Consumption Linkages of Mechanical Wheat Production in Pakistan

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1. INTRODUCTION

In many developing countries like Pakistan, most research work on farm mechanisation has focused especially on farm labour displacement and income effects. These studies measure only the micro or direct effect of mechanisation on a specific farm unit, area or locality. They lack macro level impact of technologies that emerge from linkages between farm and non-farm sectors and between farm and the household. The importance of these production and consumption linkages in agricultural growth has been emphasised [Hazel and Roell (1983); Mellor and Lele (1973); Mellor (1976); Yotopoulos and Nugent (1976)]. The growth linkages between farm and non-farm economy are primarily due to increases in household consumption expenditures. Increases in household consumption expenditure is directly related to escalation in income.

Leontiefs (1951, 1966) inpu-output system provides a framework measure the overall effect of farm mechanisation employment an income. King and Byerlee (1977) measured links between changes income distribution and its effect on employment. Rangarajan (1982); Hazel an Roell (1983) showed that agricultural growth has substantial effects on other sectors economy. Ahammed and Herdt (1983 1985) also used the input-output system. The present study is basically an adoption of Ahammed and Herdt's (1983) model. A system of linear homogenous equations which permits solutions by simple matrix inversion operations hsa been used.

2. METHODOLOGICAL FRAMEWORK

The wheat production sector was divided into five sub-sectors (technological options) ranging from non-mechanised to fully-mechanised. The model balances production sectors and household classes.

The consumption expenditure of a household depends on the level of income, an exogenous variable, in the model. This will help in predicting effects of various policies. Total imports were divided into two groups: intermediate use and consumption because data on separate consumption imports was not available. Total savings were obtained by summing various income groups.

In the wheat production system gross value added consisted of payments to landlords, payments to operators and payments to hired labours. These payments determine income of landowner, operator and hired labour groups of the household classes included in the model. Non-wheat and non-farm household groups were assumed to be fixed proportions of total output in these sectors. Total labour requirements in the economy were obtained by summing labour requirements for all industries.

Expressed in matrix notation the model becomes:

$$[A][B] = [C]$$

Where

A = a 18 × 18 square matrix of structural coefficient
B = a 18 × 18 column vector of endogenous variables
C = a 1 × 18 column vector of the exogenous variables

The solution is therefore

$$[C] = [A^{-1}][B]$$

All the elements on the main diagonal of the matrix are positive. All remaining non-zero elements are negative and are smaller than one. Therefore, matrix A must have an inverse.

In order to isolate the effect of farm mechanisation, the model simulates the effect of an one percent increase in final demand for wheat, using each alternative production system in turn, that is, m subsets of final demand vectors are considered. Each vector contains one positive element for the system producing a given quantity of wheat, while the rest of the elements are taken to be zero. In each case, the vector of endogenous variables generates:

1. direct and indirect employment, 2. income distribution, 3. savings, 4. import, 5. direct and indirect requirements of inputs.

In this paper only the results of the simulation are discussed with respect to employment, and income distribution within the wheat economy.

The model examines the equilibrium state of the economy under alternative states of wheat farm mechanisation. The total impact on the economy is calculated as the sum of (a) labour intensity, (b) consumption, (c) income distribution, and

(d) import substitution effects, plus the feedback effects of resulting changes in total output. The exercise is a static comparative simulation of additional wheat production from five wheat production systems corresponding to different degree of mechanisation.

The present study analyses the overall effect of mechanised wheat production employment and income in 1983-84. Data required by the model were obtained from various government and semi-government sources. Some unavailable data were estimated.

The Pakistan Institute of Development Economics [Saleem *et al*. (1983)] constructed an input-output table of Pakistan's economy in 1975-76 consisting of 118 different sectors which for the present study were initially aggregated into nine broad sectors. The wheat sector was then disaggregated into five sub-sectors according to the mode of mechanisation. The PIDE input-output tables were based on the 1975-76 fiscal year; the present model used 1983-84 as the base year. In order to update these tables each sector was multiplied by the wholesale price indices using 1975-76 as a base year.

The wholesale price indices had different values for different sectors (commodity). The resulting new input-output table was therefore not consistent (i.e. rows sums were not equal to their corresponding column sums). Furthermore, the aggregate final demand and gross value of output were not equal. Hence, two further consistency procedures were incorporated to achieve (1) consistency with the final demand aggregation and gross value of output and (2) internal consistency within the input-output table. For the formal entries in the final payment, quadrants were scaled up or down to achieve the desired column sums. Internal consistency (i.e. to achieve equality between total demands and total supplies was achieved by applying the Row and Sum Method (1973).

3. DIRECT AND INDIRECT EFFECT OF WHEAT MECHANISATION ON EMPLOYMENT

In the wheat production sector employment includes both hired as well as family labour whereas the non-wheat sector which was estimated from the input-output tables and the Labour Force Surveys indicated only hired labour. The direct effects of mechanisation on employment occur only in wheat production or on farm. These are calculated from the gross output of crop required to meet the final wheat production from a specific sector divided by the on-farm output over labour ratio. The indirect effect on employment is the change in other sectors' employment generated by the forward and backward linkages resulting from wheat farm mechanisation.

The results of the one percent increase in consumption simulation are pre- sented in Table 1. Total employment in the country was estimated as 7,282 million man days in the 1983-84 fiscal year. The results showed that overall, the maximum

Table 1

Employment Implication of One Percent Increase in Consumption of Wheat when Increase is Met from Specific Production Sector (Million Man-days)

Wheat Production System			Actual Economy	Total Emp.*	Absol.	Dir No.	Ind.	Indirect/
Land Pres.	Harvest- ing	Thres- hing	1983-84	(1)	Incr. +	Incr.	Incr.	Direct Incr.
				7,282.08	(2)	(3)	(4)	(5)
Bullock Manual		Manual/ Bullock		7,384.33	22.33	9.46	12.87	1.36
Tractor Manual		Manual/ Bullock		7,303.64	21.64	8.19	13.45	1.64
Bullock Manual		Thresher		7,303.75	21.75	8.54	13.21	1.54
Tractor Manual		Thresher		7,303.12	21.12	4.54	16.58	3.65
Tractor Combine		Harvester		7,302.94	20.94	4.74	16.20	3.42

* EMP. = Employment, + Incr. = Increase, No. ABSOL. = Absolute.

increase in employment in absolute terms was found on non-mechanised farms or those using bullocks where the increase were 22.33 million man days as of fully mechanised farm it was 20.94 million man days. The indirect increase in employment was 3.33 million man days higher in extensive mechanised farm as of bullock or non-mechanised farms. There was more than double decrease in on-farm or direct employment. These results reveal that mechanisation increased indirect employment. These indirect employment effects are due to consumption linkages. Mechanisation produce more income. There was also an increase in employment of the people directly engaged in machine production, distribution and maintenance activities. In fact, off-farm workers (mechanics, sale agents, etc.) belong to the moderate or lower income groups. So, an increase in their income also enhances secondary employment effects. There were more consumption link- ages by an increased in lower profile income groups as observed by other con- sumption linkages studies. [Desai (1986); Hazell and Roell (1983); King and Byerlee (1977); Mudahar (1974)]. In the present study their share in secondary employment was not separated.

The mechanised farms employed more hired labour at the cost of family and permanent labour. This also implies more consumption linkages, because the hired labour comes from landless poor classes or a lower income profile which has a very high propensity to consume. Their consumption mainly consists of

local and domestic goods which are produced by labour-intensive methods.

These results reveal that micro studies using on-farm employment data over-estimate the net displacement of labour. There was more indirect employment as one moved towards higher mechanisation.

4. INCOME DISTRIBUTION WITHIN THE WHEAT ECONOMY

Mechanisation affects income distribution and equity among rural house-holds. The results obtained from the model on income distribution within the wheat economy are presented in Table 2.

Table 2

Income Redistribution Implications for Wheat Farm Household when One Percent Increase in Consumer Spending for Wheat Increase is Met from Specific Production Sector

Wheat Production System			Actual Economy 1983-84 Income (Mil. Rs)	Hired Lab		Operator	Landowner		Total Inc. Income of Wheat Farm
Land Prep.	Harvest-ing	Thres-hing		Abs.*	Inc.+ Sha.	Abs. Inc. Sha.	Abs.	Inc. Sha.	
			1,853.4			3,716.8	18,212.5		23,737.7
Bullock	Manual	Manual/ Bullock		26.7 (10)		108.2 (42)	123.5 (48)		258.4
Tractor	Manual	Manual/ Bullock		25.2 (09)		115.7 (41)	138.4 (50)		279.3
Bullock	Manual	Thresher		28.7 (10)		126.8 (45)	124.9 (45)		280.4
Tractor	Manual	Thresher		34.0 (11)		135.0 (42)	148.7 (47)		317.7
Tractor	Combine	Harvester		37.4 (09)		160.4 (41)	192.8 (50)		390.6

*Abs. = Absolute increase, + Inc. sha. = Incremental share.

These results show that as the intensity of mechanisation increases there is a commensurate increase in the total income of wheat farms. Increased incomes of mechanised farms are due to mechanisation and in the efficient utilisation of resources. These are indicated by low quasi elasticities, [Mustafa (1987)].

In recent years a strong custom market for farm machinery has emerged especially for tractor ploughing. A new class of farmers entrepreneur has emerged who has invested heavily in farm machinery and actively sought business. This entrepreneurs trend increases the income of farmers. Malik (1983) found that 82 percent of the farmers were hiring tractors for various purposes. The profitability of the tractor hiring business is beyond the scope of the present study. However, it is clearly a significant source of income which is increasing rapidly.

Total incremental income of wheat farm was the highest for intensive mechanised farming. This reveals that mechanisation has an important impact on increase in income. The higher share of operator income is in the technological option where combine was used for harvesting the wheat. This reveals that in extensively mechanised farms total income increased for all household categories as compared to less or non-mechanised farms, whereas level of employment was decreased. So there is a trade-off between income and employment. This increases inequity. The present model does not consider the long-term effects of increase in income of landlords.

CONCLUSIONS

The model used in this study provides a number of important conclusions which are useful for mechanisation policies in Pakistan. The fragility of the data base and strong assumptions of the model, demand some caution in drawing conclusions. However, the consistency and order of magnitude of the major findings give confidence to the results.

The model fails to prove that inverse secondary effects of mechanisation on employment are neutralised by the increase in indirect employment. However, as we move towards intensive mechanisation, more secondary effects on employment emerge. If wheat was harvested manually while all other operations were carried out mechanically, higher secondary employment was generated. The secondary employment effects were due to consumption linkages. These have been usually neglected in farm employment studies. This direct effect alone over-estimates the true displacement of labour.

Both direct as well as indirect labour was decreased while shifting from manual harvesting to mechanical harvesting. This gives a vital conclusion that the combine harvester in the country plays an important role in displacing labour. Smale (1987) also found similar results. So if the government is sincere in its policy of increasing employment, the liberal policy towards the big combine harvesters should be checked or special duty or tax should be imposed on their import and encourage locally made combine and reapers which have more positive secondary effects on the economy than combines.

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Comments on
"Consumption Linkages of Mechanical
Wheat Production in Pakistan"

As much research work has been done on the direct effects of mechanisation on employment and income distribution, ignoring the indirect effects, the author has wisely focussed his research on direct as well as indirect effects of wheat mechanisation on employment and income distribution within the wheat economy. Little quantitative work has been done on the effects caused by production and consumption interactions between agricultural and non-agricultural sectors, or by the so-called backward and forward linkages. The backward linkages (inputs) generate demand for machinery and improved implements as a shift occurs from traditional to mechanised agriculture. Employment is created in the manufacture, sale, repair and maintenance of that machinery and equipment. The forward linkages (output) create demand for services to handle additional output including transport, processing and distribution of output. Infrastructure facilities e.g. feeder roads, storages necessitated by increased output generate further employment. The paper does not indicate how much of these employment multiplier effects have been captured by the model used.

Although the study concludes that the secondary effects of mechanisation on employment fail to neutralise the on-farm displacement of labour, one cannot draw any firm conclusions from the scanty evidence presented. Table 3, for instance, shows that the one percent increase in consumption of wheat leads to a 0.305 percent increase in direct and indirect employment with bullock cultivation, but to only 0.298 percent increase with tractor tillage and the use of thresher. From this, the author concludes that the use of tractor and thresher leads to displacement of labour. The study, however, does not show whether the difference between 0.305 percent and 0.298 percent is statistically significant or not. And even if it were significant, the difference is so small that it could easily be neutralised in a further round of the employment multiplier or by some such measure as import substitution of agricultural machinery by domestic production.

The author has himself indicated in his paper the various limitations of his model and of the data used. He says that unavailable data were "estimated". In Table 1, for instance, he uses assumed yields/hectare under different technological options. There seems to be some discrepancy in the yield assumptions. In both options 1 and 3, tillage has been done by bullocks and harvesting is manual. The

only difference is in the threshing, which is by bullocks in option 1 and by thresher in option 3. Yet the assumed yield in option 3 is about 25 percent higher than in option 1. The study does not explain why the assumed yields are so different in the two technological options. Similar observation applies to assumed yields under options 2 and 4.

On the basis of his analysis, the author comes up with some interesting policy recommendations. He suggests that the import of big combine harvesters should be discouraged. The only rationale behind his recommendation is that combines result in the displacement of labour. It should be recognised that economic policies are based on a careful consideration of all the relevant factors and cannot be dictated by one factor alone. If, for instance, increased production of wheat was seriously constrained by the non-availability of seasonal labour for harvesting the crop, mechanised harvesting could be the only way out. It would not be advisable to ban the import of combines or make their cost prohibitive till domestic manufacturing capacity is fully established.

To conclude, the author has presented a thought-provoking paper. Hopefully, it will lead to further research. The data constraints need to be removed by collecting actual data from the field. The 'estimation' of data must be avoided. Much more research work needs to be done on the direct and indirect effects of mechanisation on labour displacement before any definitive policy recommendations can be made.

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