countries are currently facing rapidly escalating wage rates (Fig. 2).

The implications are that traditionally labor intensive operations such as transplanting, weeding, and harvesting will no longer be profitable and farmers, even poor farmers, will seek means for saving labor for these operations. This process is often irreversible. The movement to direct seeding is an example of this. Does this phenomenon occur at the cost of livelihood for poor and landless women? This depends very much on the alternatives available to the displaced women, and on their restrictions to move into non-agricultural employment. In Northeast Thailand, the rapid migration of female labor to the cities induced the adoption of direct seeding and mechanical seeders. In this situation there was no displacement of female labor(Patcharawan, et. al., 1992). Similar examples are available for Korea, Malaysia, and increasingly in Central Luzon, Philippines.

Increases in operational holding size

Even in densely populated countries where economic development progresses, there is an increase in wage rates and an increase in operational holdings. These phenomenon are brought about by the increased opportunity costs of labor both as a source of power and as a source of management. Several examples across Asia attest to this phenomenon- Thailand, Malaysia, Korea, and even in Northwest India (Punjab, Haryana, etc.). Larger operational holdings provide economies of scale in farm

operations and require higher levels of mechanization. Land preparation, transplanting, and harvesting are commonly the operations mechanized.

Movement away from subsistence production systems

As the opportunity cost of family labor rises, small farm operations for subsistence production will become increasingly unprofitable. Landless tenant farmers will gradually find their way to the urban industrial sector. Small landowners will likewise find it more profitable to sell or lease their holdings rather than to cultivate them. Subsistence farmers will increasingly depend on non-farm income to purchase their foods rather than grow their own foods. Seasonal migration of male family members to the cities will increase and female family members who are uneducated, without skills, and without access to technologies will be left behind to manage minor crops and home responsibilities such as collecting water and fuelwood. They will need light implements, tools for cultivation, and fuel saving technologies to reduce their time and work burden.

WHAT ENGINEERING TECHNOLOGIES CAN HELP POOR WOMEN?

Pingali, et. al., 1987, grouped the agricultural operations according to the relative intensity with which they require power, or energy, in relation to the control functions of the human mind or judgement. Operations such as land preparation, transport, milling, grinding, and threshing are power intensive, while transplanting, weeding, and winnowing, for example, are control intensive operations (Table 1). Postharvest processing operations are extremely labor-intensive and tedious to perform. Miracle (1967) reported for instance, that to grind a week's supply of maize meal- thirty pounds - by hand would take from eight to fifteen hours. The same operation would take an hour with a hand mill and perhaps not more than ten minutes with a motorized mill. Similarly, it takes one woman half a day to handpound 5 kgs of rough rice while the micro-mill can process 50 kgs of rough rice in 1 hour (Alcober, 1993). A rice flour mill with a power of 1.5 HP electric motor can mill up to 10 kilograms dry rice flour per hour (Bautista, et. al., 1994).

Other similar machines which will not take them away from the homes are likely to be accepted by farm women. There is a trade-off between manual operations vs enhancing household production. If these operations are not mechanized, then women lose because they have to spend less time for leisure and other home production activities.

On the other hand, labor saving technologies for control intensive operations such as transplanting and weeding, will be profitable only as wage rates rise relative to other sources of power. Transplanting and weeding (interculture operations) control intensive operations requiring one's ability to discriminate between the plant and the weed. Interculture with draft animals requires line sowing and may or may not emerge rapidly after the introduction of the plow. Even where it does emerge, hand weeding is still required within the rows. *Only where wages rise to very high levels is intrarow weeding preferred to herbicides and a mechanical weeder.*

Harvesting operations are of intermediate to high control intensity and are rarely mechanized in countries where wages are low. Where harvested volumes are large and wages are high, this operation tends to be mechanized rapidly. In China mechanical

harvesting is confined to large-scale commercial farms. Mechanization of this operation is not likely to be profitable in the smallholder sector (Pingali. et. al., 1987). Thus, ex-ante assessment of newly developed labor saving machines such as stripper harvesters and mechanical transplanters, including the Ultralite transplanter, is necessary before they are introduced in rice growing areas.

CONSIDERATIONS FOR DEVELOPING AGRICULTURAL ENGINEERING TECHNOLOGIES FOR WOMEN

Definition of the target groups

Appropriate technology can only be technologically relevant to the needs for whom it is designed. There is a greater chance of acceptance and adoption of technologies which help female farmers who have land and resources which they have some control over. Female heads of households, such as *de jure* (widows) and *de facto* (due to seasonal and permanent migration of male) who maintain and manage their households alone, are immediate targets of engineering technologies which can reduce their time in doing a task, reduce their drudgery and provide them flexible time for fulfilling their reproductive roles.

Landless women will also benefit from engineering technologies which can provide them with alternative source of income such as the use of a flour mill for processing rice cakes. Social scientists should conduct such ex-ante and impact studies on engineering technologies so that policy makers can anticipate the negative consequences of a specific machine and alternative employment opportunities can be provided to those who will be displaced.

Development of intermediate technologies

Agricultural engineers should now think of developing intermediate technologies which are relevant to local needs, requiring minimal energy, reducing drudgery, can easily be adopted for local reproduction, and can be managed and operated by women's groups.

There is a need to examine the economic benefits of ownership vs contractual use of small machines; the use of small machines in isolated subsistence societies vs the use of large scale machines for well connected market oriented societies.

Farmer participatory approach and community based- technology transfer

The experience in the Philippines showed the importance of getting the users' (women farmers) perspective and feedback in designing, testing and evaluating specific technologies for women (Paris, et. al., 1994). Many excellently designed technologies on the drafting boards were not easily accepted by the farmers due to the lack of consultation and consideration by agricultural engineers of the farming systems, socioeconomic, and cultural circumstances wherein the users are located. Adoption of engineering technologies will greatly depend on women's knowledge and skills in managing, operating, and repairing specific machines. Therefore training should be compatible with technology transfer. Managing machines for contract services rather

than on individual ownership empowers women to raise capital for small credit schemes for other poor and landless women.

CONCLUSION

We would like to emphasize that engineering technologies can both help and hurt poor women depending on the circumstances and the way in which these technologies are promoted. Benefits can be maximized by understanding the systems in which these technologies are to be introduced. Harmful effects can be minimized by having a clear idea of the consequences of machinery use and consequences of inappropriate promotion of machinery through, for example, government subsidies.

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Table 1. The power and control intensity of agricultural operations.

Type or sequence	Low control intensity and high power intensity	Intermediate power and control intensity	High control intensity and low power intensity
Type of operation			
Stationary	Guiding, milling, crushing, water lifting, threshing, wood cutting	Sifting, winnowing	
Mobile	Transport	Harvesting root or grain crops	Weeding, harvesting tree crops, fruits, or vegetables
	Primary tillage interculture	Secondary tillage	Seeding
Usual sequence of adoption			
Animal draft	First	Second	Third
Mechanized power	First	Second	Third

Source: World Bank, 1987

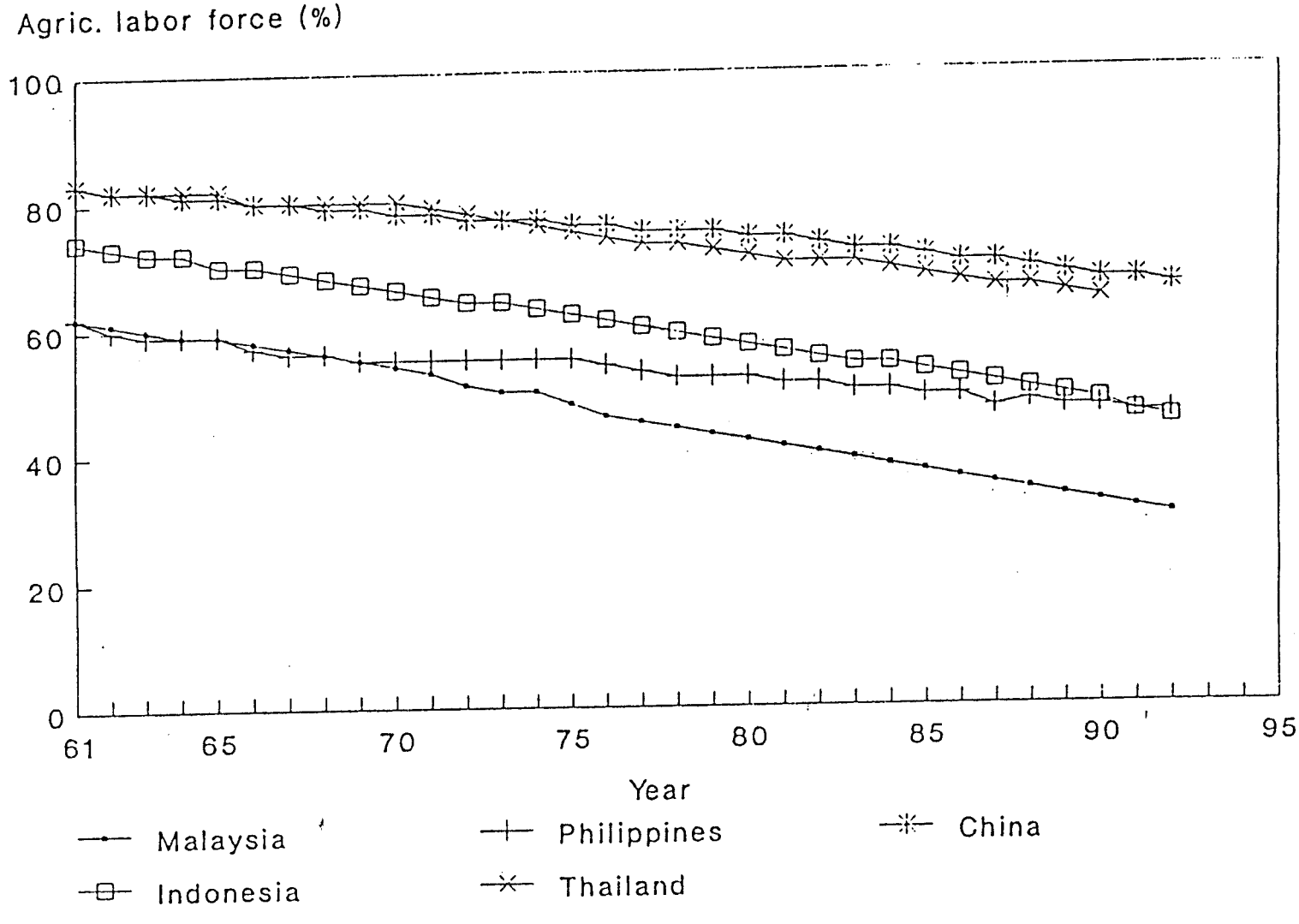

Fig. 1. Share of agriculture to total labor force, 1960-92.

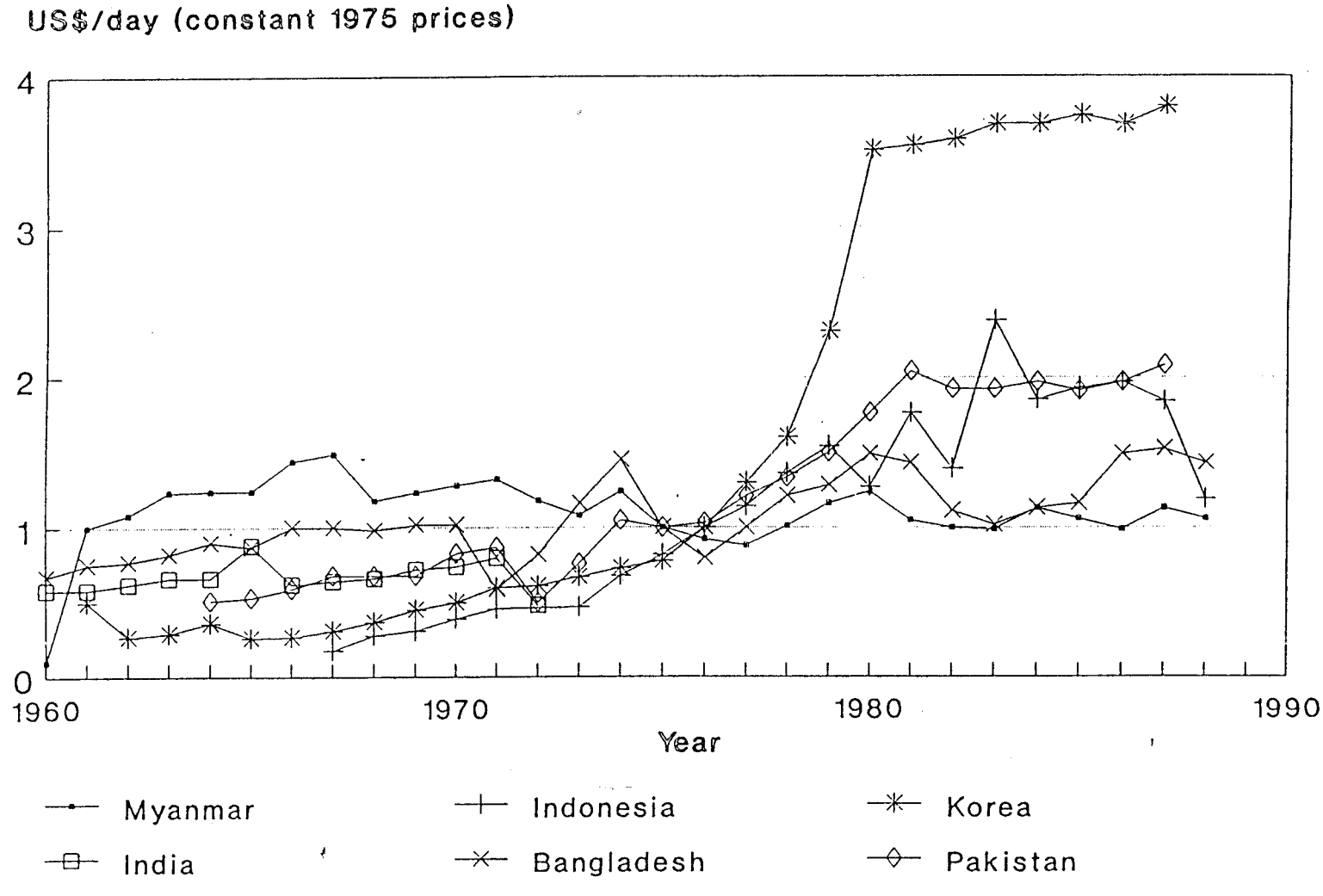

Fig. 2. Trends in wage rate (US$/day, constant 1975 prices), 1960-88.