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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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FARM MECHANIZATION IN PAKISTAN: POLICY AND PRACTICE

By

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REVIEW OF FARM MECHANIZATION IN PAKISTAN
Policy & Practice

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SUMMARY

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. From 1966 to 1975 the average annual imports of tractors stood at only 4040 units, but from 1975 to the present about 15,000 tractors have been imported each year. Furthermore, the average size (horsepower) of the imported tractors has risen from 36-55 HP range to 47-66 HP.

The second part presents some of the results of a study of farm mechanization in Punjab Province funded by A/D/C and carried out by graduate students at the University of Agriculture, 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. This 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.

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COUNTRY SITUATION AND FARM MECHANIZATION POLICY

Agriculture is the largest sector in the economy of Pakistan and seventy-five per cent of the population live in rural areas. Fifty-three per cent of the work force is employed in the agriculture sector which produces about 30 per cent of the GNP and accounts for about 36 per cent of Pakistan's foreign exchange earnings from merchandise exports. In addition, large parts of the industrial and service sectors depend on raw materials and customers from the agricultural sector. The agriculture sector consists of some five million farms with an average area of 10 acres, a highly skewed distribution and a high incidence of tenancy. About 70 per cent of the 47.6 million acres of cultivated farm land is irrigated, mainly from a large network of canals which provides water to 74 per cent of the irrigated area. The late 1960s and early 1970s was a period of rapid agricultural change in Pakistan with improvements in the availability and control of water through an expansion of canal capacity and considerable investment by farmers on tubewells, increasingly greater supplies of chemical fertilizer, and the rapid adoption of high-yielding varieties of wheat and rice. The changes led to more intensive farm operations and land use, greater farm income, and increasing demand for more and better farm power.

In 1965, animals constituted the main source of farm power — there were about 10.5 million work animals and only about 10,000 tractors. Between 1966 and 1970 18,000 tractors, mainly in the 36-55 horsepower range were imported, but there was increasing Government concern that Pakistan agriculture was being adversely affected by a shortage of power, and that tractorization was the answer.

The main set of guidelines governing farm mechanization policy in Pakistan was drawn up in a major Government study of 1968-70 by a high-powered Committee (Farm Mechanization Committee 1968 and 1970).

The Farm Mechanization Committee estimated that tractors supplied only 14 per cent of the available farm power in 1978 and that work animals still dominated the scene by providing 75 per cent. Total farm power available was estimated to be about 0.1 HP per acre of cultivated farm land. The Committee argued that:

"in developed countries the power available on the farms is many times more than in West Pakistan. The Food and Agriculture Organization of the United Nations in the Indicative World Plan has taken note of the low power availability in the developing countries and has suggested that in such countries 0.2 HP per cultivated acre is a minimum desirable standard. The same has been recommended by the U.S. President's Science Advisory Committee. The Committee is of the opinion that non-availability of adequate power at the farms is an important obstacle in the way of sustained increase in agricultural production. The type and level of farm power availability affect agricultural productivity in several ways . . . (i) Expansion of cultivated area (ii) Reduction of fallow lands (iii) Increase in cropping intensity (iv) Increase in crop yields. As mentioned earlier, only 0.1 HP per cultivated area is available as against the minimum arguments of 0.2 HP per acre. It has been brought out that this shortage of power at the farms is likely to be further aggravated with the increase in the cultivated area and the adoption of more intensive farming. The Committee, therefore, feels strongly that the gap between the present availability and the requirements of power should be bridged as soon as possible. Animals as a source of power are inefficient, wasteful and more expensive. Nevertheless, if the expanding power requirements at the farms have to be met by increasing the number of animals, it would be an almost impossible task to provide 15 million additional bullocks that would be required by 1985, and the country can ill afford to put about 12.5 million more acres of land under fodder to feed the additional bullock population and the supporting stock of breeding cows and bulls. On the contrary, there is an urgent need for reducing the bullock population so as to release land area from fodder production and use it to produce more food and commercial crops". (2, pp. 69-71).

The Farm Mechanization Committee proposed a programme of tractor imports as shown in Table 1, and the popularization of tractor powered implements. "For efficient operation of tractors, it is necessary that at least three different implements, excluding the trailer should be available with each tractor". The 1968 survey had shown that while most tractor owners owned cultivators, there were very few mould board and disc ploughs for primary tillage (farmers used cultivators for this operation) and few row planters, seed drills, fertilizer distributors, wheat threshers and combines.

As a result of the Committee's programme of tractor imports, total farm power availability would rise from 0.1 HP in 1968 to 0.167 HP per acre in 1985. The share supplied by animal power would decline from 75 to 35 per cent, the contribution of human power would fall from 11 to 6 per cent, and the share provided by tractors would rise from 14 to 59 per cent. In absolute terms, the Committee predicted a decline in HP from work animals from 3.65 to 3.26 million, a small increase from human labour from 0.53 to 0.55 million HP, and a substantial increase from tractors, 0.66 to 5.46 million HP.

This programme of increasing the power available to Pakistan's large farm population by importing tractor is the crux of the Committee's report and is the basis of Pakistan's Farm Mechanization Policy down to the present. But in its report, the Committee covered and made recommendations on a wide range or related aspects of Farm Mechanization as the following chapter headings show:

1) Introduction
2) Historical Review
3) Agricultural Conditions
4) Studies of Agricultural Machinery
5) Farm Power Availability, Requirements and Programme of Farm Mechanization
6) Socio Economic Aspects of Farm Mechanization
7) Standardization
8) Pattern of Mechanization
9) Manufacturing
10) Spare, Repair and Servicing
11) Pricing of Agricultural Machinery, Duties and Taxes
12) Imports System and Financing of Imports
13) Credit
14) Technical Manpower Requirements and Facilities for Education and Training
15) Research and Extension
16) Statistics
17) Institutional Setup for Planning, Evaluation and Coordination.

We can note here that in Chapter 6, the Committee recognized that the tractors were going predominantly to large farms, and that there was a tendency for large tractor farms to grow even larger through the resumption of land previously farmed by tenants (Table 2). It observed, however, that the ex-tenants were being absorbed as farm labour and "the tractors on such farms . . . are serving as a supplemented source of power and not necessarily as a replacement of the tenants . . . The small farmers by and large are self-cultivators and the introduction of tractors on such farms does not create any problem of tenant displacement". (2, p. 80).

Pakistan has not developed the capacity to manufacture tractors and all machines are imported. Tractorization began slowly, and until 1957 there were no restrictions on the makes and models that could be brought in. Consequently, there were at least 30 different makes/models operating on Pakistani farms and tractor owners were experiencing problems of maintenance and spare-parts. In 1978, Government restricted future imports to seven makes, and thereafter, it continued to control and standardize the range of tractor available. While this policy made good sense, subsequently it had a checkered history as Government depended increasingly on credit and barter trade arrangements for the supply of tractors. This history is summarized as follows:

Up to 1957	-	no restriction on type of tractor imported	
1957	-	imports restricted to 7 makes:	
		1 Massey Ferguson	(UK)
		2 David Brown	(UK)
		3 International	(UK)
		4 Fordson	(UK)
		5 Lanz	(WG)
		6 John Deere	(USA)
		7 Zetor	(Czech)
1961	-	imports restricted to 4 makes	
		1 Massey Ferguson	
		2 International	
		3 Ford	
		4 Lanz	
1962	-	Deutz added in collaboration (credit) with the WG Government	

1966	-	Zadrugar (Yugosl) and Bylarus (USSR) added under barter (credit) arrangements, Zadrugar only up to 1968, while Bylarus continued through to the present.
1968	-	Fiat (Italy) added under credit arrangements.
1969	-	Government list of 8 makes (13 models) announced: 1 Massey Ferguson (135) 2 International (45 HP, UK and 504D, USA) 3 John Deere/Lanz (4020, USA and 45HP, WG) 4 Ford (2000,4000) 5 Deutz (D-4006, D-5006, D-6006) 6 Bylarus (MTZ-50) 7 Holder (AM-12) 8 Zadrugar (50/1) In October 1969 IMT 533 (35HP) from Yugoslavia added.
1970	-	Zetor (45HP) added again under barter arrangement and imported in 1970/71, 1972/73 and 1973/74.
1971	-	John Deere and Deutz dropped
1973/74	-	Ursus added with single import of 1000 55HP tractors under barter arrangement with
1974/75	-	Zetor, IMT and International dropped
1977/78	-	Only Massey Ferguson, Ford, Fiat and Bylarus imported

Between 1965 and 1969, the World Bank, through the provision of IDA credits totalling $US 43 million was a major financer of Pakistan's farm tractorization programme, but by 1970, the Bank had become concerned about the possible adverse effects of the programme and initiated a study to examine "the major consequences of the introduction of large scale tractor technology in Pakistan". The report, by John P. McInerny and Graham F. Donaldson was released in February 1975 as a World Bank Staff Working Paper (McInerny and Donaldson, 1975). This was an empirical study based on a survey of 202 farmers who had purchased tractors through the first IDA credit, mainly in 1967. Farm operations data were obtained from the sample relating to the years 1966/67, that is before the tractor was obtained, and 1969/70 about two years after the farmer started using the tractor. The main findings were as follows:

1. growth in the average size of the farms by a factor of 2.4. The sources of additional land were

- land previously uncultivated	22 percent
- land previously rented out	42 percent
- land newly rented in	24 percent
- land newly purchased	12 percent

2. tractor farms increased the number of crops cultivated: from 4.77 to 7.39, and the overall cropping intensity increased from 111.5 per cent to 119 per cent.

3. reduction of the area sown to fodder crops by 50 per cent with the land being transferred mainly to wheat (rabi winter season) and rice (kharif monsoon/summer season).

4. labour used per farm increased, but allowing for the increase in farm size labour use per cultivated acre declined by some 40 per cent. Calculations of labour displacement were complicated by the absorption by tractor owners of land previously cultivated by tenants. The study estimated that each tractor replaced between 3 and 12 full time jobs.

5. tractor use averaged about 1200 hours a year. The hours were higher on large farms but smaller farms hired out more extensively. About two thirds of all tractor-use hours was given to "cultivation", and about 12 per cent to "on-farm transport".

6. the return on investment to the individual tractor farmer was estimated to have been about 57 per cent.

7. the social rate of return was estimated at 24 per cent.

8. there were significant social costs resulting from adjustments in the pattern of resource use, and the structure of agriculture consequent on the introduction of tractors (wage, labour and tenant displacement) that, if social accounting methods could have been used, would have reduced substantially the economic benefits.

The Bank study showed that in Pakistan tractorization was used by tractor-farmers to expand the area they operated by taking over land previously farmed by others, rather than to intensify cropping on the farm lands they operated before the tractor were acquired. Two major policy questions arise from this: (1) why did farmers adopt such a behavioral patter, and (2) how can it be reversed. McInerny and Donaldson discussed broadly the kind of policies which

could increase social benefits and reduce social costs: (1) measures which would constrain the "predatory behaviour" of the mechanized farms such as progressive taxes on land holdings and/or operated farm areas, legal restrictions on farm size, and security of tenure for tenants, (2) measures to increase the cost of capital (tractors), then kept artificially low through cheap credit, relative to labour and production inputs, and (3) encouragement of tractor hire services. They also raise the issue of the appropriateness within the context of the typical farm size and production patterns of Pakistan agriculture, of the basic unit of the mechanization programme — the 45-55 HP four-wheel tractor. A smaller unit (10-30 HP) could spread the private benefits more widely among the rural population and incur less serious social costs.

The report concludes: "it is clear that no definitive judgement is possible as to whether tractor mechanization in Pakistan (or similar) agriculture is "good" or "bad". Rather, one can only conclude that any particular mechanization "package" can give rise to a variety of effects, both locally and sectorally, the specific result being determined by a host of accessory considerations which made up the frame work of constraints and incentives which condition and mould the innovative process. On the evidence of the survey analysis reported herein, the tractors introduced into Pakistan under the first IDA credit gave rise to a particular pattern of effects which arguably was not as beneficial to the sector and the economy as a whole as might have been the case had a somewhat different "package" — institutional frame work — been implemented". (3, p. 91).

Land reform legislation of 1972 and 1977 put ceilings on land ownership and attempted to improve the security of tenants, but landowners were adept at getting around the legislation and, if anything, the position of tenants worsened. There is no evidence that the land reform legislation did anything to curb the "predatory behaviour" of the tractor-farms and, as will be shown below, the land-accumulation activities of tractor acquiring farmers described by McInerny and Donaldson have continued unchecked.

Government farm mechanization policy does not appear to have been much affected by the evidence of high social costs. It continues to be based on the "power shortage" argument of the Farm Mechanization Committee and implementation involves little more than the importing of tractors and the provision of cheap credit to tractor-buyers. The policy is stated on the Fifth Five Year Development Plan 1978-83 as (1) the "liberal import of tractors, sold at market price without subsidy"; (2) improved availability of tractors through their "assembly and progressive manufacture" in Pakistan; and (3) "allowing the importation of two-year old second-hand tractors and power tillers . . . freely against genuine foreign exchange earnings/savings of Pakistanis working abroad", (Planning Commission, 1978).

The main question that has taxed the Government is not "whether tractors", but "how many tractors". An importing programme was recommended by the Farm Mechanization Committee in 1970 for the period 1971 to 1985 (Table 2). In 1975 an FAO Mission was commissioned to review this programme for the Fifth Development Plan, and it recommended that 15,000 tractors should be imported in each of 1976 and 1977 to catch up with "demand" and that during the Plan period annual imports should be between 10,000 and 11,000, that is, at about the level recommended for this period by the Farm Mechanization Committee. When the Plan came out, it specified that "about 15,000 tractors will be imported annually ... to wipe out, inter alia, the backlog demand. The net population of tractors, excluding replacement, is expected to go up from about 71,000 in 1977-78 to 111,000 in 1982-83 (4, p. 69). Very recently, on August 16, 1981, the Federal Agriculture and Food Minister announced that the Government had decided to import 20,000 tractors each year (Pakistan Times, 17th August, 1981).

The actual numbers of tractors imported each year since 1965-66 are given in Table 3, and this series shows clearly the new emphasis on "tractorization" that began in 1975. Average annual imports 1965-66 to 1974-75 was 4040 units, mainly in the 36-55 HP range, but between 1975-76 and 1980-81 average imports stood at 14,470, and there had been an upward shift in the power range to 47-66 HP. (Table 4).

Other aspects of the mechanization policy set down by the Farm Mechanization Committee have not been implemented as vigorously: assembly and manufacture of tractors, power tillers and implements, for example. A joint venture with Massey Ferguson set up an assembly plant near Lahore in 1977 and most Massey Ferguson 135s (47 HP) sold in Pakistan since then have beeen processed through this plant. Also in 1977, the Pakistan Tractor Corporation set up a workshop near Multan to put together Fiat tractors imported in a "partially knocked-down" condition. In August this year, both the Federal and Punjab Agriculture Ministers announced that arrangements are being made to manufacture tractors in Pakistan, the Provincial Minister specifying a number — four, of which two would be in the public sector and two in the private sector. The coming-on-stream of the Pakistan Steel Mill in August may have given new emphasis to plans to manufacture farm machinery. In collaboration with the International Rice Research Institute, the Government set up a research project to design and test power threshers near Rawalpindi in 1977, but this has not had any visible effect on farm mechanization so far. The fabrication of cultivators, wheat threshers, trailers and other tractor powered farm implemtnts has been left almost completely to the private sector, as also has the repair and maintenance of farm machinery. The few Government (Depts. of Agriculture, Cooperative and Works) repair workshops have contributed very little to the maintenance of private farm tractors. Pronouncements about importing and manufacturing power tillers for the small farmers have not had any visible effect on the farm scene.

The Agricultural Development Bank of Pakistan (ADBP) has played the leading role in providing cheap (12%) credit for the purchase of tractors and tubewells. It has consistently provided loans on about half the new tractors purchased each year covering about 90 per cent of the purchase costs (Table 5). A disproportionately high percentage of these loans has gone to large (influencial) farmers, and to counter this to some extent, ADBP and the Rural Supply Cooperative Corporation in 1979 initiated a special scheme in Punjab to lend up to 50 per

cent of the cost of a tractor to farmers in the 12.5 to 25 acre bracket. In 1979, 784 tractors were financed under this scheme (13% of all tractor loans in that year). Also in 1979, ADBP started making loans for the purchase of wheat threshers: until than the bank had kept away from financing tractor powered farm implements.

THE A/D/C FARM MECHANIZATION STUDY

During 1978-79 A/D/C supported three projects on farm mechanization in Pakistan:

1. An evaluation of farmers' decision making for investment in farm machinery with special reference to tractors (principal investigator, Mr. Muhammad Munir);
2. An assessment of the capacity of workshops and farmers to repair and maintain farm machinery (principal investigator, Mr. Khawaja Altaf Hussain); and
3. An enquiry into the effect on rural labour of the adoption of mechanical threshing of wheat (principal investigator, Mr. Javed Gardezi).

Mr. Munir and Mr. Hussain successfully completed M.Sc. (Agricultural Economics) theses at the University of Agriculture, Faisalabad, Pakistan from their projects and Mr. Gardezi's thesis is being written now.

The Study Procedure

The team conducted three surveys during 1978-79, two involving farmers and one involving tractor repair/maintenance workshops, spareparts shops and implement manufacturers.

The first farm survey, designed primarily for Mr. Munir's study obtained, in addition to material needed for his analysis of decision making, the data on farmers' capacities to service and maintain their tractor used in Mr. Hussain's study, details on tractor use in own-farm and hire service activities, and

historical data on the process of farm mechanization. This last requirement was the main influence on the survey design. It was decided that rather than draw a stratified random sample of tractor-farms in a particular location, we would take the whole District Faisalabad as the area and draw a random sample of villages from each of the sub-divisions of the District distinguished by different land-use/farming patterns. Half the villages were to be on main roads and half on minor roads. Forty villages were so selected, and in each a pre-survey visit identified all tractor owners — a total of 125 farmers owning 129 tractors. The results of this survey are given in Table 6. The common constraints of time, transport and finance compelled us to cut down the number of farmers to be surveyed, and this was done by removing the villages with fewer than two tractors. This left us with 25 villages and 114 tractor-farms. Twenty-six of these farms were excluded because

1. four were operated by managers for absentee owners and the managers did not feel free to cooperate;
2. three were owned by non-farmers; and
3. nineteen could not be contacted during the survey and two subsequent visits to their villages.

The survey was conducted, therefore, in the 25 villages with 88 tractor-owning farmers — 79 per cent of the possible number of respondents.

This method of selecting the sample farmers facilitated the collection of historical data on the process of farm mechanization from the first tractor in 1952 to 1978, but it caused problems in assessing the consequences of mechanization on the size of farms, tenants, cropping patterns and land use intensities, since we were dealing with farmers who have owned tractors anywhere between a few months and 25 years. While Mr. Munir conducted this survey with great care, we were over-stretching the memories of some respondents. In analysing the "before and after" data related to the major consequences of tractorization (farm area, tenants), I have compromised by excluding the farmers who purchased their tractors before 1973, and while the problem remains, it is somewhat less acute.

A different sort of problem arose in the thresher study. This was conducted near Multan, an area where wheat is the major rabi (winter) season crop and cotton replaces wheat during the kharif (monsoon-summer). Four villages were selected — two in a fairly standard farm area and two in a river-flats area of predominantly large farms. In each village, a random sample of 15 owners of mechanical wheat threshers (and tractors) was drawn and a like number of farmers who threshed their 1978-79 wheat crop by traditional methods with bullocks. The problem and also a finding of the study, was that very few large and medium farmers were still doing their threshing with bullocks: most were having their wheat threshed mechanically on contract. The result was that in the sample the average wheat area per farm threshed mechanically (by farmers who owned threshers) was 48 acres while for the farms threshing with bullocks it was only 7 acres, and we were unable to compare farms which differed only (or even mainly) the method of threshing.

The Process of Farm Mechanization in Faisalabad District

Most farmers in locations with usable underground water began the process of farm mechanization with diesel or electric tubewells, and the tubewell often preceeded the second step, the purchase of a tractor and cultivator, by several years. For some farmers the investment in the first tubewell and first tractor came together, and in our sample of 88 farmers 17 began active farming only when they bought their first tractor; before this they had leased out their farmland to tenants. Generally it was the major investment in the tractor that committed the farmer to the process of farm mechanization, first in the mechanization of land preparation and later to other operations such as threshing. While there had been limited farm mechanization before 1973, the first tractor in the sample villages had been bought in 1952, the pace quickened maredly after 1973 (Table 7). In 1972 there were only 27 tractors operating in the sample villages and by 1979 this had grown to 90. During this period there had been some turnover of tractors: while 90 tractors were being operated by the 88 sample farmers they had in fact purchased 112 and sold 22. All farmers bought a cultivator at the time they bought their first tractor.

Investment in other tractor attachments before 1973 had been fairly uncommon. Along with the 29 tractors in service in 1972 there were only eight trailers, four (wheat) threshers, eight pulleys, eight levellers, two cane-crushers, one rotovator, one disc-harrow and one seed drill.

After 1972 the number of tractors increased rapidly and so did the investment in attachments. By 1979 the sample farmers owned 59 trailers, (63% of sample farmers), 53 threshers (58%), 59 pulleys (63%), 44 levellers (46%), 9 cane-crushers (10%), and ten other items: 49 per cent of the trailers and 64 per cent of the threshers had been purchased in 1977 and 1978.

The points to note are, first, the very recent increase in investment in both tractors and major attachments, and second, the still limited range of tractor attachments being bought.

Table 8 shows the pre-tractor status of tractor-buyers in terms of land owned and farm area operated. Between the two periods before 1973-1978, there had been an upward shift in the importance of the small landowner and farm operator as a tractor buyer, and a corresponding decrease in the importance of large landowners and farm operators. Furthermore, the small tractor-farmers became important buyers of mechanical (wheat) threshers and trailers. (Table 9).

Table 10 shows the make, model and horsepower of the 90 tractors owned by the sample farmers. Generally, farmers bought machines that were available at the time their bank loans were sanctioned or other funds were in hand and usually they had little or no choice between makes and models. The ownership pattern is not, therefore, a good guide to farmers' preferences. However, we noted that in most cases where a farmer replaced an older unit he did so with a higher horsepower tractor; the trend was away from the 44-45 HP tractors to 46-48 HP units and, in many cases to larger units in the 55 and 64 HP classes. However, most farmers declared a preference for a particular make and model of

tractor and matched make-model and work task with considerable consistency: Ford 4000 (55 HP) was preferred to heavy duty general work, Fiat 640 (64 HP) for long periods in the summer heat driving a wheat thresher, Bylarus (55 HP) for heavy hawling of bricks and the like, and the Massey Ferguson 135 (47 HP) for general farm cultivation work.

The average cost of a tractor increased 325 per cent between 1968 and 1978 (Table 11), and while the ADBP loans on the tractors it financed rose to cover this, many farmers were having to find increasingly large sums from other sources in order to mechanize their operations. After 1973, credit from sellers of second-hand tractors and other non-institutional loans became important, particularly for small farm tractor buyers.

Using average cost figures for the different items (1973-1978) the package investment in a tractor, cultivator, trailer, thresher and pulley cost the farmer in the order of Rs. 89,000:($ 8,900)

- tractor	Rs. 56,500
- cultivator	Rs. 3,200
- thresher and pulley	Rs. 17,700
- trailer	Rs. 11,400
	Rs. 88,800

The total investment in farm machinery by the sample farms was about Rs. 6,800,000 of which 48 per cent had come from the farmers' own resources, 31 per cent from bank loans, 7 per cent from overseas remittances, and 10 per cent from other sources (Table 12). Bank loans were restricted almost completely to the investment in tractors, and they had financed 49 per cent of this investment in the sample villages as well as on the whole country (Table 6), but were biased towards the larger farmers (Table 13). Smaller farms relied more on overseas earnings, and because they bought a number of second-hand tractors, on sellers and non-institutional credit. Tractor attachments were mainly funded from farmers' own funds.

We have described a number of significant changes that have taken place in the process of farm mechanization since 1972, particularly since 1976:

1. the rapid increase in the number of tractors in the sample villages;
2. the rapid increase in the number of trailers and threshers;
3. the broadening of the ownership pattern of tractors and attachments to include more relatively small farmers: 26 per cent of the tractor owners were farming less than 25 acres in 1978; and
4. the increasingly heavy indebtedness of farmers engaged in farm mechanization.

Consequences of Tractorization

1. Changes in farm size

Only the 62 farmers who bought their first tractor after 1972 are included in this assessment. Between the year prior to purchasing the tractor and the end of 1978, 24 farmers increased the farm area they operated, 22 registered no change, 3 decreased the area farmed, 13 began active farming after being non-farming landlords, and one was a non-farmer before and after (Table 14). The first group increased their farms by a factor of 1.91, and they achieved this by (1) reducing the farm land they previously rented out to tenants — 70 per cent, and (2) increasing the area rented in — 3 per cent. Forty-five tenants farm families lost their farms in this process, possibly more if the area rented in by the tractor-farmer had previously had other tenants. The second interesting group, the landlords who became operating farmers only when they bought tractors, accounted for 17 per cent of the total farm area in 1978 of the 63 farmers under examination. Thirty per cent of their 1978 farm area was rented in and 70 per cent was land previously rented out. Thirty-three tenants lost their farms as their landlords became farmers.

In Table 15, the farmers are divided into pre-tractor farm size categories to show that the "predatory behaviour" of a large proportion (59%) of tractor farmers was not restricted to those who began as large farmers. The Farm Mechanization Committee had claimed that small farmers behaved differently. In our sample 82 per cent of the pre-tractor farmers were "small" by the Committee' reckoning (up to 50 acres), but these 40 farmers expanded their farms by a factor of 2.51 and expelled 33 tenants. The 14 pre-tractor landlords also were fairly small land-owners: the average holding was 21 acres and only one owned more than 50 acres.The smallest landlord(one acre)expelled his single tenant and then rented in another 15 acres. It is clear that the practice of expelling tenants and renting in additional land is not restricted to any land owning or operated farm area category.

These practices do not appear to be declining over time. Table 16 compares the changes in farm size according to the year the tractor was purchased and shows no change in behaviour between 1972 and 1978.

Finally, Table 17 shows the percentages of the total farm sample falling in size categories with respect to owned and operated land before the tractor and in 1978 with the tractor. While there were no significant changes in the distribution based on owned land, there was a clear movement into larger size categories with respect to the areas farmed.

2. Changes in land use

While the area operated by the 49 pre-tractor farms had increased between the pre-tractor year and 1978 by a factor of 1.41, the area actually cultivated increased by a factor of 1.45 showing that there had been an apparent 4-5 per cent increase in cropping intensity. Since we do not know how the lands that were rented out in the pre-tractor year were used, we cannot say whether this represents a real change or not. McInerny and Donaldson had a similar problem in estimating changes in land use intensity and their results also showed a

small change (7% increase). In our sample the largest increase took place on the 14 farms which, in 1978, were farming less than 25 acres (37% increase), while there was actually a decline in cropping intensity on the 4 farms with 100 or more acres (by 21%). Details are shown in Tables 18, 19 and 20.

There was a change in the cropping patterns of tractor-farms. Most farms recorded increases in the proportions of their cultivated area sown to wheat in the rabi (winter) season (average 4%), rice in the kharif (monsoon-summer) season (average 1.0%), and in miscellaneous crops such as vegetables in both seasons (5%). At the same time, there were declines in the area sown to maize and cotton in kharif (3%) and to fodder in both seasons (5%). Apart from the decline in fodder acreage, the other changes appear to be similar to changes taking place generally in the District, and they cannot be attributed directly to tractorization.

From our study there is no strong evidence that the tractors had brought about substantial increases in the intensity of land use, or in the dominant cropping patterns of the District.

3. Effect on tenants

Eighty eight tenants lost their lands when the landowners bought their first tractors: in most cases the ejection of tenants took place in the same year that the tractor was driven onto the owner's land. As noted above this practice was as prevalent in 1978 as it had been in 1968. The sample farmers had, prior to buying tractors, leased land out to 105 tenants of whom only 17 were left in 1978. Furthermore, the average farm of the pre-tractor tenants had been 12 acres, while that of the remaining 17 was only 8 acres. (Table 21).

4. Effect of livestock

Since the tractor replaces the bullock in some farm operations particularly in land preparation work, we expected to find a decline in draft animals on tractor farms. There had been about 333 bullocks on the sample farms prior to the purchase of tractors (3.8 per farm), and in 1979 there remained 159 (1.8 per farm). On average each tractor had replaced one pair of bullocks. (Table 22). However, farmers have several choices here and they did not act in a uniform way: only 12 farmers sold all of their bullocks (54) after buying a tractor; 44 sold some bullocks and kept some (245 to 107); 10 farmers kept their bullocks (30); 12 farmers had none before or after the tractor, and 10 farmers actually increased their bullock numbers (4 to 22). Most farmers did not regard the tractor as a perfect substitute for bullocks in all farm operations and in particular they preferred bullocks (cheaper/better) for chopping and carting fodder, planking, intercultural operations, cane-crushing and linesowing. Only two farmers said that they kept bullocks as a stand-by for times when their tractors were under repair.

There was little change in the pre and post tractor numbers of milch animals on the sample farms. It is apparent that farmers regard draft and milch animals as distinct and separate enterprises and that a reduction in the numbers of draft animals does not lead to a corresponding increase in the milch herd. We noted earlier that there was a 25 per cent decrease in the area sown to fodder crops.

5. Effect on labour

The tractor-farm survey in District Faisalabad did not obtain data on hired or family labour except to ask farmers how many workers they employed on a full time or permanent basis. While the number for 1978 (184) is probably accurate, the pre-tractor number (164) spread over many years, cannot be taken too seriously. However, using these numbers there was an increase of around 12 per cent in the numbers employed permanently by the 88 sample farmers after theybbought their tractors. Two factors complicate this simple arithmetic: first, only 71 of the 88 farmers were operating farms before buying their tractors, and therefore, the number of permanently hired labourers per farm fell, from 2.28 to 2.09 (by 8%); and second, because there was a 53 per cent increase in the operated farm area, the number employed per cultivated acre declined from 0.06 to 0.05 (by 17%). A further complication arises from the knowledge that 86 tenant families were expelled from the area operated by the 88 sample farmers and while many of these may have remained to swell the pool of labours working on the farms on a casual or seasonal basis, their removal as tenants reduced substantially the on-farm labour pool and the labour they earlier had put into their tenanted farms.

The farm survey carried out in 1979 near Multan to study the wheat threshing operations of traditional and mechanized farms obtained details of labour use during the harvesting-threshing season. Mechanization caused no

change in the labour used for havesting as this was mainly contracted out and except for carting the cut wheat to the threshing area, was not mechanized, but it reduced substantially the amount of labour used for the threshing operations.

In the analysis of these data, we include within "threshing" all operations from stacking the cut wheat at the threshing site to the production of clean grain and cut chaff. The components of this operation under traditional and mechanical methods are as follows:

Traditional threshing	Mechanical threshing
1. preparation of threshing floor	1. preparation of threshing area
2. drying of wheat	2. drying of wheat
3. pharra making	3. threshing
4. threshing	
5. first winnowing	
6. sand cousing	
7. second/first winnowing	

There were differences between the traditional and mechanized sample farms, such as farm size, areas of wheat harvested (average 7.1 and 48.0 acres), and yields per acre (average 15.9 and 24.8 maunds), which made a direct comparisons tricky. Nonetheless, the orders of magnitude are clear:

	Traditional	Mechanical	Proportionate change
1. average days taken per acre of wheat	1.32	0.30	0.23
2. average man-hours of labour per acre of wheat	41	27	0.66
3. average man-hours of labour per maund threshed wheat	2.56	1.09	0.43

Bullocks were employed in traditional threshing on average for 15.27 animal hours per acre of wheat threshed and the tractor and thresher for 3.75 hours.

Surprisingly, the operational costs to the farmers, that is, mainly the cost of labour (both cases), maintenance of bullocks and implements (traditional) and fuel and maintenance-on-the-job of tractor and thresher (mechanical) were similar: Rs. 60.92 ($ 6.09) per acre for farmers using traditional methods and Rs. 57.48 ($ 5.75) for farmers using thresher and tractor. But the composition of costs were very different:

	Traditional	Mechanical	Proportional difference
1. cost of power and equipment per acre threshed	Rs. 19.37	Rs. 38.73	2.00
2. cost of labour per acre threshed	Rs. 41.50	Rs. 18.75	0.45

The effect of mechanical threshing of wheat on employment therefore, is to reduce the amount of labour needed for the operation by about 36 per cent, and to reduce the earnings of the labouring community from threshing by about 55 per cent. From the point of view of the farmer, the savings in labour cost are transferred mainly to the cost of fuel and machinery maintenance.

Although the A/D/C study was not designed to assess the effects of farm mechanization on rural employment and the incomes of the rural labouring community it does provide evidence that the overall impact has been negative.

1. In the context of Pakistan, tractorization has led to the expansion of farm area operated by tractor-farmers at the expense of tenants and others who previously farmed the areas involved. There is little evidence to suggest that tractor-farms are more intensively farmed, and it is possible that the areas taken over from tenants may be less intensively cultivated. The argument that tractorization leads to more intensive cropping and, therefore, more on-farm employment does not

hold for Pakistan. On the other hand, the expulsion of tenant families directly reduces the amount of labour applied to the area previously rented out.

2. The recent spread of tractor powered wheat thresher had reduced directly employment in this important seasonal activity. Adoption of other tractor powered equipment, such as rice threshers and harvesters, would reduce still further the main employment and income earning opportunities of the rural labouring community.

3. The rapid spread of hire-services based on the tractor and attachments duplicates the labour saving effects on farms which have not invested in tractors, that is, we are no longer dealing with "tractor" and "traditional" farms but with a whole range of "intermediate" farms which are hiring a labour-saving technology for a number of operations including threshing.

5. Tractor use and the development of a hire-services market

The average number of hours the 90 sample tractors were operated over a 12 month period was 1,120, 58 per cent was on land preparation and cultivation, 20 per cent on wheat threshing, 18 per cent on carting and hawling work, and 4 per cent on other jobs. (McInerny and Donaldson reported the average hours of use for the 202 tractors surveyed in their study at 1200 a year of which 67 per cent was for "cultivation" and 12 per cent for "carting", when these survey was conducted there was no thresher on the sample farms).

Between tractors there was considerable variation in use-hours due to:

1) the operated farm area of the owning farmer,
2) the tractor attachments owned, and
3) the extent to which the owner engaged in the hire-services market which was dependent very largely on the first two factors.

The effect of farm size on tractor use is shown in Table 23. On farms over 100 acres (11) the tractors were worked an average of 1188 hours a year on the owners' farms; farms in the 50-100 acre group (23) ran their tractors for 900 hours a year on the home farms; the average for the 31 farms in the 25-49 acre group was 489, and for the 23 farms below 25 acres it was only 286 hours. This is reversed when we look at the hours the tractor was used for hire-services; 243 hours a year for the tractors attached to farms over 100 acres, 226 for the 50-100 acre group, 530 for the 25-49 acre farms and 773 for the under 25 acre farms. The result is that the total use hours, on own farm plus hire services work, evened out the average use hours between farm size categories.

Both the type of hire-services business and the amount of tractor working time given to this enterprise depend on the equipment and attachments the tractor owner has. We have already seen that the running time given to hire-services jobs depends on the size of the tractor owner's farm, that is, on his own on-farm requirements. Table 14 shows the tractor use hours, both on-owner's-farm and on hire-service business for tractor and equipment combinations. The highest average use hours were recorded for the tractor+trailer and the tractor+trailer+thresher combinations, and the lowest for the tractor+cultivator combination. The tractor+thresher combination recorded the highest percentage of use-time in hire-services and the tractor+trailer+thresher combination recorded the lowest: we should note there that the former combination was typical of the small farm tractor owners, and the latter was typical of the larger farms. Most tractor owners did a fair amount of contract ploughing, but those with the addition of a thresher did a great deal of contract threshing, and those with the single addition of a trailer concentrated, naturally, on contract carting.

Only 18 of the 90 sample tractors were not used for hire-services jobs during the survey year. Table 25 shows the difference in tractor-use hours between the tractors which were, and were not engaged in hire-services,

again divided according to equipment/attachment combinations, and also between farms over and under 50 acres. Here we can see clearly the importance to the smaller farm tractor owners of the hire services market whatever combination of attachments he owned.

It is the development of the hire-services market in recent years that represents the most important change in the process of farm mechanization. We have seen the development of a new class of small-farmer entrepreneur which, has invested heavily in farm machinery and has gone out actively to seek business. In this study we are unable to measure the extent of this business or how profitable it was to the farmer-entrepreneur, but what evidence we have points to it being already quite extensive, growing very rapidly, and, at the present time being sufficiently profitable to encourage rapid growth. It also appears that the demand for tractor-based services is high and increasing and this is an indication that the charges are at levels acceptable to a large majority of customer-farmers.

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TABLE 1 Farm Mechanization Committee's Proposed Programs for Tractors

	No. at the beginning of Plan Period	Replacement Needs	Net Addition	Total Import/ Manufacture	Progressive Total at the end of Plan Period
TRACTORS					
1969	17,100	500	4,000	4,550	21,100
1971-75	25,000	12,200	23,600	35,800	48,600
1976-80	48,600	24,200	32,700	56,900	81,300
1981-85	81,300	46,100	41,100	87,200	122,400

SOURCE: Farm Mechanization Committee Report pp. 72-73.

TABLE 2 Pakistan: Private Tractor Owners by Area Owned and Operated - 1968

Area (Acres)	Tractor Owners			
	Owned Area		Operated Area	
	Number	Percent	Number	Percent
None	496	3	147	1
Under 25	1397	10	813	5
26 - 50	2247	16	2168	15
51 - 100	3242	22	4000	27
Over 100	7182	49	7439	52
	14567	100	14567	100

SOURCE: Farm Mechanization Committee Report, 1970, pp. 60-61.

TABLE 3 Pakistan: Tractor Imports 1956/57 to 1980/81

	Number Imported	Accumulated Total	Accumulated Total Assuming 10 Year Life
1965/66	1,665	10,828	10,828
1966/67	4,113	14,941	14,941
1967/68	2,182	17,123	17,123
1968/69	4,411	21,534	21,534
1969/70	5,696	27,230	25,064
1970/71	3,879	31,109	26,777
1971/72	4,224	35,333	28,835
1972/73	1,847	37,180	28,516
1973/74	5,216	42,396	31,566
1974/75	7,190	49,586	37,091
1975/76	10,809	60,395	43,787
1976/77	15,554	75,949	57,159
1977/78	11,902	87,851	64,650
1978/79	15,175	103,026	74,129
1979/80	18,923	121,949	89,173
1980/81	14,302	136,251	99,251

SOURCE: Agricultural Statistics of Pakistan, 1979.

TABLE 4 Pakistan: Tractors by Horsepower 1968 and 1975

Horsepower	Percentage on 1968	Percentage on 1975
Below 35	16	3
36 - 55	75	77
56 - 66	8	20
Over 66	1	*
	100	100

SOURCES: 1968 - Farm Mechanization Committee Report, 1970.

1975 - Pakistan Census of Agricultural Machinery, 1975.

TABLE 5 Agricultural Development Bank of Pakistan Lending for Tractor Purchases

	Number Tractor Loans	Average Loan (Rs.000)	Number of Loans as % Tractor Imports of Same Year
1961-65	1614	22.5	
1965-66	810	22.5	49
1966-67	2550	19.5	62
1967-68	2115	20.2	97
1968-69	2280	18.3	52
1969-70	2618	18.3	46
1970-71	3056	19.3	79
1971-72	1906	19.6	45
1972-73	1679	26.0	91
1973-74	1997	27.3	38
1974-75	3122	42.2	43
1975-76	6043	57.6	56
1976-77	5888	54.2	38
1977-78	5768	56.2	48
1978-79	6003	51.7	40
TOTAL	47449		49

SOURCE: Agricultural Development Bank of Pakistan, Annual Report 1978-79.

TABLE 6 Pre-Survey Identification of Tractor Farms in the Sample Villages, Faisalabad District

Tractors Per Village	Number of Villages	Number of Tractors	Number of Owners
8	3	24	22
7	3	21	21
6	6	36	35
5	2	10	10
4	1	4	4
3	3	9	8
2	7	14	14
1	11	11	11
0	4	0	0
	40	129	125

TABLE 7 Farm Machinery Purchased by 88 Sample Farmers

	Tube-well	Tractor+ Cultivator[1]	Trailer	Wheat Thresher	Pulley	Leveller	Cane Crusher	Other Items[2]	Tractor Farms
To 1965	16	5	-	-	-	-	-	1	3
In 1966	5	2	1	-	-	-	-	-	5
1967	1	2	-	-	-	-	-	-	6
1968	7	3	1	-	-	2	1	1	9
1969	-	6	-	-	-	-	-	-	13
1970	5	3	4	-	1	4	1	-	15
1971	1	5	1	2	4	2	-	-	20
1972	1	3	1	2	3	-	-	1	22
	36	29	8	4	8	8	2	3	
1973	3	8	2	2	3	-	-	3	29
1974	4	13	3	1	-	8	-	1	40
1975	2	12	8	8	9	7	2	1	50
1976	7	18	9	4	6	2	2	-	65
1977	3	19	16	11	15	12	1	2	80
1978[3]	5	13	13	23	18	7	2	-	88
	24	83	51	49	51	44	9	7	
	60	112[4]	59	53	59	44	9	10	
% of farmers owning in 1978	50	100	63	58	63	46	10	5	

NOTES:
1. Usually purchased together.
2. Seed drill (5), rotovator (3), disc harrow (2).
3. To August 1978 only.
4. While 112 tractors had been purchased 22 had been sold. The balance of 90 tractors were operating on the sample farms in 1978.

TABLE 8 Farm Size in Year Tractor Purchased

(Percent of Farmers)

Acres	Land Owned			Farm Area Operated		
	Before 1973	1973-78	Difference	Before 1973	1973-78	Difference
0	4	0	- 4	16	22	+ 6
Less than 25	24	35	+ 11	20	25	+ 5
25 - 49	36	38	+ 2	36	38	+ 2
50 - 99	16	22	- 6	8	13	+ 5
100 and Above	20	5	- 15	20	2	- 18
	100	100		100	100	
No. of farmers	25	63		25	63	

TABLE 9 Tractor Attachments by Area of Operated Farm in 1978 (Post Tractor)

Farm Size (Acres)	Number of Farms	Percentage of Tractors-Farms With:			
		Cultivator only	Cultivator Thresher	Cultivator Trailer	Cultivator Thresher Trailer
Under 25	23	17	26	27	30
25 - 49	31	26	16	19	39
50 - 99	23	26	4	22	48
100 & Above	11	9	9	9	73
TOTAL Sample	88	22	15	20	43

TABLE 10 Tractors Owned by Sample Farmers in 1978

Horsepower	Number	Maker
44	6	IMT/International
45	4	Fiat/International
45.5	9	Massey Ferguson
46	8	Ford
47	19	Massey Ferguson
48	14	Fiat
55	21	Ford/Bylarus
64	9	Fiat

TABLE 11 Average Cost and Sources of Financing Tractors Purchased After 1967

	Number of Tractors Purchased	Average Cost (thousand Rs.)	Percentage of Cost From				
			P.A.D.B. Loan	Other bank loans	Seller & Non-Loan	Overseas Earnings	Own Sources
1978	13	58.1	21	15	29	21	15
1977	18	56.5	42	7	16	0	33
1976	17	60.1	50	0	19	5	27
1975	11	54.7	69	0	6	9	10
1974	10	37.9	26	5	14	20	36
1973	7	40.1	35	0	13	26	26
1972	2	31.4	83	0	0	0	17
1971	5	19.7	78	1	0	21	0
1970	2	17.2	0	0	0	0	100
1969	3	19.7	17	0	0	32	51
1968	1	18.0	100	0	0	0	0
	89	-	43	5	18	10	24

TABLE 12 . Sources of Funds for Investment in Farm Machinery by 88 Sample Farmers: to August 1978

Item	Units	Total Investment (Rs. 000)	Sources of Funds (% of Total Investment)						
			Farm Income	Bank Loans	Overseas	Non-Farm	Seller Loan	Private Loan	Other
Tractor	90	4,212.4	23	49	10	6	5	6	1
Cultivator	89	283.0	90	5	4	-	1	-	-
Trailer	59	666.3	93	-	-	3	1	-	3
Thresher	52	641.7	94	-	-	-	6	-	-
Pulley	59	125.8	94	1	5	-	-	-	-
Leveller	44	40.2	96	-	1	1	2	-	-
Other		826.4	100	-	-	-	-	-	-
TOTAL Rs.		6,795.8	3280.5	2098.5	445.0	379.0	277.6	251.4	64.1
%			48	31	7	6	4	4	-

TABLE 13 Sources of Funds for Tractor Purchases by 88 Sample Farmers: to August 1978

Operational Farm Size in 1978 (Acres)	Number Farms	Percentage of Purchase Cost					
		Cash			Loan		
		Overseas Remittances	Farm Income	Other Income	Bank	Private	Seller
Under 25	23	23.8	16.8	13.7	33.7	0.8	11.3
25 - 49	31	11.2	17.4	7.1	51.7	8.6	4.0
50 - 99	23	2.4	52.1	1.7	41.4	2.9	0.0
100 & above	11	0.0	18.6	0.0	78.0	3.3	0.0
TOTALS	88	10	23	6	49	6	5

TABLE 14 Changes in Operated Farm Area Beofre and After Tractor By Direction of Change

Farmers who	Number	Area Farmed Before Tractor (Acres)	Area Farmed in 1978 (Acres)	Proportional Change
1 Increased the farm area operated	24	688.5	1314.5	1.91
2 Did not change the farm area operated	22	676.5	676.5	1.00
3 Decreased the farm area operated	3	139.0	88.5	0.64
4 Began farming	13	0.0	423.5	-
5 Did not farm	1	0.0	0.0	-
	63	1504.0	2503.0	1.66

TABLE 15 Changes in Operated Farm Area and Sources of Change Before and After Tractor by Farm Size - Before Tractor[1].

(Averages)

Pre-Tractor Operated Farm (Acres)	No. Farms	Operated Farm		Rented In		Rented Out		No. Tenants		Farm		Proportionate Change		
		Before	After	Before	After	Before	After	Before	After	Before	After	Operated Farm	Rented In	Rented Out
		(in Acres)												
Less than 25	16	13.8	21.8	1.3	3.9	7.3	0.8	0.8	0.2	9.8	4.0	1.58	3.00	0.11
25 - 49	24	30.1	44.8	2.7	8.0	11.3	1.0	1.1	0.1	10.5	8.0	1.48	2.96	0.09
50 - 99	8	57.4	69.4	7.8	12.8	16.3	4.7	1.9	0.4	8.7	12.5	1.21	1.64	0.29
100 & above	1	100.0	100.0	25.0	25.0	-	-	-	-	-	-	1.00	1.00	-
All Farms	49	30.7	42.4	3.6	7.6	10.6	1.5	1.1	0.2	10.0	8.2	1.38	2.10	0.14
Non-Farmers Before Tractor	14	0	30.3	1.8	12.5	20.9	1.4	1.9	0.2	11.3	6.8	-	6.94	0.07

1. Farmers who purchased tractors from 1973-1978.

TABLE 16 Changes in Operated Farm Area and Sources of Change Before and After Tractor - by Year Tractor Acquired[1].

(Averages)

Year Tractor Bought	No. Farms	Operated Farm		Rented In		Rented Out		No. Tenants		Avg. Tenant Farm		Proportionate Change		
		Before	After	Before	After	Before	After	Before	After	Before	After	Operated Farm	Rented In	Rented Out
		(in Acres)												
1978	7	25.7	35.6	4.5	4.7	8.5	0	0.9	0	9.7	0	1.39	1.04	-
1977	11	27.7	40.6	0.9	3.9	15.2	4.7	2.0	0.5	7.6	10.3	1.47	4.33	0.31
1976	12	26.5	30.4	5.5	9.5	3.4	0.3	0.4	0.1	8.2	4.0	1.15	1.73	0.09
1975	5	37.4	62.5	7.2	17.2	20.1	0	1.4	0	14.4	0	1.67	2.39	-
1974	9	37.5	52.0	3.3	5.9	13.9	2.0	1.2	0.3	11.4	6.0	1.39	1.79	0.14
1973	5	35.5	47.1	0	8.0	3.5	0	0.4	0	8.8	0	1.33	-	-
	49	30.7	42.4	3.6	7.6	10.6	1.5	1.1	0.2	10.0	8.2	1.38	2.10	0.14

1. Only farms which acquired their tractor from 1973-1978 and who had previously farmed.

TABLE 17 Distribution of Sample Farmers by Size of Operated Farm Pre and Post Tractor

	Operated Farm Area (Acres)				
	0	Less than 25	25 - 49	50 - 99	100 and above
Pre-tractor (%)	20	24	38	11	7
1978 with tractor (%)	1	25	35	26	13

TABLE 18 Cropping Intensities by Season and Farm Size[1].

		Before Tractor %	After Tractor (1977/78) %	Proportionate Change
All FArms	Rabi	91	95	1.04
	Kharif	71	70	0.99
	Total	141	146	1.04
Less than 25 Acres	Rabi	90	100	1.11
	Kharif	63	79	1.25
	Total	104	141	1.36
25 - 49 Acres	Rabi	90	93	1.03
	Kharif	69	66	0.96
	Total	135	138	1.02
50 - 99 Acres	Rabi	87	97	1.11
	Kharif	68	67	0.99
	Total	138	146	1.06
100 Acres & Above	Rabi	100	93	0.93
	Kharif	92	77	0.84
	Total	176	155	0.88

NOTE: Annual crops (sugarcane and orchards) are counted in both Rabi and Kharif cropped acreages as well as the total. Farm size groups are based on 1977/78 (post tractor) operated holdings.

TABLE 19 Crop Acreage As Percentage of Cultivated Area Before and After Tractor

	All Farms		Less Than 25 Acres		25-49 Acres		50-99 Acres		100 Acres and Above	
	Before	After	Before	After	Before	After	Before	After	Before	After
RABI										
Wheat	38	42	25	26	36	40	41	45	41	43
"Other"	1	2	3	2	1	4	1	2	*	1
Oilseed	2	2	1	1	3	3	2	2	1	1
Fodder	9	6	13	9	8	5	7	6	6	3
All RABI	50	52	51	46	49	52	51	54	48	50
KHARIF										
Rice	10	11	2	4	5	6	11	10	22	23
"Other"	1	4	3	6	*	7	1	4	1	*
Maize	7	6	4	5	9	8	6	6	9	4
Cotton	8	6	3	1	8	3	11	8	4	9
Fodder	9	7	13	10	10	9	8	6	6	4
All KHARIF	35	35	30	32	33	33	37	33	40	40
Annual Orchard	3	3	5	6	3	3	2	3	1	*
Annual Sugarcane	12	11	10	12	15	13	10	10	11	9
Total Cultivated Area	2118	3074	274	353	698	839	751	1206	395	676
Number of Farms	49		14		18		13		4	

NOTES: 1. Farms which bought tractors 1973-78 excluding those who had not operated the farm before the tractor.

2. After tractor = 1977-78 farm size groups based on 1977-78 operated holdings, that is, post tractor.

TABLE 20 Crop Acreage As Percentage of Operated Farm Area Before and After Tractor[2].

		All Farms[1]		Less Than 25 Acres		25-49 Acres		50-99 Acres		100 Acres and Above	
		Before	After	Before	After	Before	After	Before	After	Before	Aft
RABI	Wheat	54	61	39	48	49	55	57	65	72	66
	"Other"	1	4	4	4	1	5	1	3	*	2
	Oilseed	3	3	2	2	5	3	3	3	1	1
	Fodder	12	9	21	16	11	8	10	8	11	8
	ALL RABI	70	75	65	70	66	71	71	79	84	77
KHARIF	Rice	14	16	3	7	7	8	15	15	38	35
	"Other"	2	6	4	11	*	10	2	5	1	*
	Maize	10	9	6	9	13	11	8	8	16	7
	Cotton	11	9	5	3	11	4	16	12	6	13
	Fodder	13	10	21	18	14	12	11	9	10	7
	ALL KHARIF	50	50	39	48	45	45	51	49	70	62
ANNUAL	Orchard	4	4	8	10	4	4	3	4	1	1
	Surgarcane	17	16	16	21	20	18	14	15	20	15
WASTE/ FALLOW	Rabi	9	5	11	0	10	7	12	2	0	7
	Kharif	29	30	38	21	31	33	32	32	9	22
Total Operated Area(Acres)		1501	2110	264	250	519	610	543	826	225	437
Number of Farmers		49		14		18		13		4	
Mean Farm Area (Acres)		30.0	42.2	18.9	17.9	27.3	32.1	41.8	63.5	56.3	109.3
Cropping Intensity (%)		141	149	104	141	135	139	138	146	176	155

NOTES: 1. Farmers which bought tractors 1973-1978, excluding those who had not operated the farm before the tractor.

2. After tractor = 1977-78. Farm size groups based on 1977-78 operated holdings, that is, post-tractor.

TABLE 21 Tenancy Before Tractor, and in 1978

(88 farms)

Kind of Change in Farm Size	No. Farmers	Area Leased Out (Acres) Before Tractor	1978	Diff.	% Change	No. of Tenants Before Tractor	1978	Average Tenancy (Acres) Before Tractor	1978
Increased	34	687	57	- 630	- 91	59	8	11.6	7.1
"New" farmers[1]	17	397	40	- 357	- 89	38	5	10.4	8.0
	51	1189	97	- 1092	- 91	97	13	12.3	7.5
No change	33	39	12	- 27	- 69	5	2	7.8	6.0
Decreased	4	18	31	+ 13	+ 72	3	2	6.0	15.5
	88	1246	140	- 1106	- 88	105	17	11.9	8.2

1. Had not farmed prior to owning a tractor.

TABLE 22 Changes in Livestock on Tractor-Farms[1]

	Nos. Before Tractor	Nos. in 1979	Change Nos.	Percentage
Draft animals (bullocks) (No.)	333	159	- 174	- 52
Milch animals (cows/buff)(No.)	616	645	+ 29	+ 4
Area under fodder (acres)	619	461	- 158	- 25

1. bullocks, buffaloes, cows, she-buffaloes only

TABLE 23 Tractor Use by Farm Size

Operated Farm[1] (Acres)	Avg. hrs. of Tractor Operation Per Year	Percentage of Tractor Hours: Owner's Farm	Hire Services
Over 100	1431	83	17
50 - 100	1126	80	20
25 - 49	1019	48	52
Under 25	1059	27	73

1. In 1978.

TABLE 24 Tractor Use by Main Tasks and Equipment Combination

Equipment Combination	No. Cases	Mean Farm Size[1] (Acres)	Use Type	Total Use Hrs/Yr/ Tractor	Total Use %	Percentage of Total Use Hours: Land Prep/ Cultivation	Wheat Threshing	Carting	Other
Cultivator	19	31	Own Farm	505	63	46	6	2	9
			Hire Out	302	37	29	7	-	2
				807	100	75	12	2	11
Cultivator+ Thresher	13	32	Own Farm	329	32	26	4	1	1
			Hire Out	696	68	39	29	-	-
				1025	100	65	33	1	1
Cultivator+ Trailer	18	39	Own Farm	619	49	33	3	9	5
			Hire Out	643	51	25	4	22	-
				1262	100	58	7	31	5
Cultivator+ Thresher+ Trailer	40	58	Own Farm	845	68	40	8	18	2
			Hire Out	392	32	12	16	3	-
				1237	100	52	25	21	2
All Combinations	90	46	Own Farm	652	58	38	6	11	4
			Hire Out	467	42	20	14	7	-
				1119	100	58	20	18	4

1. Operated farm in 1978.

TABLE 25 Comparison of Tractor Use Hours Between Tractors which were, and were not, Hired Out

Equipment Combination	Farm Size Category[6] (Acres)	Mean Tractor Use Hours: Tractors Not Hired Out No.	Tractors Not Hired Out Hrs.	Tractors Hired Out No.	Use on Home Farm Hrs.	Use on Hire Jobs Hrs.	All Uses Hrs.	All Tractors No.	All Tractors Hrs.
Tractor+ Cultivator	50+	2	869	5	716	205	921	7	906
	-50	4	324	8	329	589	918	12	720
Tractor+ Cultivator+ Thresher	50+	1	824	1	880	500[1]	1380	2	1102
	-50	0	-	11	234	789[2]	1023	11	1023
Tractor+ Cultivator+ Trailer	50+	2	1445	3	748	664[3]	1392	5	1413
	-50	1	497	11	367	877[4]	1244	12	1182
Tractor+ Cultivator+ Thresher+ Trailer	50+	6	1473	15	891	335	1226	21	1296
	-50	1	1350[5]	18	536	609	1145	19	1156
All Tractors	50+	12	1320	24	836	356	1192	36	1235
	-50	6	524	48	500	706	1206	54	1130
	All	18	1055	72	612	589	1201	90	1172

NOTES:
1. None with thresher (all cultivation work)
2. 37% with thresher
3. 18% with trailer
4. 31% with trailer
5. An usual case: 1 40 acre farm which reported 300 hours pumping irrigation water and 300 hours land levelling.
6. Operated holding in 1978.

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