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BACKGROUND PAPERS FOR DISCUSSION

AT

THE INTERNATIONAL SEMINAR

ON

"COMPARATIVE EXPERIENCE OF AGRICULTURAL DEVELOPMENT IN DEVELOPING COUNTRIES SINCE WORLD WAR II"

NEW DELHI

25th, 26th, 27th and 28th OCTOBER. 1971

THE INDIAN SOCIETY OF AGRICULTURAL ECONOMICS
46-48, Esplanade Mansions, Mahatma Gandhi Road, Fort,
BOMBAY-1.

SOME QUESTIONS CONCERNING GROWTH, TRANSFORMATION AND PLANNING OF AGRICULTURE IN THE DEVELOPING COUNTRIES

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Recent literature on agriculture in the developing countries has tended to draw a sharp distinction between those that have been able to accelerate the rate of growth in this sector to phenomenally high levels over a short period of time and those that have failed to do so. This difference in performance has been attributed to the successful transformation of traditional agriculture in the former through changes in technology. The inference has also been that the same or similar changes in technology in other developing countries would lead to comparable break-throughs in agriculture and to high rates of growth within relatively short periods.

It is necessary to examine closely the factual basis of this hypothesis and its analytical and policy implications. For if the facts and the hypothesis are correct one would be justified in assuming that the institutional framework of agrarian economies is not a serious obstacle to growth and that what is needed above all is concentration on specific questions relating to the mechanics of the technological change required in each case and the supply of the necessary inputs. Moreover, if growth rates of the order usually mentioned in this context can be achieved in agriculture, it would be much easier than it has appeared up to now to solve the many other problems, such as inflation, foreign exchange shortage and idle manpower, faced by developing countries.

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* Extract. Journal of Development Planning, No.1, United Nations, New York, 1969.

Two countries that are generally cited as having achieved phenomenally high rates of growth in agriculture in the period following the Second World War are Mexico and China (Taiwan). The Mexican experience has been highlighted particularly in Professor Schultz's analysis of how to transform traditional agriculture in a short period:

> Agricultural production in Mexico has been increasing at the unusually high rate of 7.1 per cent per year. The lesson to be learned from what Mexico has accomplished is especially germane to many low income countries seeking to develop a modern economy. Mexico entered upon this growth very recently. The foundations for growth were not laid by an earlier gradual development spread over many decades.[1]

At the other end of the spectrum, India has often come in for considerable attention as an example for a country in which agriculture has failed to grow rapidly.[2]

It would, therefore, be of interest to examine in some depth the growth rates achieved in agriculture in Mexico, Taiwan and India, the factors which have contributed to their respective growth performances, and the lessons that could legitimately be drawn from them.

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1 Theodore W. Schultz, Transforming Traditional Agriculture (New Haven, Conn., Yale University Press, 1964), p. 19.

2 This refers to the view widely held in the earlier half of 1968 when this paper was written. Since then large increases in food-grain output have been reported and have given rise to the impression that there has been a "green revolution" in India. The analysis contained in this paper remains intact however and is very relevant to an assessment of the nature of this revolution and its potentialities.

I. Mexico

It is clear enough from the available data that, while agricultural production in Mexico was stagnant in the period between the two world wars[3], it has been increasing rapidly since the early 1940s. What is open to doubt is the accuracy of the growth rates mentioned in this context, and some of the inferences drawn from the Mexican experience in the second period covering approximately two decades.

In the first place, an examination of the data shows that the high rate of growth in Mexican agriculture during this period is attributable to a large extent to a phenomenally high rate recorded in the earlier half of this period; in the second half there was a perceptible and fairly sharp decline. Thus the rate of increase of agricultural output as a whole was 6.5 per cent per annum between 1939 and 1949 but it dropped to 3.7 per cent per annum in the following decade.[4]

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3 Given below are the index numbers of the volume of agricultural production in Mexico (with 1929 as the base year):

1925-1928	...	114.1
1931-1934	...	105.2
1935-1938	...	111.5
1941-1944	...	152.2

SOURCE: Nathan L. Whetten, Rural Mexico (Chicago, University of Chicago Press, 1948), p.255. The index numbers are those constructed by the Secretariat of National Economy of the Government of Mexico.

4 W.W. Hicks, The Agricultural Development of Mexico, 1940-1960, unpublished doctoral thesis submitted to the Food Research Institute of Stanford University in October 1965 (available in microfilm). Extensive use has been made in the present paper of the statistical material contained in this volume which is an important and extremely valuable contribution to the available literature both on Mexico and on problems of agricultural development in general.

Similarly data for crop output alone for the pe riod 1948-1963 show that while it grew at a compound rate of 8.5 per cent per annum between 1948 and 1955 the rate of growth declined to 4.1 per cent between 1955 and 1963.[5]

Most of the assessments made of the Mexican performance relate to the period as a whole and do not make any attempt to distinguish between factors that might have contributed to the very high rates of growth in the earlier phase and those underlying the deceleration and lower rates later. A typical example is the following summary by three agricultural scientists who were closely associated from the early 1940s with the development of the plant varieties and agronomical practices adopted in Mexico and were in fact the pioneers of the movement:

> Then was 1943; now is 1963. The place is Mexico, both then and now; but it is not the same Mexico now as it was then, for there has been a revolution between then and now..... The population increased 70 per cent between then and now, but the production of the three basic foods increased 300 per cent..... Even more noteworthy, however, is the way in which it was accomplished, for it was done not so much by using more acres as by helping each acre produce more.... "Agricultural revolution" is no mere figure of speech, for Mexico is indeed "on the road to tremendous progress". The 1941 agriculture was traditional; now it is progressive. And it will continue to progress because it is continually becoming more scientific.[6]

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5 United States Department of Agriculture, Economic Research Service, Changes in Agriculture in Twenty-six Developing Nations, 1948 to 1963 (Washington, 1965), Table 4.

6 E.C. Stakman, Richard Bradfield and Paul C. Mangelsdorf, Campaigns Against Hunger (Harvard, Mass., Harvard University Press, 1967), pp. 1-9.

Other appraisals of Mexican agriculture made in the middle of this period have however some light to throw on the factors responsible for the high rates of growth recorded in the first half. Given below are extracts from a report by a group of experts sponsored by the World Bank and the Government of Mexico in 1952:

> The average annual rate of increase of agricultural production, which amounted to 4.7 per cent in the period 1940 to 1949, increased slowly from 4.4 per cent in 1940-1944 to 5.0 per cent in 1945-1949; according to preliminary estimates, the increase in production in 1950 amounted to 16.1 per cent..... The rise in output since 1939 was due to more intensive use of arable land, extension of cultivated area and improvement of old and new lands by irrigation. Greater use of new and improved lands made it possible to grow more valuable crops and to increase yields. Better farming methods contributed little to higher yields.....
>
> From 1939 to 1950, the average increase in harvested area was 3.1 per cent per annum. As in the case of agricultural production, the area harvested expanded slowly upto 1949, the increase averaging 1.9 per cent annually in 1940-1944 and 2.3 per cent in 1945-1949; also as with production, preliminary and somewhat tentative estimates for 1950 show a greater than usual increase, 13.4 per cent over the previous year....
>
> The increase in yields accounted for 23 per cent of the rise in agricultural production in the twelve years from 1939 to 1950..... The increase in yields between 1939-1950 were due primarily to the extension of cultivation to superior new lands and to improvements of old lands placed under irrigation. On the other hand, no significant rise in yields occurred in the older unimproved agricultural regions.... The higher yields obtained on the new lands were due to the virgin soil, to relatively greater use of irrigation, and in some cases, to more favourable climatic conditions than in the older regions.... the increase in yields is attributed only in

> limited degree to the use of improved seed and of fertilizer, or to other improvements in agricultural methods.... On the basis of an estimate..... that the use of hybrid seed increases yields by about 25 per cent per hectare, it can be determined that less than 2 per cent out of an over-all increase of 58 per cent in corn production between 1939 and 1950 was attributable to the use of hybrid seed distributed.....
>
> Between 1939 and 1950, important changes occurred in the distribution of crops over the total cultivated area which produced a relative increase in the area devoted to crops with higher yields and unit values. Thus, corn declined from 71 per cent of the harvested area in 1939, to 66 per cent in 1945-1949, and 65 per cent in 1950. On the other hand, the harvested area for cotton rose from 3.8 per cent of the total in 1939 to 5.1 per cent in 1945-1949 and 8.5 per cent in 1950. Similarly the harvested area for oilseeds increased from 1.4 per cent of the total in 1939, to 2.9 per cent in 1945-1949, and 3.3 per cent in 1950.... These changes in the crop pattern were responsible for 60 per cent of the rise in agricultural production in 1940-1944 and therefore had more effect on output than the increase in harvested area or than the higher yields per hectare; in 1945-1949, such changes accounted for 32 per cent.[7]

It is clear from this that whatever growth took place in Mexican agricultural output as a result of applying new "modern" inputs was recorded in the second rather than in the first half of the period of two decades normally considered in this context.

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7 The Economic Development of Mexico: Report of the Combined Mexican Working Party, published for the International Bank for Reconstruction and Development (1953), Chapter II, pp. 27-29, 31.

A closer examination of the data also reveals striking regional differences in agricultural performance, the growth rate in the older and more densely populated regions of the country being much lower than in the northern part (more specifically in the north and Pacific north regions) which, though more sparsely populated, received the bulk of the investment in irrigation after 1939.[8] The relevant data are as follows:

RATE OF GROWTH OF AGRICULTURAL OUTPUT PER ANNUM

	1939-1949	1949-1959	1939-1959
Mexico	6.5	3.7	5.1
North	8.9	4.9	6.9
Pacific north	11.9	7.9	9.9
Central	7.7	2.5	3.6

It will be seen that in the central region--which has about one-half of the country's population--the rate of growth of agricultural production was only 2.5 per cent per annum between 1949 and 1959.

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8 Irrigation accounted for 12-16 per cent of the total public investment per annum in Mexico between 1939 and 1950; public investment itself formed nearly two-fifths of gross domestic investment during this period. Consequently the area under irrigation increased from 0.24 million hectares in 1939 to 1.19 million hectares by 1950. See The Economic Development of Mexico, tables 15 and 20. The share of irrigation in public investment continued to be high after 1950--not to mention private investment which also increased.

The north and Pacific north regions were not only sparsely populated but arid and dry, for which reason they were largely unaffected by the ceilings on the size of agricultural holdings imposed by earlier land reforms:

> Holders having more than 1,000 hectares, although accounting for only 0.3 per cent of the holders, had 61.9 per cent of the land (in all Mexico); those having more than 40,000 hectares had one-fourth of all the land censused in 1940. Large holdings however persist mostly in the semi-arid region where the land is not suitable for cultivation and can be used only for grazing or for a very extensive type of agriculture.....two-thirds of all holdings having more than 1,000 hectares are found in the north and north Pacific regions, where it is too dry for farming without irrigation.[9]

These large holdings were consequently the greatest beneficiaries of the subsequent investment in irrigation in these regions.[10]

Within the north and Pacific north regions the agricultural growth that took place was concentrated mainly in seven states: Baja California, Coahuila, Chihuahua, Durango, Sinaloa, Sonora and Tamaulipas. These states accounted in 1940 for only about three-fifths of the total population of these regions, and for less than a sixth of the total population of the country. They claimed however 50 per cent of the area irrigated after 1939, and accounted in 1957 for nearly

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9 Nathan L. Whetten, op.cit., pp. 177-178.

10 Between 1939 and 1959 the total area irrigated in Mexico increased from 1.7 million to 4.3 million hectares; of the increase of 2.6 million, the share of the north and Pacific north regions was 1.6 million.

70 per cent of the total area in the irrigation districts of Mexico. By 1957 nearly the whole of the cotton production (to be exact 95 per cent) and about two-thirds of the wheat production of the country were also grown in these seven states. The extent to which agricultural performance in Mexico in the period 1939-1959 was a reflection of the increase in production recorded in these states will be evident from table 1. It will be seen that the seven states accounted for 85 per cent of the increase in the total value of the output of cotton and wheat in the two decades.

TABLE 1 : INCREASE IN AREA, PRODUCTION AND THE VALUE OF OUTPUT OF COTTON AND WHEAT IN MEXICO, 1939-1959

Country	Cotton			Wheat		
	1939-1949	1949-1959	1939-1959	1939-1949	1949-1959	1939-1959
Mexico						
Area harvested[a] (thousands of hectares)	337	212	549	-18	400	382
Production (thousands of metric tons)	352	558	910	95	747	842
Value of output (millions of pesos)	739	1934	2673	175	862	1037
Seven States						
Area harvested (thousands of hectares)	246	276	522	25	256	280
Production (thousands of metric tons)	332	527	859	59	472	531
Value of output (millions of pesos)	700	1824	2524	106	522	628

SOURCE: W.W. Hicks, op.cit.

a The total area harvested (under all crops) rose in Mexico from 6.7 million hectares in 1939 to 8.6 million hectares in 1949 and to 12 million hectares by 1959--recording an increase of 80 per cent in the course of the two decades.

It is also important to note that while the production of cotton increased by 544 per cent (from 158,000 to 1,017,000 metric tons) between 1939 and 1959 in these states, and of wheat by 207 per cent (from 257,000 to 788,000 metric tons), the area under these crops also increased during this period by no less than 272 per cent (from 192 to 714 thousand hectares) and 101 per cent (from 271 to 551 thousand hectares) respectively. A large part of the increase in production is therefore attributable merely to the extension of area under cultivation (not to mention the fact that most of this additional area was also newly irrigated).

Within these seven states themselves the growth was concentrated to a significant degree in two, namely Sinaloa and Sonora, since the largest percentage increases in harvested area took place within their territory. Between 1949 and 1959 in particular the harvested area expanded at the compound rate of nearly 68 per cent per annum in Sinaloa and 10.5 per cent per annum in Sonora.[11] By 1961 Sonora was producing nearly one-half of Mexico's total output of wheat; naturally the higher productivity here had a significant impact on the average for all Mexico. According to W.W. Hicks,

> ..... it was the increase in the wheat area in Sonora, where yields were high and increasing rapidly, that was largely responsible for the increase in the average yield in Mexico.[12]

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11 In 1940, Sinaloa and Sonora together had a population of less than 0.9 million out of a total population of nearly 20 million in Mexico. Nathan L. Whetten, op.cit., appendix, table 2.

12 W.W. Hicks, op.cit. This author states that, since this was a state in which yields were already high, the extension of harvested area accounted for more than twice as much of the increase in production as increase in yield.

As for the increase in cotton production in the northern region, it was to a large extent due to the ceilings imposed on cotton acreage in the United States of America which made it more attractive to grow cotton in the areas south of the border in Mexico. In consequence, not only was there a ready market for the cotton produced but considerable financial assistance became available from private merchants for the extension of the area under cotton in Mexico.[13]

These facts place in a broader perspective the performance of Mexican agriculture in the period following the Second World War. It is fairly clear that it was largely a kind of "enclave" development made possible by heavy investments in irrigation opening up new areas for cultivation as well as by certain special circumstances, such as that of proximity to the United States of America, which favoured this region.

> The analysis of cotton and wheat yields in the seven states on a state-by-state basis suggests that the expansion of irrigation into new areas of northern Mexico where techniques, machinery, fertilizers, insecticides, and credit from the United States were adopted may have accounted for the bulk of the increase in production.[14]

It is reasonable to suppose that the large size of holdings in this region, comparable to that on the other side of the border in the United States, as well as the similarity of the soil and climatic conditions facilitated such transfer.

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13 Loans given by private merchants to agriculture increased by over 1,400 million pesos between 1949 and 1959, and loans given by all sources of credit (including government sources) by over 6,400 million. About three-fourths of the former and two-thirds of the latter were concentrated in the northern region. Private merchants included international cotton merchants like Anderson and Clayton. See W.W. Hicks, op.cit.

14 W.W. Hicks, op.cit.

What has been accomplished in Mexico is somewhat similar to the kind of development that has taken place in limited regions under favourable circumstances in many other countries in the course of the last century; furthermore, the transformation of traditional agriculture as such was not even attempted in Mexico. These facts are borne out by others closely associated with the experiment:

> It would be most unfair to suggest that the irrigated Yaqui valley in northwest Mexico is representative of the total of Mexico's agriculture. It is, however, representative of a type of agriculture in Mexico and also of a type of agriculture which may be found in many other countries in Latin America and I expect also in other parts of the world; a type of agriculture which is the direct result of an attempt to increase the size of the technological sector relative to the traditional sector. Where the attempt has not been to accomplish a rapid transformation of the traditional into the technological but in contrast has been to guide "new growth" into the technological.[15]

Past experience also suggests that, however high the resulting rates of growth in agriculture might be over certain periods, such development does not necessarily lead to transformation of agriculture but often only to the emergence of dualism within this sector. That the Mexican experience during this period has nevertheless been cited asa demonstration of the possibility of transforming traditional agriculture is a remarkable example of the kind of casual empiricism that is

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15 Donald K. Freebairn, "Relative production efficiency between tenure classes in the Yaqui valley, Sonora, Mexico", Journal of Farm Economics, December 1963. Mr Freebairn was attached to the Rockefeller Foundation and associated with the co-operative agricultural research programme of the Mexican Secretariat of Agriculture and the Rockefeller Foundation.

abundantly in evidence in the literature on development problems.

II. China (Taiwan)

The rate of growth of agricultural production in Taiwan is somewhat lower than that claimed for Mexico. For the period 1948-1963 the estimated rate of growth of crop output is only 4½ per cent per annum (compared to nearly 6¼ per cent per annum for Mexico). The inclusion of forestry, fishery and livestock output would no doubt raise the rate, and figures of 5½ per cent per annum and more have been sometimes mentioned for certain periods (such as for 1953-1964). Nevertheless, most assessments covering the entire periods since the early 1950s place the rate of growth of agricultural output at only about 4½ per cent per annum.[16]

This growth rate in agriculture supported a phenomenally high rate of growth of the economy of Taiwan during this period. The gross national product (at constant 1964 prices) increased at a rate of over 7.5 per cent per annum from the early 1950s as a result of which the per capita income in the country went up by more than 75 per cent by 1964 despite a rapid increase in population in the intervening period.[17] In fact, at the beginning of this period, the level of income per head of the population was no higher in Taiwan than in most of the

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16 United States Department of Agriculture, Taiwan's Agricultural Development: Its Relevance for Developing Countries Today, Foreign Agricultural Economic Report No.39 (Washington), April 1968, p. vii.

17 Neil H. Jacoby, An Evaluation of U.S. Economic Aid to Free China, 1951-1965 (Washington, Agency for International Development, Department of State, 1966), Chapter VIII.

developing countries (that is, the approximate equivalent of $US100 per annum); but by the middle of the 1960s its per capita income had doubled and was nearly $US200 per annum. The performance in the agricultural sector during this period contributed therefore materially to carrying the economy of Taiwan to a more advanced stage of development.

Taiwan's is also clearly a more genuine case of transformation of traditional agriculture than Mexico's. Even before the Second World War over 70 per cent of the farms were less than three hectares in size and the average size of farms in Taiwan was only a little over two hectares; by 1960, more than 85 per cent of the farms were less than three hectares in size and the average size of farms declined to one hectare.[18] The high growth rates recorded have been chiefly in farms within this size range where mainly family labour is used.

The growth performance of Taiwan during this period is however to a great extent determined by the trends established in an earlier period of its history. An appreciation of these earlier trends and of the factors contributing to them is essential for an assessment of Taiwan's experience in the period following the Second World War and its implications for other countries.

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18 United States Department of Agriculture, Taiwan's Agricultural Development, p. vii. Also, S.C. Hsieh and T.H. Lee, Agricultural Development and its Contributions to Economic Growth in Taiwan (Taipei, Joint Commission on Rural Reconstruction in China (United States and China, 1966), appendix, Table 12.

Figure I* shows on semi-logarithmic scale the movements of an index of agricultural output for Taiwan covering the period 1901-1960.[19] In these six decades taken as a whole the growth rate was little over 3.1 per cent per annum. It will be seen that though the post-war period recorded much higher rates of growth--in fact over 8.5 per cent per annum if we take the fifteen years starting from 1945--they represented to a large extent a process of catching up with the earlier trend line.[20]

The relatively high rate of growth of agricultural output in Taiwan in the pre-war period was the result of policies actively followed by Japan as a colonial power. Japan was short of food and other agricultural products and needed to develop Taiwan as an additional source of supply. A large part of the agricultural growth recorded during this period was due to the extension of cultivated land area, this area having more than doubled between 1901 and 1940 (from 376,000 hectares to 860,000 hectares);[21] but a significant

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* Figure I is not reproduced here.

19 Yhi-Min Ho, Agricultural Development of Taiwan, 1903-1960 (Nashville. Tenn., Vanderbilt University Press, 1966), chapter 3, figure 4. The first five years of the century represented however a period of recovery from the first Sino-Japanese War and recorded exceptionally high rates of growth; if these years are excluded, the growth rate for the period 1906-1939 would work out to only about 2.6 per cent per annum.

20 ".....1939 was the peak year of agricultural production in Taiwan before the war. Not until 1952 did Taiwan break this previous record in its agricultural production. If 1952 is regarded as the year ending the post-war reconstruction period, the growth rate for the post-war period then became 3.22 per cent, which is slightly lower than the pre-war rate of 3.32 per cent (of 1906-1939)..... Because the year of 1939 was far off the linear trend, it seems to be more appropriate to take the long-term growth rate of 2.57 per cent as the representative growth rate for the pre-war period".
Yhi-Min Ho, op.cit. p.33.

21 Ibid., p.48.

part is also attributable to changes in technology. Higher-yielding plant varieties and techniques of intensive cultivation such as multiple cropping of land and use of chemical fertilizers--all of them familiar to Japan--were introduced into the country during this period. But no changes were made in the land tenure system which remained highly oppressive.

It is therefore evident that the performance of Taiwan's agriculture before the Second World War was due in the main to the extension of cultivated area and to technological improvements. Both however were dependendent on a large-scale expansion of the area under irrigation. From around 30 per cent of the cultivated area at the turn of the century, the share of irrigated land in the total area under cultivation was raised under Japanese rule to nearly 62 per cent by 1940.[22]

The Japanese also used somewhat unconventional methods to bring about the adoption of new crop varieties and methods of cultivation in Taiwan, as will be evident from the following extract:

> It was tacitly assumed, and even frequently expressed by experts at the Taipei agricultural station research bureau that police power had to be employed to force new farming techniques on to rural communities resisting change. One observer evaluated the police force's role in these terms: "In each district throughout the island the chief of the police exercised the power to protect and change traditional behaviour as well as introduce new customs and ideas; he also was dedicated to stimulating industry and increasing the wealth of his area and laying the groundwork for a new communication system. There are many benefits to be

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22 Ibid., table 16, p. 49.

> derived in this way for developing an area". Since the police penetrated to every village household through the ho-ko (pao-chia) system, it was relatively easy for them to insist on the adoption of new sugar cane or rice seeds and supervise their use.[23]

Though the use of the police force for this purpose is easier to excuse than other uses often made of it by imperial powers in their colonies, it is also important to bear in mind that, in the absence of a land tenure system providing the necessary incentives for the transformation of agriculture, methods of this kind were needed to produce the results that were shown in Taiwan.

Once a break-through was made the further development of agriculture in Taiwan wa s much easier. After the Second World War there was little scope for further extension of the cultivated area but it was possible to increase the area under irrigation, extend multiple cropping, introduce new and even better plant varieties, and intensify the application of nutrients. It should, however, be observed that (a) the quantity of commercial fertilizer consumed in Taiwan in 1960 was only 20 per cent higher than in 1940;[24] (b) the

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23 Ramon H. Myers and Adrienne Ching, "Agricultural development in Taiwan under Japanese colonial rule", The Journal of Asian Studies (Ann. Arbor, Mich.), Vol. XXIII, No.4, August 1964. The quotation is from a publication in Taiwan of 1919.

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Year	Quantity (thousands of metric tons)	Year	Quantity (thousands of metric tons)
1938	472	1958	682
1939	489	1959	679
1940	555	1960	665

Yhi-Min Ho, op.cit., chapter 5, table 21.

growth of agricultural output in the period since the Second World War has been to a large extent due to high rates of growth recorded in the forestry, fishery and livestock subsectors as well as in food products like vegetables and fruits, which in turn were made possible by the rapid growth in demand on account of the doubling of per capita income during this period;[25] and (c) the rate of growth of output of rice, which was the dominant item in production and consumption earlier, has been much lower than that of these other agricultural products, in fact only about 3 per cent per annum.[26]

It should also be recalled that in the period following the Second World War the land reforms that were carried out in Taiwan altered significantly the institutional framework of agriculture. Not only were many of the larger holdings broken up but a much higher proportion of holdings came to be owner-cultivated, so that large rents no longer had to be paid as before by cultivating tenants.

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25 The growth of output of vegetables and fruits, particularly during the recent years, has been to a larger extent attributable to export demand as well as a general diversification of demand in the economy, due to rise in income.

26 Production in the agricultural sector as a whole grew at an average rate of 5.9 per cent per annum in the period 1953-64, but the rate of growth of output of forest products during this period was 7.5 per cent per annum, of fisheries 9.9 per cent per annum and of livestock 7.3 per cent per annum, so that the rate of growth of agricultural products excluding these was only 4.6 per cent per annum. Within this group, the output of rice increased at an average rate of just 3.1 per cent per annum. See Ministry of Economic Affairs, Taiwan Statistical Data Book, 1967, p.24.

> Before 1949, 39 per cent of the total farm families in Taiwan were tenant farmers. They were reduced to only 17 per cent of the total in 1957. Changes in the number of owner-farmers were also accompanied by a change in the acreage of owner-cultivated land. Of a total area of 680,000 hectares of private cultivated land, the proportion cultivated by owner-farmers was increased from 61 per cent to 85 per cent.[27]

In short, the rapid growth of agricultural output in Taiwan in the post-war period was not simply due to technological changes introduced during these years; the foundations for technological progress had been laid earlier over a period of four decades. Indeed the more immediate contributory factors were recovery and the return to the pre-war trend line, the rapid growth in demand for agricultural products other than cereals generated by growth in income, and the increased incentive given to farmers by land reform for more intensive application of inputs.

III. India

In comparison with the performance of agriculture in Mexico and Taiwan the growth recorded in India since the early 1950s is clearly less impressive, being only approximately 3 per cent per annum compound rate for the sector as

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27 S.C. Hsieh and T.H. Lee, op.cit., p.83. Before the Second World War over two-thirds of the land under rice was under tenancy.
"The numerous tenants competed among each other for rental of land. Tenancy contracts were short, usually only for one year. They were oral contracts.... Rental rates were high. Tenants paid 50 per cent or more of their main crops to landlords for use of land".
United States Department of Agriculture, Taiwan's Agricultural Development, pp. 44-45.

a whole. For crop output also, the rate of growth has been no higher. It is probable that in the national income statistics there has been some underestimation of growth in some of the subsectors, in particular in that of livestock products, but it is unlikely that this would make a great deal of difference to the over-all growth rate in the agricultural sector.

The growth rate for India as a whole conceals, however, some important interregional differences in agricultural performance. While the rate has been lower than the national average in some regions, and indeed so much lower that, in seven out of fourteen major states in the country, the growth of population has outpaced the growth of food-grain production, in some others it has been much higher. This will be evident from table 2.

The rates of growth recorded in some of these states were comparable to, and even exceeded, the rates achieved in Mexico and Taiwan. Though agricultural output in Mexico grew at the rate of a little over 5 per cent per annum in the period 1939-1959, the rate recorded in the second half of this period was (as observed earlier) only about 3.7 per cent per annum. Even this is likely to be an over-estimate, as the data for Mexico do not fully allow for the progressive increase in the coverage of the Government estimates of

TABLE 2 : COMPOUND RATES OF AGRICULTURAL GROWTH IN INDIA, 1952/53 TO 1964/65

Region	All crop output	Food-grain output	Population
Punjab	4.56	4.17	2.16
Gujarat	4.55	2.06	2.61
Madras	4.17	3.66	1.25
Mysore	3.54	3.31	2.08
Bihar	2.97	3.05	2.12
Maharashtra	2.93	2.20	2.32
Rajasthan	2.74	2.42	2.68
Andhra Pradesh	2.71	3.21	1.63
Madhya Pradesh	2.49	2.32	2.51
Orissa	2.48	2.39	2.16
Kerala	2.27	3.68	2.33
West Bengal	1.94	1.14	2.92
Uttar Pradesh	1.66	0.85	1.84
Assam	1.17	0.76	3.15
All-India	3.01	2.50	2.19

SOURCE: Government of India, Ministry of Food and Agriculture, Growth Rates in Agriculture, 1949/50 to 1964/65. The rate of growth of crop output is a little higher, at 3.19 per cent per annum, for the period 1949/50 to 1964/65.

agricultural production (more particularly of corn).[28] In Taiwan, too, the rate of growth of agricultural output--excluding forestry, fishery and livestock products--was no more than 4.6 per cent per annum between 1953 and 1964; and (as already pointed out) the rate of growth of output of rice, the main food-grain grown in Taiwan, was only 3.1 per cent per annum during this period. Table 3 shows the growth rates for different crops in the three states of India in which rates comparable to those recorded in Mexico and Taiwan were achieved in the period 1952/53 to 1964/65.

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28 There is also some additional circumstantial evidence for suspecting the accuracy of the official Mexican estimates of the rates of growth in agriculture which have been used uncritically by Professor Schultz and others. For instance, though per capita income in Mexico was no more than $150 in 1939, the share of agriculture in the total national product was only 22 per cent, which is exceptional for economies in this range of income. Moreover, in spite of the fact that the per capita income in Mexico doubled itself in the following two decades, the share of agriculture was still 20 per cent in 1960, or in other words only a little lower than in 1939. If the earlier underestimation of agricultural production is allowed for, it is not improbable that the share of agriculture was higher to begin with and that it fell more sharply during this period. W.W. Hicks, op.cit.

It should perhaps be added that, by allowing for the increase in the area coverage of the official estimates of agricultural production in India, food-grain production in 1949-1950 which was originally estimated to be 48 million tons has been subsequently placed at over 60 million tons; the estimates of rates of growth of agricultural production in India are based on the index numbers of agricultural production revised to take into account the extensions in coverage. While these revised index numbers for India are still defective in some respects and have occasionally come in for critical comment, the data relating to Mexico appear to be much less reliable.

TABLE 3 : RATE OF GROWTH OF OUTPUT OF DIFFERENT CROPS IN THE PUNJAB, GUJARAT AND MADRAS STATES IN INDIA, 1952/53 TO 1964/65

Crop	Punjab	Gujarat	Madras
Wheat	5.38	3.12	-
Rice	8.68	5.59	4.89
Maize	3.83	-	-
Jowar	0.98	1.06	4.20
All food-grain crops	3.66	2.06	4.17
Cotton	7.06	5.42	4.56
Sugarcane	6.72	10.56	7.68
Tobacco	-	6.51	0.70
Ground-nuts	-	9.01	4.55
All crops other than food-grain	7.04	6.62	4.17
All crops	4.56	4.55	4.17

The increase in output recorded in these states can be broken down according to certain proximate and identifiable sources of growth--namely, extension of area under crops, changes in the crop-pattern (in the direction of more highly valued crops), and increases in crop yield per unit of land. The results of such an exercise, based on the data available for individual states and covering the period 1951/52-1953/54 to 1958/59-1960/61, are given in table 4.

While the extension of the area under crops was the major source of growth in the Punjab, and changes in the crop-pattern in Gujarat, in Madras it was the increase in crop yield per acre. One needs to consider what it is that

TABLE 4 : RELATIVE CONTRIBUTIONS OF DIFFERENT ELEMENTS TO THE GROWTH OF CROP OUTPUT IN THE PUNJAB, GUJARAT AND MADRAS STATES

State	Percentage increase attributed to: area increase	change in crop-pattern	increase in crop yield	"interaction"[a]	Total
Punjab	69.93	22.38	7.98	-0.29	100.00
Gujarat	22.16	68.21	21.29	-11.66	100.00
Madras	19.70	25.00	52.70	2.60	100.00

SOURCE: B.S. Minhas and A. Vaidyanathan, "Growth of crop output in India, 1951-54 to 1958-61: an analysis by component elements", Journal of the Indian Society of Agricultural Statistics, December 1965. Data for different crops within each state are not fully corrected for errors due to extensions in the coverage of official agricultural statistics; this has to be borne in mind in interpreting the results of this analysis, more particularly in the case of states like Rajasthan where such extensions are known to have been very large.

a "The interacting terms in our scheme is essentially in the nature of a balancing entry". B.S. Minhas and A. Vaidyanathan, op.cit.

made these the main sources of growth--which would indicate also why these states were able to achieve rates of growth comparable to those recorded in Mexico and Taiwan.

The case of the Punjab is a particularly interesting one. For a number of historical reasons the north-western region of India, and, more particularly, that part of the

Punjab which was included in it and is now in the territory of Pakistan, received the bulk of the public investment undertaken during British rule, a high proportion of which went into irrigation. Thus, in the period 1898-1914, when gross public investment annually was itself in the range of 3.75 to 5.5 per cent of the national income (and net public investment about 2.5 to 4 per cent), and irrigation accounted for about one-eighth of this investment, no less than 50 per cent of the gross investment in irrigation was in the Punjab.[29] As a result there was an increase of as much as 150 per cent in the stock of irrigation assets in this region during the period and a more than proportionate increase in the area irrigated. While the Punjab accounted for only 4.5 million acres out of 13.5 million acres under irrigation in India in 1899/1900 its share went up to 7.0 million acres out of 17.0 million acres by 1913/14; which, in turn, led to the production of wheat in the Punjab increasing by about 60 per cent during this period and of raw cotton by no less than four and a half times.

The partition of the Punjab resulted in the greater part of the irrigated area of the region falling into the territory of Pakistan, and this fact--together with the need to rehabilitate the refugees who migrated into India--made heavy investments in irrigation necessary in the eastern part of the Punjab in the years immediately following 1947. Most of this investment was in the Bhakra Nangal Project, the

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29 See M.K. Thavaraj, "Public investment in India, 1898-1914: some features", The Indian Economic Review (Delhi), Vol.II, No. 4, August 1955; also by the same author "Capital formation in the public sector in India: a historical study, 1898-1938", Papers on National Income and Allied Topics (Indian Conference on Research in National Income), Vol. I, ed. V.K.R.V. Rao and others (Asia Publishing House, Bombay, 1960). The data presented in this paragraph are taken from these two papers.

largest multi-purpose project in India's first Five Year Plan.[30] This project not only helped to increase the area under irrigation in the region but, as in Mexico at about the same time, brought into cultivation some relatively arid and dry areas, thereby increasing the total crop area itself. The net area irrigated in the Punjab State (of the Indian Union) increased from 38 per cent of the net sown area in 1950/51 to 43 per cent in 1962/63; meanwhile, the gross crop area in the state increased by nearly one-third during this period.[31]

Figure II* shows the areas covered by the new Bhakra canals in the Punjab. The northern part of the state, and even some areas in the centre, already had canal irrigation from earlier investments in irrigation (as in western Punjab in Pakistan) and the areas where irrigation was newly provided were therefore mainly in the extreme south and south-west. It will be seen from figure III which depicts the annual growth rates by district between 1952-1955 and 1959-1962, that these areas in the south recorded rates of growth of over 10 per cent per annum during this decade and that crop output even in some of the other areas benefited by the project grew at a rate of between 5 and 10 per cent per annum.[32]

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30 For more information on this project, see K.N. Raj, Some Economic Aspects of the Bhakra Nangal Project: An Analysis in Terms of Selected Investment Criteria (Bombay, Asia Publishing House, 1960).

31 The extension of the area under cultivation in the Punjab as a result of irrigation during this period was of course proportionately much less than in Mexico.

32 It would appear from some unpublished data made available to the author that the picture is broadly the same even for the period 1952-53 to 1964-65. Bhatinda, Patiala and Hissar recorded increase in crop output of approximately 10 per cent or more per annum, while in Karnal, Mahendragarh, Ludhiana and Jullundur crop output grew at the rate of between 5 and 10 per cent per annum.

* Figures II and III are not reproduced here.

The total population of the Punjab in 1961 was over 20 million (of which the population in the seven districts in which crop output increased most rapidly was nearly 3.5 million); the total area under cultivation was around 8 million hectares (of which these seven districts accounted for nearly one-half). It is clear then that in terms of population size and cultivated area the Punjab is about two-thirds as large as Mexico, while in the areas within the state in which the growth rate has been highest both the population and the area under cultivation are evidently larger than in the corresponding regions of Mexico. Though the average size of holdings is larger in the Punjab than in most other parts of India it is very much smaller than in the northern regions of Mexico; the degree of concentration in the ownership and operation of land-holdings also appears to be much lower in the Punjab.[33] If the achievement of high growth rates in relatively small-sized holdings based on family labour is the criterion, the performance of agriculture in the Punjab since the Second World War is perhaps more worthy of attention than in Mexico during this period.

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33 The average size of an agricultural holding in the territory of the Punjab (as in 1953/54) was only 11.0 acres, which was slightly larger than the all-India average of 7.5 acres. See "Report on land-holdings (4), rural sector--states", The National Sample Survey, No.66, tables 2-5. Taking into account all the assets (including land but excluding some financial assets) held by households in the rural sector, it has been estimated that the top 10 per cent of the households in the Punjab accounted for only 47 per cent of the assets held by all households in the state (compared to 56.5 per cent in Madras and 60.0 per cent in Andhra Pradesh, both in southern India). See "Distribution of value of total assets among households resident in the rural sector of India", Reserve Bank of India Bulletin (Bombay), October 1966. Transfers of land through leasing do not also significantly alter the size-distribution of holdings in the Punjab.

The State of Madras, and more particularly some of the districts within it, has similarly many features in common with Taiwan. The area under crops as well as the population are no doubt much higher (about ten and three times as high, respectively, as in Taiwan), but in both cases a high proportion of the cultivated area has been under irrigation for a fairly long period as a result of earlier investments. (The irrigated area in Madras has increased in recent years, from about 35 to 41 per cent of the net sown area.) In fact in the Thanjavur district of the state, where the area under crops is nearly four-fifths as high as in Taiwan and the population about one-fourth in size, nearly 80 per cent of the crop area is irrigated. As in Taiwan, the main food-grain grown in Madras is rice; and the Thanjavur district, often described as the rice bowl of South India, grows about one-fourth of the total production of rice in the state. With the high percentage of land under irrigation, the State of Madras (and more particularly the districts like Thanjavur) has also come in for special attention in recent years through programmes for intensive agricultural development formulated as part of the Five-Year Plans.

However, the highest rates of growth of crop production in Madras in the period since the late 1940s have been recorded (as in the Punjab) in the districts in which the irrigated area increased most. As will be evident from table 5, this is because the gross area sown has registered the largest increases in districts where the percentage increase in irrigated area has been highest. These were also generally districts in which productivity per acre was relatively lower than elsewhere in the state, and so the effect of extension of irrigation was to raise productivity by a larger percentage than in other districts where

TABLE 5 : GROWTH OF CROP OUTPUT[a] IN TEN SELECTED DISTRICTS OF MADRAS STATE (SOUTHERN INDIA), 1949/50 TO 1962/63

	Growth rate per annum (compound)	Percentage of gross area sown, 1949/50-1951/52	Output per acre, 1949/50-1951/52 (in Rs)	Percentage of gross area irrigated, 1949/50-1951/52	Percentage increase in gross irrigated area between 1949/50-1951/52 & 1960/61-1962/63	Percentage increase in gross area sown between 1949/50-1951/52 & 1960/61-1962/63	Percentage increase in output per acre between 1949/50-1951/52 & 1960/61-1962/63	Percentage contribution of increases in crop yield to growth of output between 1949/50 & 1962/63[b]
Group I								
Chingleput	8.8	40.6	95.8	56.3				
Ramanathapuram	7.4	34.4	93.3	42.2				
North Arcot	5.9	44.3	129.1	34.0				
Coimbatore	5.4	46.3	103.1	25.4				
Average	6.9	42.0	105.3	35.5	63.2	34.6	60.4	46.7
Group II								
Salem	5.0	41.0	91.7	19.0				
Tirunelveli	4.7	45.1	121.0	37.9				
Madurai	4.5	44.6	129.2	40.7				
Average	4.7	43.2	113.9	31.0	25.1	20.6	33.7	52.8
Group III								
Thanjavur	3.0	69.5	185.9	80.0				
South Arcot	3.0	58.1	140.7	37.7				
Tiruchirappalli	2.8	50.9	126.5	33.7				
Average	3.0	58.3	151.0	50.4	21.4	9.9	29.9	62.7

SOURCE: R. Thamarajaksh, "Growth of agriculture in Madras State, 1949/50 to 1962/63", in Ministry of Food, Agriculture, Community Development and Co-operation, Agricultural Situation in India (Delhi), December 1967; also by the same author, Agricultural Growth in Madras State, 1949/50 to 1962/63 (occasional papers No.1, Agricultural Economics Research Centre, University of Delhi).

a The study covers fifteen crops accounting on the average for 90 per cent of the total area under crops in the selected districts.

b The method used for isolating the contribution of increases in crop yield to the growth of production is the same as in the paper by Minhas and Vaidyanathan referred to earlier (see source note to table 4).

productivity was higher to begin with. It will be seen that in districts which already had extensive areas under irrigation and where the further increases in irrigated and gross sown areas were relatively much smaller, not only was growth of crop output dependent to a larger extent on increases in crop yield per acre but the rate of growth of output recorded was itself much lower (exactly as in the areas of Mexico and Taiwan that had been under irrigation earlier). In the Thanjavur district, where the area under irrigation and the productivity per acre were highest to begin with, the recorded growth rate of crop output was no more than 3.3 per cent (which is of the same order as that of rice output in Taiwan in the same period).

Gujarat presents a special case of a state in which the irrigated area is relatively small (less than 10 per cent of the net sown area) but where the climatic and soil conditions favour the cultivation of crops other than food-grain with relatively high productivity per acre. These crops accounted for 48.3 per cent of the total crop area in Gujarat even in the early 1950s (compared to 24.5 per cent for all India). In response to rapid growth in demand (particularly for raw cotton and ground-nuts) their share went up to 53.9 per cent by 1964/65, the area under raw cotton and ground-nuts alone accounting for over 37 per cent of the total crop area in the state and for 70 per cent of the area under other than food-grain crops. With the introduction of improved varieties, additional inputs of fertilizer, and probably some diversion of better quality land, the productivity per acre also went up during this period by no less than 25 per cent in the case of cotton and over 50 per cent in the case of ground-nuts. The high growth rate recorded in Gujarat was therefore essentially due to the

special circumstances governing the demand for and the production of raw cotton and ground-nuts.

IV. General Implications

The implications of these empirical findings are important. A feature common to Mexico, Taiwan, the Punjab and Madras is that they had not only considerable irrigation facilities as a result of past investments but there was extension of irrigated area during the period in which high rates of growth were recorded. Such extension led to an increase in the gross area under crops during the same period and was responsible to a significant degree for the increases in output. When irrigation was extended to areas with good soil but where earlier productivity of land had been relatively low due to inadequate supplies of water, such extension led not only to increases in crop area but also to higher productivity all round.

No doubt, new and higher yielding plant varieties evolved by scientific research also made their contribution, more particularly in Mexico and Taiwan, but many of these new varieties only yielded more when complemented by substantial inputs of chemical fertilizers and other plant nutrients, which in turn required assured supplies of water at specified intervals. Without such supplies there was danger not only of the complementary inputs being infructuous but, in some cases, of the yield being lower than from the use of the older varieties without these inputs.

The percentage area of the land that can be provided with assured supplies of water therefore imposes a limit to the

rates of growth that can be realized by technological change. In a country like India that has had a long tradition of irrigation, and where past investments have already exploited a large part of the more easily available water resources, not only is the scope for further extension more limited than in some other countries but it is likely to be much more costly. There might of course be particular regions in which subsoil water could be tapped at relatively low cost by means of modern technology, but one must be careful not to generalize from the performance of regions in which conditions for such exploitation of water resources are favourable. Moreover, since the areas with such assured supplies usually already have higher productivity than elsewhere, the rates of growth that can be achieved are generally lower than one might be tempted to assume as feasible from the recorded rates of growth in regions in which irrigation has been newly provided.

An important factor in the feasible rate of growth of output by absorption of an altogether new technology based on "modern" inputs is the degree of risk attached to its adoption. This may in part reflect purely subjective considerations, such as the unwillingness of farmers to experiment with new methods, but not infrequently such conservatism on their part is itself founded on experience. Agriculture is generally exposed to many uncertainties, and the capacity of farmers to bear risks is so limited that one must expect the rate of assimilation of new techniques to be relatively slow unless it is proved beyond doubt that the risks involved are negligible or adequately covered by higher returns. The absorption of the new technologies in agriculture (particularly those involving chemical fertilizers) is slower than might be

expected from the high rates of return they seem to offer from tests made in experimental stations (and even, under favourable conditions, in the field). However, a closer examination of the conditions that need to be satisfied for the realization of higher crop yields shows very often that there are many objective and clearly identifiable reasons for this.

One must also consider the steps that have to be taken in most regions of India (including those in which some kind of irrigation is available) for the adoption of new plant varieties. They include not only the provision of adequate supplies of seed and fertilizer but a number of other related measures with a significantly different orientation from those taken at an earlier period:

> The dreadful famines of the late nineteenth century, and the brush with famine conditions at several intervals of the nineteenth century, led to a dominant concern with a need to produce crop varieties that were disease, insect and drought resistant..... Research was not the only aspect of twentieth century agricultural development dominated by the need for stability. Irrigation projects were designed and built to distribute water over as many acres as possible to assure a harvest in years of drought. State plant protection services were established to act when the threat of insect attacks reached a level that presaged severe crop loss.....
>
> ..... The difference between the present varietal work and that of the past is more than just the pursuit of higher yields. The new varieties that are beginning to emerge are a significant break with traditional agriculture for they are being selected for response to inputs that are not part of conventional Indian farming. Most notable among these, of course, is fertilizer..... In addition to fertilizer, these varieties will require pampering with a range of other non-traditional inputs. Plant protection measures

> must be stepped up. As plant stands thicken with high fertility conditions, insect population and the opportunity for the spread of disease will increase. To capture the high yield potential bred into the plant by the geneticists will require constant control of pests, plant parasites, and noxious weeds....
>
> The interaction between irrigation water and the uptake of fertilizer is a favourite example of the package concept of agricultural growth where the total benefits from the application of both are greater than the sum of the benefits of each one taken singly. Higher yielding varieties able to make use of high dosages of fertilizers will demand levels of water application that go far beyond those available from irrigation systems designed for drought protection..... The social and potlitical problems of redesigning existing irrigation systems for intensive production instead of drought protection will be very large.....[34]

The re-designing of irrigation systems to suit the requirements of the new varieties has indeed very far-reaching implications. Thus it has been indicated that the full requirements of the new varieties of wheat would need a twenty-four-hour delivery of a cusec of water to be spread over no more than sixty acres, compared to the present practice in North Indian canal and tube-well systems of

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34 W. David Hopper, "The mainspring of agricultural growth", Rajendra Prasad Memorial Lecture, delivered at the 18th Annual Conference of the Indian Society of Agricultural Statistics, January 1965.

spreading it over 200 to 400 acres.[35] If adequate supplies of water are available for ,ting the higher requirements of both the new varieties and of the areas previously supplied, only the cost of securing additional supplies (such as of further investment in tube-wells) need be taken into account. But adequate supplies of water cannot be taken for granted and, if more intensive irrigation is possible only at the cost of lower area coverage, many other considerations become relevant. It certainly cannot be assumed that high rates of growth promoted by intensive irrigation are necessarily to be preferred even if as a result there are at the same time to be fluctuations in output of vastly greater magnitude.

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35 Note in this connexion the following findings and observations based on a study of the fluctuations in food-grain output in India from 1901 to 1966:

> "..... there is a marked difference in the situation obtaining in 1951/52 to 1965/66 and that obtaining in the two earlier periods. The growth between 1900/01 to 1923/24 was very slow and it occurred mainly due to extension of area. Droughts were quite frequent and severe and had relatively greater impact on marginal land. Between 1924/25 and 1950/51, there was a general stagnancy in production, droughts were relatively less frequent and less severe and the extension of irrigation in certain areas of the country was also having a somewhat stabilizing effect. There was hardly any increase in the use of inputs like fertilizers and the risk from this factor was absent. In the period 1951/52 to 1965/66, there was not only an unprecedented increase in the rate of the growth but there was also a sharp increase in both acreage and use of inputs like fertilizers. There was, no doubt, an appreciable increase in irrigation also, but it was neither sufficient in volume nor utilized with sufficient care and economy so as to compensate for the destabilizing effect of the first two factors. So, when a widespread and severe drought

(continued on page 36)

There are also specific problems relating to each crop which often hinder the rapid absorption of a new technology. For instance, the new varieties of rice--essentially hybrids based on the Indian and Japanese types--require the fulfilment of certain important conditions. There are significant differences in the factors governing the supply of water in India and Japan, the seasonal variations in rainfall in rice-growing areas being generally much less sharp in Japan (and even in Taiwan) than in most parts of India. Since the yield of plants is affected not only by drought but by excessive supplies of water at the germination, seeding and later stages of growth, the need for drainage and other techniques of controlling water-supply is vastly greater in India. The varieties hitherto grown in India were "tough, vigorous plants, chosen to withstand and produce under all but the worst the monsoon could do", [36] the introduction of the new varieties poses a wholly new kind of problem which might require both considerable investment and time for its solution (except perhaps in certain regions). There are also other problems involved in introducing the Japanese type

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(f.n. No.35 contd..)

> struck the country in 1965, there was a sharp decline of as much as 17 million tons in food-grain production, an order of decline which the country had not seen for over forty years."

S.R. Sen, "Growth and instability in Indian Agriculture", Address to the 20th Annual Conference of the Indian Society of Agricultural Statistics, January 1967.

36 W.D. Hopper, op.cit.

in the tropics, due both to its greater vulnerability to disease[37] and the consumer preference in India.[38]

Apart from the technical problems associated with the adoption of new technology, there are usually institutionaly impediments resulting from the pattern of land-ownership and the factors governing transfers of land and capital (including finance) for production purposes. In the absence of economies of scale the optimum size of the farming units may be small (particularly in countries with a relatively abundant supply of labour), but the risk associated with leasing out land tend to restrict the scale of such transfer from those with large holdings to those with little or no land and, consequnetly, the size distribution

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37 "Japanese rice has a resistant quality against rice stem-borers. Both the number of egg-mass and larvae that actually bore into the plant is small and the damage is little. However, with the other (Japanese) type in foreign countries, the number that actually bore into the plant is larger and the damage greater..... Immunity against this insect decreases with the more abundant use of nitrogenous fertilizer".

Takekazu Ogura (ed.), Agricultural Development in Modern Japan (Tokyo, FAO Association, 1963), appendix to part III, pp. 611-612.

38 The quality of the rice produced by the new varieties is different and in some cases thought to be inferior by consumers to the quality produced by existing varieties in India. This would naturally affect the price expectations of producers, particularly when large increases in yield are expected to be realized from the new varieties, and would discourage their adoption beyond a certain point. This tendency is already evident in certain regions in India, more so because of the zonal system which restricts the free movement of food-grains between different states.

of "operational holdings" is often not markedly different from that of "ownership holdings".[39] Moreover, the ability to borrow tends to be very closely linked with holdings of land and other assets, with the result that those who have small holdings are unable to secure credit for applying new inputs (other than labour) on the necessary scale. Thus, given the additional risks associated with the new technology it is sometimes only the larger holdings that are in a position to adopt them, and this too only to the extent that the returns at the margin appear to them adequate to cover the risks of hiring more labour and incurring other necessary costs. The smaller holders usually have an advantage in so far as the new technology requires intensive application of labour (as in the case of rice) but little credit, since the risks attached to the new technology also set limits to the application of other inputs. The tendency of the larger landholders is generally neither to lease out land to small holders nor to hire labour on a large scale but, as far as possible, to adopt labour-saving techniques and utilize available land and other inputs only to the extent consistent with these techniques. The result is that, even when there are no economies of scale, the availability of modern technology leads very often only to dualism in the agricultural sector (as in Mexico) rather than to transformation of traditional agriculture.

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39 An analysis of these and related phenomena is attempted in K.N. Raj, Accumulation and Growth in Agrarian Economies (to be published)

Given all these constraints the rate of growth of agricultural output would also tend to be much lower than one might expect on the basis of norms established from experiments conducted under favourable conditions. Strategies of development based on the expectation that phenomenally high rates of growth can be realized in agriculture might therefore prove to be a serious mistake in many countries even if there are examples of such strategies having succeeded in some. Certainly the high rates of growth recorded in regions like northern Mexico, Taiwan, Madras and the Punjab are unlikely to be realized in large areas of the developing world in which the natural conditions for transforming the technology of agriculture are much less favourable.

There is as much danger in over-estimating the potentialities of growth in agriculture and basing other policies on the assumptions of phenomenally high rates of growth in this sector as in not recognizing the importance of agriculture to economic growth. From one extreme the pendulum has recently swung to the other, and some correction of perspectives is perhaps now called for. Unfortunately, the policies and diplomacy of foreign aid encourage both donors and recipients of such aid to highlight particular achievements without an objective assessment of all the relevant factors.

Clearly, if the areas in which technology can be rapidly transformed are limited by inadequate supplies of water, the case for making the most efficient use of resources in the regions in which such transformation is possible becomes even stronger than otherwise. This is where

the need to make institutional changes in agriculture comes in. It is generally the case that the regions which are most fertile have a relatively higher percentage of land under tenancy; but the terms on which tenants operate often discourage the kind of investment and intensive inputof labour that agriculture in these regions calls for. Further, as indicated, in many of the developing countries today transfers of land through leasing do not significantly alter the size-distribution of land holdings to the extent required to promote the full utilization of the available labour in these economies. If the rate of growth are still higher than elsewhere it only shows the dominant influence of the favourable technical conditions in these regions, not that the most efficient use is being made of the available resources. This aspect of the problem has been increasingly neglected in recent years in the belief that technological changes in agriculture can by themselves yield high rates of growth and that, since institutional reforms call for strong political action that might meet with resistance, it is wiser to concentrate on the technological changes. Most developing countries do not in fact have such a choice and have to advance on both fronts to realize the rates of growth in agriculture they require for rapid economic development.