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Economic Implications of the "Green Revolution" and the Strategy of Agricultural Development in West Pakistan

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ECONOMIC IMPLICATIONS OF THE "GREEN REVOLUTION" AND THE STRATEGY OF AGRICULTURAL DEVELOPMENT IN WEST PAKISTAN

by

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INTRODUCTION

The short-stemmed varieties of wheat and rice imported from abroad and the increased use of fertilizers have dramatically enlarged the potential for rapid increases in the agricultural output of West Pakistan. This recent break-through in foodgrain production is sometimes referred to as the "green revolution." Because of the generally favorable conditions in West Pakistan in regard to irrigation water and solar energy, and due to the unusually favorable weather in 1967/68 in particular, the "green revolution" is spreading most rapidly. It is high time to focus our attention on some of the economic implications of the new developments in agriculture.

Recent agricultural growth in West Pakistan has been the result of improvements in the input-output relationship in the agricultural sector; however, the relationship between land and man in agriculture and that between agricultural production and other economic activities tend to be neglected in the current discussions of the ways in which the country may sustain the recent growth performance. Having identified the sources of growth in the agricultural sector during the 1960's,[1/] some expound the virtue

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Of course, I assume sole responsibility for the analysis, opinions, and conclusions contained in this paper.

1/ Private groundwater development contributed substantially to the growth of West Pakistan's agriculture during the Second Plan period (1960-65). Although the adverse weather conditions in the early years of the Third Plan period (1965-70) retarded growth in the agricultural sector, blessed by the good weather, a spectacular performance was achieved in the 1967/68 season. The prime source of output growth in this most recent spurt is the much more favorable input-output relationship attributable to the development of new varieties of major crops, especially wheat and rice, and to the improved environment of the farmers resulting from more liberal policies of input provision and output price support programs.

of further improving the input-output relationship by introducing an extensive mechanization program in the agriculture of West Pakistan. The engineering criteria used in such arguments are seemingly flawless. It is even speculated that machine power can raise the status of the agricultural worker from the level of drudgery to that of high level technical competence. Moreover, it is attractive to state that after water and biological-chemical technology have been introduced, mechanical-engineering technology should follow to promote further improvements in the basic input-output relationship in agriculture.[2/] However, the choice of technique, the ways in which the factors of production are to be combined, and the phasing in of new technologies cannot be determined solely on the basis of mechanical-engineering criteria. There are other questions which call for economic analysis focused not only on the input-output relationship in agriculture per se, but also on the marketing and distribution systems and on the relation between agriculture and non-agricultural sectors of the economy.

The opportunities created by the "green revolution" present some challenging economic issues besides the mechanization question. A rapid increase in agricultural output and the consequent increase in the marketable surplus of agricultural products are expected to overwhelm the processing, warehousing, distribution, and marketing systems that exist today. The rapid achievement of self-sufficiency in foodgrains will bring a very sharp reduction in the P.L. 480 program in Pakistan and in the generation of counterpart funds that the government has relied upon to finance a substantial fraction of its development program. A rapid increase in cash income anticipated for the agricultural sector will call for a re-examination of the system of agricultural taxation as well as the entire strategy of

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2/ The phrase "biological-chemical technology" refers to agricultural technology bound up with the biological growth process of farm products and yield-increasing chemicals such as fertilizers, pesticides, and herbicides. The phrase is used in contrast to "mechanical-engineering technology". As becomes clear in the text of the paper below, "biological-chemical technology" is more divisible, quicker in payoff, and primarily yield increasing in contrast to "mechanical-engineering technology" that is in general "lumpy", slow in payoff, and primarily labor-displacing.

economic development. The problem of a stagnant agriculture has been primarily on the supply side; now that agriculture has experienced a rapid increase in productivity it must face an increasingly difficult problem of expanding effective demand to match the growth of supply. The euphoria of the present situation cannot, itself, sustain the view that there is unlimited demand for increased agricultural output. The prospects for international as well as domestic marketing have to be seriously explored.

In this paper I shall deal with only a few of these problems. My immediate concern is the question of tractor mechanization in West Pakistan.[3/] I shall deal with other problems in the context of this main theme but only to the extent that they are relevant to the theme. First, the economic implications of Pakistan's demographic characteristics will be analyzed in order to give perspective to the agricultural development of the country. Attention will be focused on the relationship between the land/man ratio and the output trend in the agriculture of West Pakistan. Secondly, I shall review the sources of productivity growth in the agriculture of Japan and the United States. The experiences of these countries provide us with a comparative framework for analyzing the interrelationship between factor endowment and strategy of agricultural development. Thirdly, the question of tractor mechanization in West Pakistan will be examined from the standpoint of economic efficiency and the choice of strategy for agricultural development. Finally, I shall present some reflections on an alternative strategy for the agricultural development of West Pakistan in view of the further progress of the green revolution.

3/ Mechanical-engineering technology in agriculture can embrace a wide range of different configurations involving motive power, machinery, and implements Consequently, there are many types of mechanization programs for agriculture. In this paper I shall call mechanization involving tractors (of 35 HP size or more) and/or self-propelled combine harvesters "tractor mechanization". It is to be understood that tractor mechanization is by no means the only way to mechanize agriculture.

1. AGRICULTURAL DEVELOPMENT IN PAKISTANI PERSPECTIVE

The 1961 census gives the agricultural labor force at 21.9 million. According to the Third Plan document, however, agricultural employment in 1960-61 was estimated to be 17.85 million man-years. The implied unemployment ratio is 18.5%. Although figures for later years are not readily available, there is a strong presumption that the increase in the agricultural labor force significantly exceeded the increase in agricultural employment. The Plan document is right in stating that the gravest problem confronting Pakistan is unemployment. The problem acquires an additional dimension when we consider the likely future trend of population growth in Pakistan. On the basis of the assumption of constant fertility and declining mortality, experts at the PIDE estimate that the population of Pakistan will increase from 93.7 million in 1961 to about 247 million in 1985[4/]. A population explosion of such a magnitude is awesome to contemplate.

According to the Third Plan, the labor force is expected to increase from 37.25 million in 1965 to 41.45 million in 1970, including the estimated man-year equivalent of the partially unemployed.[5/] Employment in agriculture is expected to increase by 3.5 million man-years, 2.0 million in East and 1.50 in West Pakistan. These projected increases in agricultural employment are assumed to be associated with planned expansions of the cultivated area, increases in the intensity of cultivation, and with a

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4/ If fertility is assumed to remain constant until 1970 and then decline linearly by 30 percent to the period 1980-85, the effect of this minor change in fertility is minimal with respect to growth rates. The growth rates of population by five-year intervals fluctuate between 3.1 percent per annum to 3.4 percent, (and between 2.9 percent and 3.2 percent for West Pakistan only). Under this assumption the population of Pakistan would double by 1981 and double again by the year 2003.
See Lee L. Bean, et al., Population Projections for Pakistan, 1960-2000, Monographs in the Economics of Development, No. 17 (Jan. 1968)

5/ Government of Pakistan, The Third Five Year Plan (1965-70), (March, 1965), p. 101.

higher demand for livestock products during the Third Plan period.[6/]

As in other countries, industrialization in Pakistan has been accompanied by a decline in the relative share of the agricultural labor force in the total labor force. The 1961 census shows the share of agriculture as 74.6 percent of the total labor force, declining from 76.5 percent in 1951. Nonetheless, given the high rate of population growth (which implies a high growth rate of the labor force), and the very high share of the agricultural labor force in the total, it will be a long time before the absolute size of the agricultural labor force starts declining. According to the calculations carried out by Bruce F. Johnston,[7/] if the share of the agricultural labor force is 80 percent, with the total labor force increasing at 3 percent and nonfarm employment growing at 4.5 percent per annum, it would take more than 50 years for the absolute number of farm laborers to begin to decline -- and by then the farm labor force would have trebled. Even if the growth rates of the total labor force and the nonfarm labor force are 2 percent and 4.5 percent, respectively, it would take 34 years before the absolute number of the farm labor force will start declining, and it would take 50 years for the share of the farm labor force to decline from 80 to 35 percent of the total.

6/ Increases in agricultural employment projected for the Third Plan period are based on the assumption that expansion in the cultivated area requires a corresponding increase in labor and on the assumption that the projected increase in land productivity (output/acre) will come in part from additional inputs of labor. We note that there is no reference to the potential effects of large-scale mechanization program which will raise the land/man ratio and decrease the contribution of labor input in the growth of land productivity.

7/ The projected changes in total, farm and nonfarm labor force were obtained by iteration on a computer by Johnston. The influence of the existing occupational structure of an economy on the rate of change of the farm labor force is given by the identity:

$$\dot{P}_a = \frac{P_t}{P_a}\dot{P}_t - \frac{P_n}{P_a}\dot{P}_n$$

where P_t, P_a, and P_n refer to the total, agricultural, and nonagricultural labor force respectively and the dots refer to the annual rates of change of the respective variables. This procedure assumes that the size of the agricultural labor force is determined as a residual on the basis of exogenously determined rates of change in the total and non-agricultural labor force.

Bruce F. Johnston, "Agriculture and Economic Development: The Relevance of the Japanese Experience", Food Research Institute Studies, Vol. 6, No. 3 (1966), pp. 251-311, particularly, pp. 309-311.

These growth rates, of course, are hypothetical and not what we observe in Pakistan. However, they are reasonably close approximations to the Pakistani situation, as can be seen by the comparison below:

	Pakistan[8/] (1951-1961)	Hypothetical Case I	Hypothetical Case II
Share of Agricultural Labor Force (%)	74.6	80	80
Compound Growth Rate (per annum)			
Total Labor Force (%)	2.8	3	2
Non-Agricultural Labor Force (%)	3.6	4.5	4.5

In view of the fact that the marginal capital labor ratio rose from an estimated Rs.3,650 in the early fifties to about Rs.5,250 in the Second Plan period and that the ratio is estimated to rise further to Rs. 7,250 during the Third Plan,[9/] the economy's ability to absorb a growing labor force into productive non-agricultural employment in the coming decades will almost certainly be below the hypothetical rate of 4.5 percent per annum, and possibly be below the rate observed for the period between 1951 and 1961.[10/] It should be noted further that 44.5 percent of the 1961 population of Pakistan were children under 15 years of age. In view of most reasonable estimates of population growth, which place the rate of increase at more than 3 percent per annum, the hypothetical growth rates of the total labor force under-estimate at least for a short while the increase in the entrants into labor markets. Thus, the assumptions in the hypothetical cases adopted here are on the generous side.

8/ Computed from the Census of Pakistan, 1961 and 1951 editions. It seems that there is a distinct under-enumeration of female agricultural workers in the 1951 census.

9/ Government of Pakistan, The Third Five Year Plan (1965-70), p. 102.

10/ It is understood that some growth in national output is necessary if the non-agricultural employment is to grow at all and that the growth in employment arising from any given growth in output depends on the sectoral composition of that growth.

If we are to limit our scope to the more industrialized and urbanized West Pakistan, essentially the same picture emerges. According to the decennial census results, the agricultural labor force in West Pakistan accounted for 65.4 percent in 1951 and 59.3 percent in 1961.[11/] Taking these figures at the face value, and assuming that the total labor force grows at the average annual rate of 3 percent, and that the non-agricultural employment increases at 4.3 percent per annum as was observed during the ten year period in West Pakistan, we can project the increase in the wing's agricultural labor force from the level of 7.48 million in 1961 to 10.12 million in 1975, 11.85 million in 1985, and 13.65 million in the year 2000.[12/]

It is of vital importance, therefore, to realize that the agricultural labor force in Pakistan will continue to increase in absolute size and to account for the bulk of the labor force for several decades. Absorption of the rapidly increasing labor force into productive employment is, rightly, one of the most urgent policy issues facing Pakistan. Since relatively capital-intensive investment is inevitable in building up the infra-structure and in expanding large-scale manufacturing industries, agriculture has a special role to play as the most important "self-employment sector"; it must not only retain the current level of the agricultural labor force but also absorb residual increases in the total labor force in excess of those finding employment in the non-agricultural sectors of the economy. One of the specific objectives of the Third Plan is "to increase the real income of farmers at least at the same rate as per capita increase in the non-agricultural sectors." Under these circumstances, however, attainment of this objective is problematical at best.

11/ On the basis of the census figures we can compute the share of the agricultural labor force in the wing's rural population. The resulting shares are 23.1 percent in 1951 and 38.4 percent in 1961 -- an increase of 15 percentage points. Demographic and economic inquiry into these annomalies are of vital necessity.

12/ The computations were carried out by iteration on the basis of the formula used by Johnston cited above (Footnote 7). The growth rate of the total labor force is based on the population growth rate for West Pakistan in Lee L. Bean, et al., op. cit.

Man/Land Ratio and Output in the Agriculture of West Pakistan

According to the decennial census results, the agricultural labor force in West Pakistan numbered 6.18 million in 1951 and 7.48 million in 1961, an annual increment of 1.9 percent. The cropped area in West Pakistan on the other hand, is officially estimated to have increased from 28.7 million acres in 1951 to 30.7 million acres in 1961 - about 0.7 percent per annum.[13/] Consequently, the land area available per worker in agriculture declined substantially during the decade.

Only crude estimates of the agricultural labor force in West Pakistan can be constructed for the years other than those covered by the decennial censuses. On the basis of the population of West Pakistan officially estimated, and a simple linear assumption as to the (declining) share of the agricultural labor force in the total population in the wing, the labor force in the agriculture of West Pakistan may be computed for selected years. The estimates obtained from this procedure are given in Table I along with the official estimates of acreage planted under crops and of gross value of crop production in constant prices.

13/ Bureau of Statistics, West Pakistan, Statistics of West Pakistan Agricultural Data 1947-63 (1964). The Pakistan Statistical Yearbook 1964 gives the total cropped acre for 1951 to be 31.9 million acres and that for 1961 at 34.5 million acres.

Table 1

Agricultural Labor Force, Planted Acreage, and Gross Production of Crops in West Pakistan, Estimates, 1951-1964, Selected Years

(in parentheses are relatives)

Years	Agricultural Labor Force (L) (million)	Planted Acreage (A) (million acres)	Gross Crop Production (Q) (million rupees in FY 1960 prices)
1950-52	6.18* (100)	24.69 (100)	4105 (100)
1954-56	6.62 (107)	26.58 (107)	4385 (107)
1960-62	7.48* (121)	28.39 (115)	4870 (119)
1964-65	7.87 (127)	29.12 (118)	5587 (136)

Sources:

Census of Pakistan, Population, 1961 and 1951 editions, US, AID, Statistical Fact Book (1968).
Central Statistical Office, Pakistan Statistical Yearbook, 1964 (1966).

*Census figures for the mid year, 1951 and 1961, respectively.

a) Planted acreage and gross value of crop production are three year averages except for the figures for the crop year 1964/65.

b) Planted acreage includes area under rice, wheat, bajra, jowar, maize, barley, gram, sugarcane, repeseed, mustard, sesamum, linseed, cotton and tobacco.

c) The percentage changes in Labor, Acreage and Output during the selected years are as follows, (they are not annual rates):

Changes in	1951-55	1955-61	1961-64
Labor	7.0	12.9	5.6
Acreage	7.0	6.8	5.5
Output	7.0	11.0	14.7

It is easy to derive relative changes in planted acreage per worker and in gross output per acre from the table. The results of such derivations are shown in the following tabulation:

Percentage Changes in Acreage per Worker and Output per Acre, West Pakistan, Selected Years, 1951-1964.14/

Changes in	1951-55	1955-61	1961-64
Acreage/Worker	none	-6.0	none
Output/Acre	none	4.2	9.2

Since the number of years included in each selected time interval is different, varying from three years for 1961-64 to six years for 1955-61, direct comparison of the percentages is not advisable. Nonetheless, a general picture may emerge upon examination of the trend indicated by these figures.

The stagnation of agricultural production during the 1950's is attributable to the worsening land/man ratio which was not fully compensated for by the slow increase in output per acre (measured in money). In contrast, the celebrated performance of agriculture during the Second Plan period is the result of the expansion in planted acreage paralleling the growth of the agricultural labor force and a rapid expansion of yields per acre (real output per acre per year).

If we are to measure the performance of agriculture in West Pakistan in terms of output per worker, the years between 1951 and 1955 should be characterized as those of virtual stagnation, the First Plan period as the period of retrogression, and only the Second Plan period may be termed a successful period. The encouraging performance during the Second Plan period took place largely as a result of water resource development, in which private tubewells were particularly important.

14/ Computed from data in Table 1.

2. SOURCES OF PRODUCTIVITY GROWTH IN AGRICULTURE

In analyzing the basic input-output relationships and in assessing the productivity performance of agriculture it is convenient to consider the following identity:

$$O = L \times \frac{A}{L} \times \frac{O}{A}$$

where O denotes output in agriculture, A planted acreage, and L stands for workers gainfully employed in agriculture. The output per worker is then given by the product of the two ratios on the right-hand side of the identity, namely, planted acreage worked by a unit of labor and output per acre. The identity states that, in incremental terms, an increase in output of agriculture results from an increase in any one of the three terms on the right-hand side so long as such an increase is not offset by adverse effects on the other terms.

Capital is subsumed in this relationship and its effects on production, either in the form of working capital such as the use of fertilizers and seeds, etc., or in the form of fixed assets such as irrigation facilities or farm machines, will appear either as a rise in yields per acre or in a rise of the land/man ratio, or in both. Additional supplies of irrigation water in the Second Plan period acted on both these terms by increasing acreage or the cropping intensity and by increasing crop yields.[15/] The new seeds and increased application of fertilizers in recent years had the effect primarily of increasing yields per acre (per crop). Inputs of herbicides and pesticides,

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15/ According to Ghulam Mohammad, additional water made available by the tubewells enabled the farmers to: (i) increase the depth of irrigation of existing crops; (ii) increase the intensity of cropping by eliminating fallowing and by double cropping; (iii) grow more valuable crops like cotton, rice, fruits and vegetables; (iv) increase the use of fertilizer; (v) increase the efficiency of bullock use; and (vi) increase the output per manual worker. Additionalsupp supplies of water, thus, played the role of catalyst in introducing the yield-increasing (per acre per year) innovations as well as in affecting the expansion of planted acreage.

Ghulam Mohammad, "Private Tubewell Development and Cropping Patterns in West Pakistan," Pakistan Development Review, Vol. 5, No. 1 (Spring 1965), pp. 1-53.

however, have the beneficial effects on yields (per crop) and also save labor required for weeding and pest control, and therefore, to that extent open up the possibility of expanding acreage per worker. By the same token, machines and implements of various types and sizes will affect the expansion of acreage per worker, to the extent that they save human labor required for various phases of agricultural operations, and increase yields per acre so far as they perform agricultural operations "better" than the manual labor alone.

It is clear that there are many ways in which factors of production can be combined to achieve a certain level of output. For any given set of factor prices different techniques of production (i.e., different combinations of factors) can be arranged in order of increasing unit cost of production. For any given price of the product this is also the order of decreasing profitability. It follows therefore, that given factor and product prices it is profitable to adopt and use the method of production which minimizes per unit cost of production. Economists would call this method of production the most efficient.[16/] Thus, from economists' point of view, that a certain operation is performed more "efficiently" in the engineering sense, be it in fuel-energy conversion, body-weight-energy conversion, or in the power-draft-speed relationship, does not necessarily mean it is a more efficient operation than other alternatives. In economists' terminology, "efficient" operations are those that maximize output at a given cost (constrained by the availability of resources and determined by the prices of inputs reflecting social scarcity values) or minimizes cost at a given level of output (required by the social appraisal of need). Economic discussions of the choice of techniques are couched crucially in terms of the relative prices (opportunity costs) of the substitutable factors of production.

16/ There are two assumptions underlying this statement. One is that the factor and product prices are given and the other is that there are no economies of scale. The statement remains valid if either one of these assumptions is dropped, provided that the other is retained.

Where a particular factor is relatively abundant, the price of that factor is low, and vice versa. Because of market imperfections and systems of discriminating subsidies and taxes, prevailing costs of the factors of production do not reflect their opportunity costs with any accuracy in developing countries. Nonetheless, it is undebatable that the economically most efficient technique is that which employs relatively larger amount of abundant resources and economizes on the use of scarce resources. In other words, the criterion of economic efficiency dictates that output per unit of scarce resource be maximized by combining abundant resources as much as economical with the unit of scarce resource.[17/]

If land is in ample supply and labor is scarce, the primary emphasis of the agricultural development may be on an increase of acreage per worker, thus raising the output of each worker in the sector. On the other hand, if labor is abundant and land is scarce, the basic theme in the growth of agricultural productivity will be an increase in yields per acre to enhance the output per unit of available (irrigated) land. Although it is often impossible to make a clear-cut theoretical distinction of the effect of an innovation in agriculture, it is convenient to associate loosely mechanical-engineering technology with an increase in acreage per worker and biological-chemical technology with a rise in yields per acre. Then, we may state that the emphasis of the agricultural development in a land-rich, labor-poor economy will be primarily on mechanical-engineering innovations, and that the basic theme in a land-poor, labor-abundant economy will be on biological-chemical innovations.

17/ The standard objection to the use of the "factor proportions argument" as given here is that factor costs may change markedly over time as a result of economic development, so that an advantage based on, say, cheap labor may prove to be quite limited in duration. Relevant consideration for the case of West Pakistan's agriculture in this respect is that the agricultural labor force is to continue to grow in absolute number for several decades to come. Thus, the opportunity cost of labor is expected to remain low until the structural transformation of the economy takes place several decades hence.

Another standard argument against the line of reasoning given here emphasizes the possibilities of reinvesting surpluses of large (mechanized) farms. I shall deal with this point in a later section entitled, "Economic Implications of 'Bi-modal' Pattern of Agricultural Development."

In case both land and labor become the constraints for the growth in agricultural production, both acreage per worker and yields per acre are proper targets for improvement. Expansion of output per acre and acreage per worker will increase agricultural output even under the condition of the declining agricultural labor force and reduced acreage available for farming.

It is common knowledge that machines and implements (of various types and sizes) save labor required for any specific operation. Proponents of tractor mechanization, however, would emphasize the yield effect rather than the labor displacement effect when faced with a situation characterized by an abundant supply of labor. One of the most important of the favorable effects of mechanical power and "efficient' implements on better yields is timely preparation of seedbed.[18/] A variation on this theme is of course "efficient", timely harvesting and postharvest processing of crops.

Introduction of a time dimension into the picture should not complicate the analysis too much, however. From economists' point of view, a high level of cropping intensity represents a situation where land is scarce relative to other inputs. Taken within each cycle of crop growth (determined by the growing period of the crops and the climatic characteristics of the area), therefore, an increased input of any one factor should be judged on the same basis as before. Because intensified cropping means simply that a greater amount of output is obtained in a given period of time due to an increased application of factors on land, presumably it is possible to intensify cropping by an increase in any factor of production other than land (say, labor or capital) at some configuration of prices of inputs.

18/ Timeliness in seedbed preparation is less critical on irrigated lands than on rain-fed areas, which have to rely on the moisture retained in the soil for the growth of crops. However, it is often argued that the time element in seedbed preparation becomes of crucial importance on irrigated lands if there is a pressure to achieve multiple cropping.

It is the contention of this paper that, given the circumstances as they exist today in West Pakistan, the beneficial effects of extensive mechanization on growth of productivity in agriculture are marginal, relative to those to be realized by a variety of improved cultural practices short of the tractor mechanization program being envisaged by engineering experts. It is instructive here to review the experiences of two countries whose agricultural sectors faced widely different circumstances in their early years of development.

Experiences of the United States and Japan[19/]

According to an illuminating study by William Parker and Judith Klein, output per man-hour in the production of principal grains in the United States quadrupled during the period between 1840-1860 and 1900-1910.[20/] The authors attribute this gain to three broad sources: (1) westward movement of crop production[21/]; (2) changes in yields per acre; and (3) mechanization and other improvements which reduced labor inputs per acre. The authors observe that mechanization and the regional shift of production are responsible for nearly the whole effect of the productivity increase in wheat and corn (maize). The changes in yields apparently play a minor role. Indeed, grain yields per acre in the United States rose only slightly, if at all, during the period before the 1920's.

19/ This section owes to my earlier article, "The Sources and Rates of Productivity Gains in Japanese Agriculture, as compared with the U.S. Experience," Journal of Farm Economics, Vol. 49, No. 5, (December 1967), pp. 1443-1451.

20/ William N. Parker and Judith L.V. Klein, "Productivity Growth in Grain Production in the United States, 1840-60 and 1900-1910," in Output, Employment and Productivity in the United States after 1800, N.B.E.R. (New York, 1966), pp. 523-580.

21/ The growth of the West relative to the low-yield border states of the upper South raised the anational average yields.

In the United States, the source of agricultural growth in the late nineteenth century and the early decades of this century is found in the advances in mechanical-engineering technology characterized as "horse mechanization" of its agriculture. Given ample land resources to the west of the country, the mechanical technology of these years increased the acreage worked by individual farmers, or what amounts to the same thing, decreased the amount of labor input per acre. During the period between the 1920's and the 1940's the so-called "tractor mechanization", mechanization of motive power -- the replacement of horses by tractors -- swept the country. This new mechanical-engineering technology had the effect of drastically increasing the acreage worked by the farm worker (reduced labor input per acre) and kept increasing agricultural output in the face of an absolute decline in the farm labor force resulting from absorption of the rural population in the urban industries.

Since the 1940's, new biological-chemical technology has started exerting its major effects on the agriculture of the United States. The innovations relating to improved seeds, fertilizers, herbicides, and pesticides took effect on the bulk of the U.S. farms and led the way to an unprecedented increase in crop yields per acre that continues today. As is well known, this new technology, in combination with the ever increasing engineering efficiency of farm machinery, is responsible for an embarrassing accumulation of surplus farm products in spite of decreases in acreage as well as in the farm labor force.

An abundance of arable land on the frontier and the most favorable land/man ratio contributed significantly to the pattern of the agricultural development in the nineteenth century United States. Since labor, not land, was the scarce resource, it was output per worker which was constantly enhanced. Under these circumstances the output per worker in the United States was first raised by increasing acreage per worker by means of mechanical-engineering innovations and, more recently, by reducing the

number of workers on the farm and by increasing crop yields per acre by means of biological-chemical innovations.

In contrast to the environment of the United States, agriculture in the nineteenth century Japan was characterized by the most unfavorable land-man ratio and the virtual disappearance of unutilized arable land (except in the northernmost parts of Japan) before the modernization process began in 1868. Despite these circumstances, a remarkably rapid growth in agricultural output was attained with notably small demands on the scarce resources, land and capital, in the framework of small-scale agriculture. In order to eke out a living with the holdings of about 1 hectare (2.47 acres) per farm household (and with its holdings typically fragmented into some 10 to 15 scattered parcels of irregular shapes), farmers practised an intensive and skillful agriculture; according to one estimate, before World War II Japanese agriculture had already attained the highest production per acre in the world, yielding an estimated net product per acre several times as large as that of the United States.22/ Since, however, the amount of land worked by a farmer was severely limited, output per farmer was extremely low. Farmers did not hesitate to expend an immense amount of labor in order to coax out the maximum possible yields from their fields.

Since the scope for expanding the cultivated area was limited by the topographic conditions as well as economic reasons, and since the number of farms stayed virtually constant over a long period until after the mid-1950's, the agriculture of Japan attempted to increase the productive capacity of a unit of available land. The ways in which this central theme has been

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22/ Professor Kazushi Ohkawa estimated net product in agriculture per hectare of agricultural land in Japan at $146 just before the war (at pre-war prices). This figure was seven times as great as that of the United States. See: Shujiro Sawada, "Innovation in Japanese Agriculture, 1880-1935," in The State and Economic Enterprise in Japan, ed. William W. Lockwood (Princeton 1965), pp. 325-351, especially p. 331.

successfully carried out in Japan form the most interesting as well as instructive elements of the agricultural development of Japan.

Generally speaking, the gains in land productivity in the early years derived largely from the institutional reforms which made possible the diffusion of techniques and knowledge over the entire country. Veteran farmers travelled throughout the country (often under government auspices) teaching improved methods of cultivation that were based initially on their own experiences rather than scientific experimentation. These techniques emphasized the achievement of higher yields through the application of improved husbandry, organic sources of plant nutrition and pre-Mendelian methods of plant improvement, primarily through selection rather than through breeding.

The production and use of chemical fertilizers began to increase rapidly during World War I, and by the late 1920's has surpassed the organic fertilizers.[23/] It is to be noted that two major factors contributed to this increase in fertilizer use over the years. One factor was the development of new variety of seeds (especially for rice) which would give a strong response to heavier applications of fertilizers. The other was the development and innovations in the fertilizer industry, which made commercial fertilizers available to farmers at increasingly favorable terms.[24/] During the period between 1890 and 1935 grain yields per acre in Japan increased by 55 percent. Of this increase about a half is attributable to the

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23/ For many years Japan has used large amounts of both farm and commercial fertilizers to maximize crop production. During the inter-war years the rates of fertilizer application per acre were already among the highest in the world. Manure, green manure, night soil, compost, and other organic fertilizers have been used in Japan for hundreds of years. The use of these so-called farm fertilizers has increased only slowly, however, because of the limited number of farm animals and the scarcity of land for raising green manure crops. For this reason, as cultivation practice became more intensive and multiple cropping spread in warmer areas of the country, the use of various types of commercial fertilizers increased rapidly. Such manufactured organic fertilizers as soya-bean cake, rapeseed cake, and fish meal were the first to become commercially important.

24/ That is to say, the price of fertilizer in terms of the price of rice declined.

contribution derived from developments in the fertilizer industry and the associated improvements in seeds.

Until about the middle of the 1950's mechanization in the agriculture of Japan was limited largely to ancillary operations (e.g., threshing and husking of rice after harvest) and irrigation systems. The field operations were carried out almost exclusively by hand, although animal power was often used in plowing. To be sure, in prewar Japan after the turn of century animal drawn implements as well as hand tools for agricultural operations were progressively improved with the advent of urban industries.[25/] However, it should be noted that mechanization of field operations in Japan is strictly a post-World War II phenomenon.

Intensive application of factors of production to the limited land is still the prominent feature of the agriculture of Japan. However, the composition of the factors of production applied to the land has changed since the 1950's when the land reform programs were completed and the spectacular growth of Japanese economy got underway. The owner farmers, newly-created by the land reform program, supported by the rise in their real incomes and prodded by the increasing real wage levels both on the farm and elsewhere, took the initiative in mechanizing field operations. Moreover, the use of agricultural chemicals which reduce the requirements for labor, particularly herbicides and insecticides, spread to all agricultural enterprises and especially to rice cultivation. The processes of mechanizing field operations and of increasing

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25/ Among these improvements important are the development of modern short-bottom plows, which permitted either deep or shallow plowing and provided added stability in handling over the older ones, the development of rotary threshers, which originally were powered by man power through a foot-pedal mechanism and replaced the comb-toothed threshers, and the replacement of long-nailed, rake-shaped weeders by the rotary intertillage weeders. The sources of motive power other than human and animal power were poor and the available mechanical power was limited to stationary machines used in irrigation, drainage, and post-harvest operations.

application of agricultural chemicals are the prima facie evidence of a gradual shift of emphasis from the land-productivity growth to the labor-productivity growth in the postwar Japanese agriculture. Nonetheless, it is to be emphasized that the recent emphasis is a consequence of a remarkable structural transformation of the Japanese economy, epitomized by the beginning of an unprecedented (absolute) decline in the agricultural labor force (at 3 or 4 percent per annum). Total agricultural labor force in Japan numbered less than 10 million in 1967, or less than 20 percent of the total labor force of the country.

In terms of sheer numbers, power threshers and huskers totalled more than 3.1 million in 1965, and their traditional importance on the farms (5.6 million households in 1965) in Japan has not diminished yet. However, power tillers have shown the most conspicuous increase since the 1950's. They numbered less than 90,000 in 1955, jumped to 1,020,000 in 1961, and increased further to the level of almost 2.5 million in 1965. In value terms, the production of power tillers (mainly destined to domestic use) constituted 56 percent of the total farm machinery produced during the period between 1961 and 1965. Almost one in every two farm households now owns a power tiller.[26/]

It is important to note that all through the pre-war period of agricultural development and also since the completion of the land reform program in the early 1950's the basic organization of the agriculture of Japan has remained small and family oriented. The theme underlying the agriculture of Japan has been

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26/ The farm equipment used in field work is light and adapted to small fields that Japanese farms operate. About 98 percent of power tillers have less than 10 horsepower and are not unlike large garden equipment used in western countries. They are designed mainly for carrying out the limited processes of cultivation, such as tillage, breaking of clods, levelling, and puddling, mostly in paddy fields. Although an increasing number of exceptions can be found recently, power machines are scarcely used in seeding, transplanting, and harvesting.

that of progressively modifying farming systems rather than attempting a wholesale substitution of "modern" for "traditional" agriculture. Moreover, in the development of Japanese agriculture the change in yields per acre has always been the most important single factor. Only after the mid-1950's, when the labor supply in agriculture became increasingly short, was mechanization for the purpose of saving labor introduced. Since land is the limiting factor, attempts at increasing land yields have always been emphasized However, the rate of expansion in yields per acre has slowed down considerably in recent years. This fact, in conjunction with the growing labor shortage, prompted the rapid rate of mechanization in order to increase output per unit of labor.27/ The essence of mechanization in the agriculture of Japan is that the acreage worked by a farmer was expanded by the adoption of labor saving equipment only after the growth in output per acre had become slow and extremely costly.

27/ It is to be noted that the combined effects of mechanization of field operations, which increased the efficiency of paddy preparation, and technical improvements in current inputs, such as the development of inexpensive vinyl sheeting materials for farm use (to protect rice seedlings from cold weather), have been the increasing possibility of shifting the growing season of crops. Farmers have become able to prepare seedbed at an earlier time than was deemed possible before the war and efficiently to prepare rice paddies for transplanting at the most opportune moment. By enabling farmers to avoid the most damaging influences of typhoons before the harvesting period, this practice contributed to increasing (and stabilizing) land yields as well as to extending the practice of multi-cropping of rice. It is important to realize that mechanization of field operations in Japanese agriculture today, exemplified by the widespread use of power-tillers, and power-sprayers, is itself intimately bound up with improvements in yields per acre of Japanese farms, and that the transplanting process and the harvesting of crops have not yet been mechanized. It may be suggested that mechanization of field operations has been carried out with an eye to increasing land productivity rather than purely for the sake of saving labor. In fact, there is a consensus among Japan's agricultural experts that the mechanization program per se has had no effect on the yields of land.

3. TRACTOR MECHANIZATION IN WEST PAKISTAN

According to the estimates by G.W. Giles, the present horsepower per cultivated area in West Pakistan amounts only to .084 horsepower per acre, consisting in human labor of .013, work animals of .061, and mechanical power of .010. On the basis of an international comparison of available horsepower per acre against grain yields per acre adopted from a study in the United States,[28] Giles concludes that "the greatest gains in yields are obtainable more rapidly up to a power input of .2 horsepower per acre," and that "considerably more power would be required for maximum yields."[29] Observing that "an investment now, even with borrowed monies, should pay off handsomely in monetary returns as well as human dignity," and that "to do it, land must be developed and farming must be placed on a fully mechanized commercial basis,"[30] he recommends a program of rapid tractor-mechanization involving 250,000 tractors (30 to 100 horsepower sizes) for West Pakistan by 1985. Aside from some important problems associated with such a bold comparison and the conclusions drawn from it,[31] it is highly appropriate to ask whether

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28/ The White House, The World Food Problem, Vol. II (May 1967), p. 398.

29/ G.W. Giles, "Toward a More Powerful Agriculture," Distributed by the Planning Cell.
Agriculture Department, Government of West Pakistan, mimeographed, (November 1967).

30/ Giles, op. cit., p. 14.

31/ There are at least three major problems. First of all, there is a problem of erroneously identifying a casually observed relationship as a causal relationship between the variables concerned. Yield per acre is a function of various factors of production besides power inputs. Since there are many alternative ways of combining different factors of production (in varying proportions) for obtaining a certain yield performance, it is misleading to single out one factor. It is not only misleading but erroneous, moreover, to identify such a factor as the cause for yield increases observable in the international (or inter-regional) comparison.
Secondly, the fact Giles ignores the importance of inputs other than power reflects his failure to distinguish various inputs with their individual characteristics. On the one hand, there is an important distinction to be made between factors which are divisible and those that are lumpy. Such factors as seeds, fertilizers, chemicals, are eminently divisible into small quantities and, therefore, neutral to scale of operating

or not in the years to come tractor-mechanization will indeed "earn" foreign exchange, or "save" it, or whether such a program is economical and in the interest of the overall economic development of West Pakistan.

Development of Official Views on Mechanization of Agriculture in Pakistan

It is interesting here to trace the transition in official views on the question of mechanization of agriculture in Pakistan. The Pakistan Agricultural Inquiry Committee looked into the question right after the independence and reported as follows:

> We depend on imports of most of the fuel oils and lubricants required, as also the tractors and implements. These are two serious handicaps. Labour, owing to natural increase of population and influx of regugees is abundant. It has got to be provided with employment. For these reasons it would be unwise to follow exactly the same pattern of rapid transition from animal to tractor power as adopted by the countries (e.g., U.K., U.S.A., U.S.S.R., etc.) as referred to above. It is estimated that complete

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31 (cont'd)

.....acreage, whereas other factors such as large farm machines and equipment are lumpy and cannot be easily introduced into small farm management units. On the other hand, there is also a crucial distinction to be made between/such as fertilizers and tubewells /inputs which are basically complementary to the farm-supplied resources of labor and land, and inputs like tractors and combines which substitute non-farm resources for farm supplied resources of labor and draft animals. One argument often made for substitution of machines for draft animals is that the animals and the land required for fodder production already represent capital investment. Such an argument neglects a distinction between capital investments which represent accumulation of farm resources and investments which require non-farm resources (e.g., machines, fuel oil, foreign exchange, etc.)

Thirdly, there is a problem of lumping together different countries with different factor endowments pursuing different patterns of agricultural development. According to the figures which form the basis of the international comparison in question, Japan ranks first among countries in grain yield per acre as well as in power available per acre. There is no denying that the rapid increase in power tillers and other power machinery in Japan is one of the most spectacular developments in the agriculture which was long characterized by such phrases as "too many people on too little land," and "labor intensive, hand-tilled, paddy-rice cultivation without livestock." However, it should be reminded that mechanization of field operations in Japan is strictly a post-World War II phenomenon and that, as we have noted, the yield obtained from Japanese farming technology before World War II, with an immense amount of labor input in the virtual absence of power machinery for field operations, was estimated to have been several times larger than that in the United States where the so-called "tractor mechanization" swept the country during the interwar years. It is safe to state that dramatic increases in yields per acre in the United States began only after the 1940's in response to the rapid development and adoption of biological-chemical technology on the American farms.

> farm mechanization would displace at least 2 out of 3 labourers. Such a change in agricultural economy might create a serious problem of unemployment. Caution against too rapid mechanization is, therefore, needed in settled areas as industrial development will take considerable time to absorb the surplus labour. We must, therefore, develop mechanization to suit our own conditions.32/

The Committee thus cautiously disavowed tractor-mechanization in Pakistan's settled areas and recommended only limited programs of mechanization in "New Canal and Anti-erosion Project areas", which were expected to provide additional employment and result in substantial increases in the production of food and cash crops.

Ten years later a set of new considerations was recognized. The Food and Agriculture Commission of 1960, charged with the responsibility to evaluate methods of increasing agricultural production after a decade of the rather slow progress in production (particularly of food crops), pointed out some dynamic considerations relevant to the question of mechanization at the time. The Commission had this to say in its report of 1960:

> The standard objection in Pakistan to the mechanization of agriculture is the fear of widespread unemployment and it is a very valid one. Moreover, it is important to use to the fullest extent the one resource the country has in abundance, namely, human labor, Nevertheless, there are strong reasons for examining the case for mechanization. In judging its value there is need to assess whether its use may not earn or save far more foreign exchange than its importation costs and, by increasing production, create far more jobs in the long run than it displaces. It is true that in Pakistan industrialization has not reached a stage where population displaced from the land can easily find employment. When individuals are displaced, real human problems are created but these individual cases of hardship have to be compared with the prospect of poverty and unemployment faced by the whole country, if agricultural production is not increased.33/

32/ Government of Pakistan, Ministry of Food and Agriculture, The Report of the Pakistan Agricultural Inquiry Committee, 1951-52, p. 11.

33/ Government of Pakistan, Ministry of Food and Agriculture, Report of the Food and Agriculture Commission (Nov. 1960), p. 106.

Reexamination of the case for mechanization by the Commission is based fundamentally on its pessimism regarding the possibility of agricultural development in Pakistan so long as her agriculture depended solely on draft power of bullocks. Since bullocks are small and underfed, the use of improved implements are precluded and the poor conditions necessitate plowing the land several times before it is satisfactorily prepared: as a consequence, planting is delayed or prevented and the intensity of land use and the cropping ratio are kept low. Low productivity of agriculture, in turn, necessitates the maintenance of small, underfed draft animals. Thus, according to the Commission report, the vicious circle of stagnant agriculture is complete. In the Commission's view, the first benefit to be derived from mechanization, therefore, was the breaking of this vicious circle in cultivation/plowing operations. By increasing the intensity of land use and the cropping ratio, output would be increased and its benefits might outweigh the short-run foreign exchange costs of mechanization programs. Given this possibility, the displacement of labor by mechanization of settled areas should be viewed from a new perspective. The standard case against mechanization of Pakistani agriculture, therefore, should be closely rescrutinized.

It is indeed interesting to compare the basic tenets of the two reports on the question of mechanization; each point of view reflects by necessity the circumstances of Pakistan's economy and agriculture as given in its respective time. During the early 1950's, the influx of refugees and the natural increase in population and the state of industrial development made the employment problem quite visible. The Committee's report, therefore, emphasized the labor-displacing effect of mechanization and disavowed the wisdom of extensive mechanization in the already settled areas. During the next ten years, however, the foodgrain position of the country deteriorated. A poor crop in 1952/53 turned Pakistan into a large net importer of foodgrains. The next poor crop in 1955/56 accentuated the food deficits and

fixed the country's position as a chronic net importer of foodgrains. In view of the need for urban and industrial development, the dissipation of the scarce foreign exchange resources on foodgrains imports came to be viewed as an urgent problem. Moreover, the combination of a low per capita output (income), a high propensity to consume farm products on farm, and a small quantity of marketable farm products, came to be regarded as limiting the possibility of rapid urban/industrial development. It is therefore quite understandable that the Commission's report emphasized the output-increasing effect, rather than the labor-displacing effect, of mechanization. It reflected the reality of the early 1960's when agriculture was stagnant and there was an urgent need for import substitution in foodgrains.

If mechanization of agriculture in Pakistan increases output which will earn foreign exchange by increasing exports of farm products and manufactures or save foreign exchange by decreasing imports of foodgrains, the foreign exchange required for imports of machines, implements, and fuel are not wasted resources. The Commission report, therefore, proposes to weigh the costs and the benefits of mechanization in terms of foreign exchange resources. Furthermore, the Commission asks whether the short-run displacement of workers from land, though undoubtedly a hardship on the individuals concerned, would necessarily outweigh the chronic, overall unemployment associated with low agricultural productivity and limited industrial development. In the Commission's view if unemployment in the short-run is inevitable[34/], policy should consider the long-run problem of overall poverty and unemployment resulting from the chronic stagnation of agricultural production.

34/ The Commission points out that due to the limitations imposed by both financial and technical considerations a very rapid mechanization in Pakistan is impossible and, therefore, that there will not be a massive displacement of agricultural laborers.

These are all difficult questions. Aside from the methodological problems involved in the cost comparisons urged by the Commission, fundamentally more difficult to resolve are the practical implications of such views when translated into policy measures. Given the fact that imported foodgrains feed the urban population rather than the rural in Pakistan, the import substitution policy being contemplated must aim at an increase in the "marketable surplus" of foodgrains as well as an increase in output per se. Since a lower per capita output (income) and a high propensity to consume farm products on farm combine to limit the quantity of the marketable surplus expected from small land-owners and tenants, as a practical matter, import substitution must aim at increasing the output of larger land-owners. By necessity, therefore, mechanization programs must be focussed on the larger land-owners.[35/] The bulk of the nation's farmers would be excluded from the benefits, and the hardship of unemployment and displacement would fall exclusively on the landless workers.

A series of developments in the agriculture of Pakistan in recent years, however, seems to make most of the Commission's query irrelevant. With the benefit of hindsight we may say that the output-increasing effects of the tubewells in the Second Plan period and the "green revolution" of the more recent years have shown, without doubt, distinctive alternatives to mechanization for a rapid agricultural development. Pakistan now has broken out of the so-called vicious circle by means which are inexpensive in terms of the scarce resources of foreign exchange and capital. Tubewells and low-lift pumps, to say nothing of the new biological-chemical inputs, are prime examples. Moreover, the country has found in the "green revolution" the way to increase output without displacing (or even with increasing) the employed labor force

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35/ This point is in addition to the more technical reason that a large management unit is prerequisite to the maximum use of machines and implements. More on this later.

in agriculture. Finally, and not least important, substantial increases in yields obtainable by the further progress of the "green revolution" would make it possible for the mass of the nation's farmers to share satisfactory increases in output while solving the problem of chronic foodgrain deficits in Pakistan.

New developments, however, have brought forth new problems. In Pakistan the marketing system, grading and processing procedures as well as transportation and storage facilities remain antiquated -- a situation tolerable so long as the marketable surplus of agriculture remains meagre. The situation in West Pakistan has now changed. A rapid increase in output has now raised the marketable surplus and taxes the facilities for handling it. Attacks on these problem areas will compete for the scarce resources of capital and foreign exchange.

The Private and Social Profitability of Tractor-Mechanization

Generally speaking, tractor-mechanization has progressed in countries where the land/man ratio is extremely favorable and where economic development has reached the phase in which a large quantity of accumulated capital per man would make the productivity of labor high and capital cost cheaper relatively to the cost of labor. As we have seen, the land/man ratio in Pakistan is expected to worsen rather than improve and, given the dimmed prospects for massive foreign assistance and the increasing population, capital accumulation per man will be slow in the foreseeable future. Nonetheless, it is clear that the tractor population in private hands has increased substantially, particularly in West Pakistan. There are indications that in the Punjab a number of large land-owners are setting up management units of 150 acres or more as they obtain tractors. On such farms the number of hired workers has been drastically curtailed as compared with the situation before the introduction of tractors and implements.[36/] There are

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36/ Reports indicate, furthermore, that even the tenants are being moved off the land. Although rights of tenants are protected by law, if the landlord introduces mechanization program on his farm and cultivates the land himself, tenants can be removed by

reports, moreover, that self-propelled combine harvesters are being purchased by some of these landowners.

A number of important factors explain this phenomenon. The government of Pakistan made it clear that the move towards self-sufficiency in food requirements is one of the specific objectives for agriculture in the Third Plan. The government has promoted new farming techniques by its policies concerning the prices of inputs and outputs which enhance farm profits. On the input side the most prominent have been the subsidies on fertilizers, pesticides, and water rates. Important also have been the government measures to grant tax and tariff exemptions to the imports of agricultural investment goods and to license imports at the artificially low official rate of exchange. On the output side a key feature of the government policy has been price support schemes on some commodities in order to provide an incentive to farmers by giving them the prospects of a more predictable income. Floor prices, which the government guarantees by purchasing in the regular commercial markets when necessary, are established for wheat, rice, maize, and groundnuts. These policy measures have been quite successful in accomplishing the immediate task for which they were intended. The use of fertilizers has continued to expand and output of foodgrains has increased. However, they have also introduced a peculiar price structure which has tended to distort real economic calculations for the agriculture of Pakistan.

According to a study by Oddvar Aresvik, assuming the world import price of wheat at Rs.12.70 per maund (the average for 1960/61 to 1964/65), the F.O.B. Karachi price of wheat for export from West Pakistan would have to be about Rs.11.00 per maund. Counting the handling and transport charges necessary for wheat exports, therefore, the price on the farm level would have to be

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36/ (cont'd)
.....legal process. This is another instance of divergence between private profitability (for landlords) of tractor mechanization and its social profitability (for the economy as a whole).

much lower (Rs.8.00 per maund).[37] Given the official exchange rate, there is no doubt that the domestic price of wheat is substantially higher than the world price. The support price is double the price "justified" by the world market.[38] In other words, the "justifiable" price of wheat, in this sense, is one-half of the current support price.

On the other hand, the substantial exemption of agricultural capital goods from tariffs and taxes means that tractors and machinery can be obtained at the official exchange rate for the price prevailing in the world market. It is evident that in terms of the quantity of output to pay for a given input, Pakistani farmers pay only about one-half the amount of wheat which the world farmers have to pay for a tractor of equal design and power. Tractor-mechanization in Pakistan becomes a profitable if not economical proposition. In Pakistan's capital-poor economy, capital equipment is obtainable at a cheaper price in terms of output than in capital-rich economies, whereas the economic measure of relative scarcity should indicate the contrary for the economy as a whole. This paradox reflects a situation in which a relatively cheap input (labor) is being replaced by a relatively dearer input (capital).[39] The prices artificially maintained

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37/ Oddvar Aresvik, "Possible Export Price for Wheat", mimeographed memorandum to Honorable M.K. Bakhsh, Minister for Food and Agriculture, Government of West Pakistan (May 1968).
Latest reports indicate that the world import price of wheat is on the decline. In early 1968 the comparable world price was about Rs.11.00 to Rs.12.00 per maund. See, United Nations, FAO, Monthly Bulletin of Agricultural Economics and Statistics, Vol. 17 (July-Aug. 1968), p. 39.

38/ On the other hand, if we focus our attention to the import price of wheat, the argument here is weakened. When the government adopts a policy of deliberately promoting import substitution (substituting domestic for imported wheat) the price set on the domestic product should be higher than the world price.

39/ The differences in the level of mechanization among countries can be explained at least in part by differences in wage rates. In the late 1950's two tons of beets or 7.5 hundredweights of grain would have paid for a week's labor in the United States, compared with 1 ton and 3.75 hundredweights in England. These differences in the real cost of labor are reflected in differences in mechanization in the two countries.

by the government measures thus make the private marginal productivity of investment in tractor-mechanization to be considerably higher than its counterpart abroad (in capital-rich countries) and its social marginal productivity at home. 40/

Microeconomics of Tractor-Mechanization and Its Implications

Despite all that has been said in government's policy pronouncements and the assertions made about the yield-increasing effects of mechanization, one is struck by the paucity of data in West Pakistan on this subject. The available data on costs and incomes comparing the mechanized farm operations and bullock power operations, such as those appearing in the report of the First Machinery Conference & Exhibition held in Lahore during early March 1967, appear to rely exclusively on a study by M.S. Gill reported in 1961.41/ According to this report, the increase in yield per acre

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40/ The fact that the private costs of obtaining tractors are lower than the social costs contributes significantly to their uneconomical uses for cartage (of people as well as goods) and other marginal uses observable in the Punjab.

41/ Muhammad Shaffi Gill, "Economics of Farm Mechanization," West Pakistan Journal of Agricultural Research, Vol. 1, No. 1 (December 1962). The study refers to experiments performed during 1952-1954. Lacking in detailed data which formed the basis of various tables presented by Gill, it is not possible to use the results for the purpose of meaningful economic calculations. The total cultivation charges per acre with the use of different tractors and bullocks are ranked in the report. However, the acreage on which these operations were performed is not given. It is common knowledge that on smaller plots of land, less expensive power (draft animals and small tractors) is economical and that in larger acreage the reverse is true. It is also reported that among various farming systems as defined by the author, the so-called "direct mechanized farming" used the maximum amount of manual labor per year. Unless the cropping intensity is increased, or the number of operations (say, weeding, fertilizing, etc.) in cultivation of a single crop is made larger, or both, it does not make sense to say that the input of labor was larger under mechanized farming than under bullock farming. This particular set of data serves to point out what the author intended, namely, that machines do not necessarily displace labor under the given situations in Lyallpur in 1952-54. Of course, however, it cannot be used for the purpose of demonstrating that machines use more labor per single operation required in growing of crops, nor that "direct mechanized farming" is the economically most efficient method of combining resources. The same is true with the report on yield performance of mechanized farming and bullock farming as discussed in text. For the purpose of strict comparison only the motive power should be different in the two situations, given other conditions approximately equal.

in case of tractor farming as against bullock-power farming, amounts to 5 maunds of maize and 4 maunds of wheat (about 25-30 percent).

Except in increasing the intensity of cropping[42] and therefore increasing yield per acre per year, it is not obvious that tractor mechanization per se has much of an effect on yield (per acre per crop) as compared with animal draft power. Experiments in Japan indicate that yield per acre does not increase from mechanization per se. These results seem to be confirmed by experiments at the International Rice Research Institute. Giles is certainly right in stating that good seedbed preparation, weed/pest control, and uniform planting depth assume much greater importance with the new varieties and heavier fertilizer applications. However, these operations can be accomplished by a number of alternative and more economic combinations of factors. Ultimately, therefore, the answer depends on how well land preparation and other operations are carried out by animal-drawn equipment and small power machines in Pakistan, whose development, improvements, and diffusion among the farmers may well be as effective as all-out tractor mechanization of Pakistani farms,[43] and may well be a great deal cheaper in terms of the scarce resources of capital and foreign exchange.

Total cost incurred in crop production consists of the following items: (1) Cost of the use of land and other fixed assets on land; (2) Costs of the current inputs, such as seeds, water, fertilizer, pest control, etc; (3) Cost of power equipment and machinery; (4) Cost of labor. It is safe to assume that the

(3) Managerial effort

42/ The possibility of increasing the intensity of cropping may prove to be important, if water is not the limiting factor, since the 1960 agricultural census reveals that the cropping intensity in Punjab is lower for farm units operating larger acreage.

43/ There is no question that the bullock-drawn implements can be much improved. It is suggested, moreover, that the draft power of the animals can be increased considerably by improving the harness and the quality of food given to the animals.

magnitude of the first two items would be approximately the same, irrespective of type of power used in producing a single crop. The last two items would depend on the field operations required and, crucially, on acres covered as well as on the type of soil. Needless to say, large tractors and equipment cannot be introduced easily to submerged wetland conditions characterizing rice paddies. Adequate traction is difficult to develop under such conditions; lack of mobility and bogging of large tractors becomes a serious problem.

Cost of the use of farm machinery consists of charges for depreciation (by use and by obsolescence), interest payment on investment (regardless of whether the money invested was borrowed or not, since the fund could have been used otherwise and yielded returns), other fixed charges (such as housing, taxes and insurance), and variable costs which depend on the actual use of the machinery (e.g., repairs, costs of fuel and oil). Since fixed charges are large for large machinery, comparative costs of the use of machinery per acre between different size machines depends on the acreage on which they are operated.

According to an experiment carried out at the Central Agricultural Experiment Station of Japan in 1963 (rice production on well-drainable field),[44/] the minimum acreage, the "threshold-acreage", required to make the use cost of 35 HP tractor equal to that of a 15 HP tractor, was between 25 to 30 hectares. (1 ha. = 10,000 m^2 = 2.47 acres). For a larger acreage the use cost of a 35 HP tractor declines more repidly than the smaller one but, unless farm size exceeds 50 hectares, it does not come down to the level of the use cost involving smaller machinery and animals in the customary method of cultivation. Because "large scale" or "medium scale" mechanization requires a larger quantity of investment, the cost of machine use per hectare with mechanized farming is greater than that in the customary methods of cultivation.

44/ Hideo Seko, Lowland Rice and Upland Farming in Japan (Central Agricultural Experiment Station, Tokyo, 1966).

However, the Japanese experiment found that the direct cost of production per hectare in mechanized farming was less than that of the customary method due mainly to the saving in the cost of labor involved. For a larger tractor the "threshold acreage" in this case was between 10 and 15 hectares and that for a smaller tractor was less than 10 hectares. Because of the decrease in yield by mechanized farming,[45/] the Japanese experiment found that the use of 35 HP tractor gives greater returns (value of output minus cost) than the customary method only when the operating acreage is greater than 30 hectares, and that the use of 15 HP tractor was not justifiable under the circumstances.

It is to be noted that the calculation was made on the basis of the Japanese price structure of the wage rate and the cost of capital. It goes without saying that the ratio between the market prices of labor and capital is higher in Japan (especially, in the 1960's) than in the present-day Pakistan. And, therefore, if one is to use the market (in the sense of "shadow" or "accounting") prices of capital and labor for Pakistan, the "threshold acreage" for the use of a larger tractor is expected to increase. It is a well known proposition that when the opportunity cost of labor is low and the rate of interest is high, the threshold acreage will be large and labor-using and capital-saving techniques will be optimal.

According to the agricultural census of 1960, only 8 percent of the farms in West Pakistan exceeded 25 acres (of cultivated land). Since there were 37.2 million acres of cultivated acea and 4.86 million farms, on the average only 7.6 acres of cultivated area was available per farm. If we add the

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45/ The yield per hectare was 3,320 kg. with 35 HP tractor and 3,150 kg. with 15 HP tractor, in comparison with 4,360 kg. obtained by the customary method. In the Japanese study the decrease in yield by mechanization is attributed to the grain loss in the use of a combine. Mechanization-enthusiasts would argue for combines because of their alleged virtue of reducing grain losses. Their argument can be disputed by Japanese experiments. But even if they were right, adoption of combines may not be economical. Grain losses can be reduced in post-harvest operations elsewhere too, say, storage and transportation, which may well be more economical to attack than adoption of combines.

reported cultivable waste of 24 million acres, and assume that the number of farms remained constant, total land area available per farm would be 12.7 acres.

Accordingly, G.W. Giles has recently advised the Government of West Pakistan to pursue a program of rapid tractor mechanization especially for farms holding more than 25 acres. On the average these large farm owners operate 54 acres, which may very well be the "threshold acreage" for tractor-mechanization, given the present structure of output and input prices in Pakistani agriculture. We have seen, however, that the present price structure is the product of artificially inflated prices of output and similarly deflated prices of farm machinery "justifiable" on the basis of import substitution only. The question regarding the future price structure, therefore, has to deal squarely with the probable future prices of agricultural products. If the output prices were to decline, or more precisely, if the relationship between capital cost and labor cost in terms of output prices should move against capital, the "threshold acreage" will rise above the level now being contemplated.

Economic Implications of "Bi-modal" Pattern of Agricultural Development

The "bi-modal" pattern of agricultural development recommended by Giles, where the program of mechanization is to be concentrated on the farms with more than 25 acres of cultivated area, calls for serious thinking in the perspective of Pakistan's agriculture and economy. There are both international and domestic dimensions in this subject regarding the output and the inputs of the agriculture of Pakistan.

Because of the favorable conditions in West Pakistan regarding the availability of irrigation water and abundance of solar energy, and due to the unusually favorable weather in 1967/68 in particular, the "green revolution" seems to have spread most rapidly in West Pakistan. However, the dwarf varieties of Mexican wheat and the dwarf varieties of rice developed by the

International Rice Research Institute are being made available to other developing countries in Asia, and their impact is just beginning to be felt. In Pakistan a supply shortage of the new seeds and limited availability of fertilizers severely limited planting until the 1967/68 season. But, Pakistan was not an isolated example. According to the 1968 annual report of the IBRD (World Bank), India and the Phillipines show a rapid expansion in acreage planted to the new varieties of wheat and rice during the past season. Good progress in introducing the new seeds is also reported in Afghanistan, Ceylon, Indonesia, Malaysia and Turkey. It can be reasonably expected that a growing number of countries in Asia and elsewhere will soon feel the impact of the so-called "miracle seeds".46/ There is no question that these countries are as anxious as Pakistan to achieve self-sufficiency in foodgrains. The spread of the "green revolution" to many countries thus diminishes the prospects of a long-run expansion of grain exports from Pakistan, and the poor quality of grain processing here severely limits the possibility of expanding the export markets (except for the traditional Basmati rice)

46/ The IBRD report is not unique. In his foreword to the 1968 annual report of the Food and Agriculture Organization, the director-general states that the "world food and agriculture situation is now in a stage of transition and hope."

According to the Financial Times, the Organization for Economic Cooperation and Development (OECD) forecasts colossal imbalances in major foodstuffs in the periods up to 1975 and 1985 if the current trends in agricultural production continue unaltered in industrial countries. The most serious of the prospective surpluses are wheat and coarse grains (also rice). These supplies are many times the prospective demand from outside sources, and even the Communist block, excluding China, could well become a net exporter. Of the under-developed countries all except India are capable of self-sufficiency. These increases will come from existing land and labor resources and takes into account population increases and rising living standards. The main factor responsible for the increases is improved yields due to better varieties and farming techniques. See: The Dawn, December 7, 1968.

in the near future.[47] The monetary return from the potential increases in the grain production in Pakistan depends crucially on effective demand. Inasmuch as 70-80 percent of Pakistan's population are members of self-supplying farm households, the growth of domestic demand for purchased foodgrains is severely limited.[48] Increase in effective demand, commensurate with the growth in potential supplies of foodgrains, therefore, is very questionable.

It is indeed difficult to imagine the problem of a foodgrain glut in a country characterized by chronic under-consumption and hunger in recent years. However, the maintenance of a government guaranteed price of foodgrains will become increasingly difficult as the marketed surplus of foodgrains increases. In anticipation of the excellent 1968 wheat crop and a fall in wheat prices after harvest, the government announced its intention to purchase "at least 5 lakh tons of wheat" in order to prevent the prices from falling below the support level.[49]

47/ See for example, J. Normal Efferson, "Prospects for Expanding Export Markets for West Pakistan Rice", (Lahore, July 1968), mimeographed, distributed by Planning Cell, Agriculture Department, Government of West Pakistan.

One of Efferson's conclusions is that "most of the medium-grain rice now being produced in West Pakistan is of such poor quality that it will not be accepted in world markets." Facilities handling wheat are physically different from those handling rice but they are not much different in quality standards.

The fact that imported foodgrains feed the urban rather than the rural in Pakistan has geared the marketing and distribution systems to handling imported foodgrains exclusively. The development of adequate marketing and distribution systems (for both domestic and overseas markets) which can cope with the new situations will require a substantial sum of capital investment.

48/ The figure would be about 60 percent for West Pakistan only. Even if West Pakistan can successfully "dump" surplus wheat on East Pakistan, the domestic market there will be limited by the fact that a larger proportion of the population are members of farm households and that they are traditional rice eaters. Of course, there are many difficult political as well as economic problems in selling surplus wheat from the West to the East Wing.

49/ Planning Commission, Government of Pakistan, Annual Plan 1968-1969 (July 1968), p. 44. 5 lakh tons equal 500,000 long tons. The current floor prices for foodgrains are guaranteed for three years from 1967/68 to 1969/70.

At this time it is not known whether purchase of that much wheat was enough to guarantee the floor price after harvest. It is worth noting, however, that government purchases would cost Rs.231.9 million for 5 lakh tons.[50] This amount is about equal to the public sector development expenditure on education and training for all Pakistan during the 1966/67 period.[51]

The "bi-modal" pattern of agricultural development recommended by Gy Giles will not only create a subsector of agriculture which is large-scale and capital-intensive, but would also promote commercial sales of output more than the growth in total output. If effective demand cannot be expected to increase as rapidly, and/or if the government cannot purchase all that is brought to the markets over and above the absorption by regular commercial channels, the prices of foodgrains must decline below the favorable level existing now. Consequences of such a development are not difficult to imagine. The great bulk of the farmers left out in the program will face a decline in their net incomes due to the worsened terms of trade for their small marketable surpluses. Large farmers will find that in order to cut the costs of operation per acre their operating acreage has to be further expanded and their operations made more commercially oriented. Expansion of acreage would take place, in the absence of the effective legal restrictions, so long as mechanical-engineering economies of scale outweighs managerial diseconomies of large-scale operation. The economic logic of this process is simple but hard. Once investments are made on fixed assets (such as tractors), the short-run cost function becomes "lower" than the long-run cost function. Since fixed costs are costs foregone in the short run, it does not affect the short-run supply of output. Prices of the product can fall to the levels that cover only variable costs

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50/ One long ton = 27.286 maunds and the support price of wheat is Rs.17.00 per maund. There are reports that in fact the government purchased 8 lakh tons so far.

51/ According to the Plan document actual expenditure for this purpose was 235 million rupees. Planning Commission, Annual Plan 1968-69, p. 20.

and not fixed costs. The impact of such a situation can be disastrous to small farmers whose total costs are largely variable.52/

A vicious circle of the large getting larger and the small getting smaller will set in until the rural population is polarized into the large, rich, farmers and small, poor farmers. The tragedy is not only that the small will suffer, as they will suffer, but that the small will have nothing to look forward to despite the apparently promising future with the dawn of the "green revolution." The undesirable effects of massive grain imports from developed countries (say, under the P.L.480 programs) will be reproduced in the domestic scene. Only difference are the changes in the actor who plays the role of surplus exporter and, more importantly, in the use of funds generated into the hands of the new large supplier.53/

4. THE STRATEGY OF AGRICULTURAL DEVELOPMENT IN WEST PAKISTAN

Beyond Self-Sufficiency in Foodgrain Production

The goal of recent agricultural policy in Pakistan has been self-sufficiency in food grain production. Measures ranging from input

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52/ It may be pointed out that tractor-mechanization is not economically justified to initiate and that once initiated it is not easy to recover from. In fact it creates a new problem of working off the excessive capitalization in agriculture.

53/ The agricultural sector is very lightly taxed. Direct taxes on agriculture have been increasing in quantum since the independence. However, the land taxes are mostly based on the land revenue assessments made thirty or forty years ago and incomes originating in agriculture are largely exempt from the general income tax imposed by the government. It is reported that in the Punjab the agricultural income tax is assessed in reference to the amount of land taxes payable rather than on the actual income of the tax payer in any particular year. (See, Government of Pakistan, Taxation Enquiry Committee Report, Karachi, 1960). Of course, this means that the mobilization of increased cash incomes in the hands of large farmers becomes difficult, if not impossible. Despite certain undesirable effects, the foodgrain imports provided Pakistan with needed foodgrains as well as the counterpart funds that the government has relied on to finance a substantial fraction of its development program.

subsidies to output price support program have all been designed and executed for the purpose of substituting domestic production for the import of foodgrains. The development of tubewell irrigation since the Second Plan period and the more recent "green revolution", however, have ushered in a new situation. One can confidently state that the substantial increases in yields obtainable by the progress of the "green revolution" will make it possible for the mass of the nation's farmers to achieve satisfactory increases in output and solve the problem of foodgrain deficits within a short period of time. As a consequence, it is now necessary to reexamine the basic orientation of the agricultural policy of the country.

Since the foodgrain is one of the cheapest sources of calories, it is only natural that the emphasis has been placed on the rapid increase in its output when there is a widespread shortage in food energy intake. Simply eliminating the foodgrain deficits, however, does not provide a final solution to the food problem of the country. There is a whole range of other problems, of which, those in the areas of production and marketing stand out.

In the sphere of production, there is an increasingly difficult problem of producing an improved output mix to provide the nation with a more nutritional diet. Pakistan's deficits in high quality proteins, edible oils, vegetables, fruits, and sugar are obvious even today. As the pattern of food consumption changes in response to increases in per capita income or in response to improvements in education and communication, the overwhelmingly large proportion of calories currently derived from starchy staples in Pakistani diets will have to decline. Effective demand for "protective foods" that are rich in vitamins, minerals, and high quality proteins, such as fruits, vegetables, meats and dairy products, will surely increase. If Pakistan were to dissipate valuable foreign exchange on imports of these food items, the attainment of self-sufficiency in foodgrains and the consequent "savings" of the scarce resource would lose much of its meaning.

Diversification of Pakistan's agriculture is rightly the next order of business; policy measures should be designed to change the cropping patterns to bring forth this result. As the rapid spread of new varieties of rice and wheat has shown beyond any doubt, farmers respond strongly to the comparative net cash return of various crops. The major determinants of the net profitability being the physical yield per acre and the price per unit of output, a new set of comparative yield performance and a new set of relative prices among crops have to be developed. The current system of support prices needs re-examination and determined efforts to improve yields of crops other than rice and wheat are called for. 54/

The improvement of food storage, processing and distribution systems in Pakistan is as important as increasing production. It is said that losses caused by micro-organisms, insects, rodents, and other factors amount to some 10-15 percent of the output of foodgrains. Reduction of such losses by better storage facilities is an immediate necessity. As the marketable surplus of farm products increases, and as the proportion that perishable commodities occupy in the total output of farms increases, the problem of adequately handling farm products after harvest becomes increasingly important. Improved food protection practices should be made available at reasonable costs to the farmers. The improvement of marketing systems assumes a unique importance, furthermore, if the emphasis is placed on the production of crops which will provide the farmer with the largest cash return. A price incentive scheme can work only if it is coupled with a highly developed marketing system.

54/ The argument here is cast in terms of food commodities. However, the same line of reasoning can be applied to the case of fiber crops. It is reported that the distinctive disadvantage in the yield per acre of cotton relative to other crops is driving cotton out of the Punjab. In fact, the urgency of maintaining or increasing fiber crop output would seem greater than that of increasing the output of protective foods.

The improvement of food storage, processing and distribution systems in Pakistan would require a substantial amount of foreign exchange and would be costly in terms of domestic resources. In view of the pressing need for improving these facilities and for strengthening the existing facilities which supply farm inputs, the priority currently given to the tractor mechanization in West Pakistan should be carefully reexamined.

Selective Mechanization

Mechanical-engineering technology in agriculture can embrace a wide range of different configurations involving motive power, machines, and implements. There are many ways in which one may classify mechanical-engineering technology in agriculture. Most important from our point of view, however, are the following two types of distinction: (1) "mechanization" as applied to each specific operation and "mechanization" as applied to several or all of the farm operations; and (2) "mechanization" as introduced into a given socio-economic organization of agriculture and calling for minor adjustments and "mechanization" calling for a highly sophisticated organization and cooperation not easily introduceable into a given situation.

The first distinction recognizes the many different operations related to growing and harvesting of crops, such as clearing of land, irrigation/drainage, plowing, seedbed preparation, planting and fertilizing, crop protection, harvesting, and preparation of products. Machines and implements can be designed specifically for a limited number, or for many, or all, of these operations. Aside from implements relying on human or animal power, tubewells, low-lift pumps and power threshers are examples of machines used specifically for limited tasks as are Japanese power tillers, dusters and sprayers. On the other hand, the development of the tractor and the so-called power takeoff, together with the development of various implements, make possible the more direct and widespread application of engine power to many different operations. In the United States the total

cultivation processes came under the aegis of mechanical power; also the harvesting processes and many post-harvest operations became thoroughly mechanized with the advent of the self-propelled combine harvester. Nonetheless, it should be clear that a tractor is by no means the only way to mechanize agriculture. Mechanization of selected processes of cultivation and postharvest operations, as in the case of Japan, may prove to be the most beneficial for the agriculture of Pakistan given the circumstances it faces now and in the decades to come.

The increase in size and specialization of farms has been one of the most significant changes in farm structure and organization associated with the adoption of tractor mechanization in the United States. Modern equipment and machines are so expensive in many instances that it is advantageous for the farmer to develop larger farms and enterprises (i.e., specialize) to make full use of the new resources and to hold down unit costs. The typical relationship between acreage and unit-cost is a curve that shows a steep decline in costs until utilization reaches about one-fourth to one-half the maximum possible with the machine and, thereafter, a very moderate reduction in costs with greater use. High costs per acre or per hour with limited use reflect, of course, the fixed charges unrelated to the actual use of the machine. Introduction of larger machines and implements, therefore, necessitates large management units, output standardization, and uniform cultural practices, which call for highly sophisticated organization and cooperation.[55/] Organizational problems loom as

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55/ On the basis of management units we may classify "mechanization" into three general types: (1) Self-employment, owner-operated mechanization, necessarily smaller to medium sizes; (2) Absentee ownership (including corporate farms), with hired managers and hired workers, conducive to large scale mechanized agriculture; and (3) Mechanization on the basis of cooperative or collective farm organizations. Under the usual circumstances it is safe to say that the first category would minimize the problems of organization.

large as technical problems, solution of one not necessarily guaranteeing the solution of the other. Smaller scale mechanization programs embracing machines for a few selected operations would be much easier to introduce into the given organization of agriculture without the necessity of a wholesale substitution of "modern" for "traditional" practices. It also has the advantage of involving a bulk of the nation's farmers in the process of agricultural innovations.

Emphasis on Divisible, Farm-Resource Augmenting Inputs

Biological and chemical innovations that have brought forth the "green revolution" are, by their very nature, neutral to the scale. They can, therefore, be incorporated into the existing institutional framework of Pakistani agriculture without drastic adjustments. Small scale peasant farms can adopt these innovations with relatively minor adjustments in contrast to technical innovations involving tractors and combines. Undoubtedly, this aspect of recent innovations has contributed to the very rapid diffusion of technology in the Punjab as elsewhere. The benefits of the "green revolution"have not been limited to a few large farmers. As with the recent private tubewell development in the Punjab, many small farmers are taking advantage of the development.

Tubewell water, new seeds and increased applications of fertilizers, which dramatize the "green revolution" on the input side, are basically complementary to the farm resources of labor and land. By making it possible to grow more crops, more lucratively, per acre of cultivated area these inputs have increased the use of labor on farms as well as the incomes of farm workers concerned. In contrast to investments in tractors and combines, that are fundamentally labor-displacing, investments in inputs such as seeds, fertilizers and even tubewells are much more conducive to augmenting the incomes of the bulk of the nation's farmers. Emphasis on these inputs, furthermore, would retard the polarization of the rural population and land holdings, and make it possible for the mass of the nation's farmers to achieve satisfactory increases in output at modest costs in terms of scarce resources of capital and foreign exchange.

As G.W. Giles has rightly stated, much can be done to "make animals more effective by improving the equipment they power".[56] It is often said that the farmer's reluctance in accepting the improved animal drawn equipment is evidence of the inertia existing in the present situation and that a drastic improvemnnt, such as tractor mechanization, is needed for breaking this situation. In view of the progress of private tubewell development and the green revolution and the increasing rewards they offer, we may expect the majority of farmers to accept voluntarily new technology developed in this area. Many of Giles' recommendations on animal-power equipment are sound and economically justifiable. The development and diffusion of the mouldboard plow, various harrows, the seed-cum-fertilizer drills, all of which are animal drawn equipment, and knapsack power sprayer-cum-duster, hand weeders, and small stationary threshers are highly desirable. These kinds of equipment can remove bottlenecks and increase the economic efficiency as well as engineering efficiency of the agriculture of West Pakistan.[57]

Interrelationship Between Agriculture and Non-Agricultural Sectors

The economic relation between agriculture and non-agricultural sectors involves exchange of products, flows of productive factors, and diffusion of ideas. Typically, an underdeveloped economy is fragmented, heterogeneous, and lacking in the cohesive forces emanating

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56/ See G.W. Giles, "Towards a More Powerful Agriculture," pp. 24-38.

57/ The "problems of success" revealed by the recent developments in the agriculture of West Pakistan are nowhere more visible than in the harvesting and postharvest operations. If indeed a bottleneck exists in the crop production processes, it is more likely in harvesting and postharvest operations than anywhere else. The delay involved in field preparation for the next crop is as much a result of "inefficient" threshing operations as that of the "inefficiency" of bullock cultivation. Moreover, the loss of grains involved in the traditional threshing operations is appalling: Giles reports that losses, from the maturity of the grain in the field onward, are estimated by experts at 25 per cent. G.W. Giles, op cit., p. 30.

from adequate transportation and communication systems. Although they are not obvious under these circumstances, the intersectoral flows of products, productive factors, and ideas characterize a two-way relationship between agriculture and industry.

The importance of each sector for the other is appreciated first by looking at exchange of products. On the one hand, there is the interdependence of sectors through direct intermediate deliveries; both sectors buy products as intermediate inputs for further production from each other. Obvious examples are cash crops such as cotton, jute and sugar on the agricultural output side and machines, implements, fertilizers and pesticides on the industrial output side. On the other hand, each sector is a source of effective demand for the final products of the other. It is important to have consistency and compatibility in industrial planning; it is equally important to recognize this interdependence and to exploit positive intersectoral relationships that promote rapid economic development.

A broad-based agricultural development is essential for creating a domestic market for the developing indigenous industries. A conscious effort to develop agricultural technology will foster domestic industries and will return a handsome reward. It is appropriate here to recall one such example in the recent experiences of West Pakistan. In reference to the spontaneous, private development of tubewells during the Second Plan period, W.P. Falcon and C.H. Gotsch observed that:

> These 25,000 (tube)wells represented an initial investment on the order of Rs.250 million, a sum thought impossible in West Pakistan's traditional agriculture. Moreover, this investment was an important stimulus to the small-scale machine industry. Whole streets in such cities as Multan, Lyallpur, Lahore, Gujranwala, Sialkot, and Daska have been devoted to the manufacture of pumps and engines, and the skill, ingenuity, and training demonstrated in these shops have been impressive.[58/]

58/ W.P. Falcon and C.H. Gotsch, "Agricultural Development in Pakistan: Lessons from the Second Plan Period," Report No. 6, Economic Development Series, Harvard University (June 1966), mimeographed, p. 12. The latest estimate of tubewells installed in the Punjab exceeds 60,000.

There is undoubtedly a similar opportunity for a rapid expansion of indigenous production of improved farm implements. The emphasis on selective mechanization would, as in the case of _tubewells, nurture indigenous industries catering directly the agricultural sector of the country. The development of such industries, in turn, would make it possible for the farmers to acquire the machines and implements at increasingly favorable terms, encouraging further use of such inputs. It would be a clear mistake to minimize this type of positive interaction betwee^.agricultural and industrial development by using large amounts of capital and foreign exchange for tractor mechanization. The progress of the "green revolution" has increased the attractiveness, . of investments in improved farm implements. Investments of this type will grow, the alleged inertia and reluctance of. the farper notwithstanding, : unless aborted by large scale, heavily subsidized, imports. ; , . -

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., SUMMARY AND CONCLUSION

In summary, --.let me recapitulate sane of the highlights of the paper.

1. Given the present share of the agricultural labor force in the total labor force and the growth rate of the total labor force of 3 per cent per annum in West Pakistan, even: if the non-agricultural employment grew at the very high rate of 4.3 percentVper year, the[1] absolute number of the agricultural labor force will continue to[1] grow for several decades, to come, . . -. · "[1]-

2. On the other hand, in view of the fact that the marginal capital labor ratio is expected to increase (due to the need for capital-intensive investments in infra-structure and in large-scale manufacturing indus tries), the economy's ability to absorb a growing labor force into productive non-agricultural employment will be limited. , ,"[1],

3. In contrast to the decades of the 1950's, the output increasing effects of the tubewells in the Second Plan period and the "green revolution" of the more recent years have shown, without doubt, distinctive alternatives to tractor mechanization for a rapid agricultural development in West Pakistan. These alternatives are inexpensive in terms of the scarce resources of capital and foreign exchange. Moreover, they increase output without displacing the employed labor force in agriculture, thus enabling the mass of the nation's farmers to share satisfactory increases in output.

4. "The world food and agriculture situation is now in a stage of transition and hope". The "miracle" seeds and the increased application of fertilizers are spreading all over the world. In view of the poor quality of foodgrain processing, marketing and distribution systems, and the grave uncertainty regarding the world markets for Pakistani foodgrain exports, the prospects for earning foreign exchange by exporting the surplus grains are at best problematical.

5. The economic argument against a rapid tractor-mechanization in West Pakistan is as follows:

a. It uses more of the nation's scarce resources and reduces the use of the abundnat resource.

b. Since water is the limiting factor in West Pakistan, the strategy that maximizes output per unit of water (or per unit of irrigated acreage) is the most economical strategy. We do have well-known technology in this regard thanks to the tubewell development and the green revolution.

c. There is no evidence that tractor-mechanization per se will increase yields; output per worker will rise only by causing unemployment.

d. Tractor mechanization will use up capital in general and foreign exchange in particular diverting it from higher priority uses. Additional specific, small-scale, divisible inputs of capital will cost less and increase output, and provide employment.

6. A rapid tractor-mechanization program will create social and political problems.

a. Given the economic-demographic characteristics of West Pakistan, it is important for the agricultural sector to absorb the residual increase in the labor force over and above those finding employment in the non-agricultural sectors.

b. The pervasiveness of the green revolution cannot take place with tractor mechanization. The polarization occurs in the ranks of the farming population because of the impossibility of maintaining the support prices. The large will get larger, the small will get smaller.

c. Tractor mechanization is an error from which it is difficult to recover because of the nature of short-run fixed costs associated with investment in tractors and creation of bottlenecks elsewhere.

7. Tractor mechanization diverts capital from other vitally needed areas. There is no overemphasizing the fact that capital is needed in building up infrastructure, education and transportation systems. Even within the agricultural sector it is of vital importance to increase the provision of water and biological-chemical inputs, such as fertilizers and pesticides. The fact that imported foodgrains feed the urban population rather than the rural in West Pakistan has geared the marketing and distribution systems to handling imported foodgrains exclusively. The development of adequate storage, marketing and distribution systems for coping with the new situation will require a substantial sum of capital investment.

8. Capital formation in agriculture should most appropriately be in the form of small-scale, divisible, easily adaptable units to (a) remove bottlenecks, (b) involve the bulk of the nation's farmers, and (c) generate employment opportunities in agriculture. Instead of tractors and combines, serious attention should be paid to the machines designed for selected processes of farm operation, such as threshers, winnowers, sprayers, engines and pumps as well as improved animal-drawn implements.

9. The strategy of emphasizing the agricultural inputs of the nature outlined in the point 8 above will also generate investment opportunities for local industry and therefore employment opportunities also in that sector. This, in turn, will have beneficial effects on the agricultural sector by providing it with inputs at increasingly favorable terms and encouraging the use of them.

10. There is a pressing need to plan for changes in cropping patterns by shifting attention to crops such as cotton, pulses, oilseeds and sugarcane and by re-examining the structure of output prices.

Water is still the major constraint for the full realization of the agricultural potential for this area. Despite the remarkable increase in the number of tubewells and the expansion of surface water supplies, many farms cannot yet realize the full benefits of the "green revolution".[59/] There are reports that the acreage of water-consuming crops, such as rice and sugarcane, is held back and even that the acreage planted under these crops has been plowed under because of the shortage of water. Moreover, in many regions the needed fertilizer is not available at the right time. The recent growth in fertilizer consumption is indeed impressive, but the amounts being distributed come nowhere near the level required for the optimum performance of the agricultural sector. In short, there is an ample scope for further exploiting well-known techniques and factor combinations for the benefit of the agricultural development of West Pakistan. Further development of the farm implement and tubewell industries, improvements in the seed/fertilizer distribution systems, investment in marketing and storage facilities -- all of these things -- may cost as much as tractor mechanization and may even press available domestic and foreign developmental resources to the limit. The returns to be reaped from such investment, however, would not only be more widespread, they would exceed by far that which is possible by tractor mechanization.

59/ The development of tubewells requires, of course, not only the installation of pumps, engines and motors, but more importantly, the provision of electricity or diesel fuel at the well site.