Vol XXI
No. 4

ISSN 0019-5014

CONFERENCE
NUMBER

OCTOBER-
DECEMBER
1966

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

AGRICULTURAL GROWTH RATES AND THEIR COMPONENTS

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This paper presents a picture of the progress of agricultural output in different countries of the world over the past decade or so. Per cent rates of growth of agricultural output during the period 1952-53 and 1962-63[1] (both years inclusive) have been computed for about 60 countries all over the world by fitting the semi-log least squares trend. No attempt has, however, been made to give the reasons for inter-country differentials in growth rates. For a limited number of countries, the rates of growth of crops have been broken down into components, namely, those due to changes in farm land surface, double cropping, changes in crop yields and improvements in the cropping pattern.

Availability of Production Aggregates

Agricultural output comprises temporary crops, permanent crops, livestock (including poultry) and dairy products,[2] the importance of each sub-sector varying from country to country. To work out the growth rates for the agricultural sector as a whole, or its sub-sectors, it is necessary to have group indices or some sort of aggregates. The readily available data for this purpose are the F.A.O. index numbers of food production and of total agricultural production, as well as the value aggregates for total agriculture and sub-sectors worked out in the process of index number construction. These value aggregates are in terms of wheat equivalent tons. These are good enough for making international comparisons of growth rates, even though they may not be free from drawbacks where the purpose is to make international comparisons of levels of production and productivity.

COMPUTATION OF GROWTH RATES

Growth rate can be arithmetic or geometric. The arithmetic (or simple) growth rate can be expressed in absolute terms or in percentage terms, while the geometric (or compound) growth rate is generally expressed in percentage terms. The simplest method of computing the arithmetic growth rate is to divide the difference in production in the initial and final years of the period by the number of intervening years :

$$Y_t = Y_o + bT^3 \qquad \ldots\ldots\ldots\ldots\ldots(1)$$

where Y_t and Y_o are output in the initial and final years and T the number of years after the initial year. When (1) is fitted by least squares, the information on pro-

1. The production data for 1963-64 have since become available, but these being still subject to change, the analysis has been confined to the series ending 1962-63.

2. Forestry, fishery and hunting are generally not included in the agricultural sector.

3. The growth rate would be the same if we worked out the increase in production in each year over the previous year and averaged these increments. Thus

$$\sum_{i=1}^{T} \left(Y_i - Y_{i-1} \right) \Big/ T = b .$$

duction for all the years (rather than for two years only) is utilized and the deviations from the growth trend are the minimum.

The geometric growth rate is given by the well-known compound interest formula

$$Y_t = Y_o (1 + r)^{T} \quad \ldots\ldots\ldots\ldots (2)$$

where 100 r is the geometric growth rate. When (2) is fitted by least squares, the growth rate will be given by

$$100\ r = (\text{Antilog } w - 1)\ 100$$

where $w = \log_{10} (1 + r)$.

The continuous function corresponding to (2) is

$$Y = A e^{rT} \quad \ldots\ldots\ldots\ldots (3)$$

where the rate of growth is 100 r. The difference between the geometric rates of growth obtained in (3) and (2) is infinitesimal in the present case. The continuous function (3) has the advantage of being easily manipulable algebraically. Tests of significance of the continuous function are also easy.

Growth rates for different countries have been worked out in terms of equation (3) above for agriculture as a whole and are shown in Table I. The growth rates for the countries marked (*) are not significant. The growth rates for all other countries are significant at the 1 per cent level, except for Argentina which has the growth rate significant at the 5 per cent level. It may be pointed out that "statistical significance" in this context means that the growth rates are significantly different from zero. Even when the growth rates are highly significant, the possibility of obtaining considerably different growth rates from those given above cannot be ruled out when different samples (*i.e.*, data for different years) are used.

Of the 57 countries for which data are available, four countries (Israel, Sudan, Mexico and Yugoslavia) had "exceptionally high" growth rates of more than 5 per cent per annum, Israel topping the list. Nine countries had "high" growth rates between 3.5 and 5 per cent. At the other end, nine countries had "very low" growth rates of below 1 per cent, three of them (Sweden, Algeria and Uruguay) shown even negative growth rates, and 8 countries had "low" growth rates of between 1 and 2 per cent. The remaining 27 countries, or nearly half of the total number of countries having necessary data, had average growth rates of 2 to 3.5 per cent.

4. Or the percentage increase in each year over the previous year can be worked out and the geometric average of these increments can be obtained.

$$\sqrt[T]{\prod_{i=1}^{T} \left(\frac{Y_i - Y_{i-1}}{Y_{i-1}} \right)} = r'$$

r would be the same as r' only if the percentage increase in output in each year over the previous year were the same. Otherwise, the two would be different.

TABLE I—AGRICULTURAL GROWTH RATES IN DIFFERENT COUNTRIES : 1952-53 TO 1962-63

Very high (4.5% and above)		High (3.5% — 4.5%)		Average (2.0% — 3.5%)		Low (1% — 2%)		Very low (below 1%)	
Israel	9.6	Thailand	4.5	South Africa	3.4	Italy	1.9	Portugal	0.9*
Sudan (crops only)	8.5	Gautemala	4.5*	Australia	3.4	Ireland	1.9	Tunisia	0.8*
Mexico	6.5	China-Taiwan	4.4	Philippines	3.3	Pakistan	1.5	Cuba	0.7*
Yugoslavia	5.4	Greece	4.3	Turkey	3.3*	Iraq	1.5*	Morocco	0.5*
		Venezuela	4.1	Japan	3.3	U.S.A.	1.5	Norway	0.4*
		Korea (S)	3.9	U.A.R.	3.3	Indonesia	1.4	Canada	0.4*
		Brazil	3.8	Panama	3.3	Switzerland	1.1	Sweden (—)	0.1*
		Malaysia	3.8	New Zealand	3.2	Argentina	1.0	Algeria (—)	0.6*
		Iran	3.7	Austria	3.2			Uruguay (—)	1.1*
				Honduras	3.0				
				France	2.8				
				Syria	2.8*				
				U.K.	2.8				
				Spain	2.8				
				India	2.7				
				Ethiopia	2.5				
				Finland	2.5				
				Peru	2.5				
				Colombia	2.5				
				Jordan(crops)	2.5*				
				Denmark	2.3				
				Netherlands	2.3				
				Ceylon	2.3*				
				Germany	2.1				
				Burma	2.1				
				Belgium	2.1				
				Chile	2.0				

A striking feature is that the developed countries showed average, low or very low growth rates, none of them falling in the groups of countries with high or very high growth rates. This appears to be partly due to the fact that in most of these countries there has been a net reduction in the labour force as a result of outflow of people from agriculture. A large part of the capital formation in agriculture in these countries, which should have led to a substantial increase in output, merely served to offset the decline in output resulting from a reduction in the labour force. The shift of people from agriculture in the developed countries seems to be the result of differences in value of marginal productivity in agriculture and the non-agricultural sectors. This gap is sought to be made good to some extent by transfer payments in the form of subsidies and price guarantees, etc., but very wide differences still exist and are bound to continue. Population growth in the developed countries being comparatively low and the income elasticity of demand for agricultural products being also comparatively small, growth in demand for agricultural products is bound to be slow, and this tends to keep low the prices of agricultural products and the value of marginal productivity in agriculture. To an extent, the high rate of growth in some developing countries and their increased capacity to export to the developed countries also plays a role. In view of the operation of these various forces, the growth rates in agriculture in the developed countries could not be expected to be high. Nearly half of the low to moderate growth rates in the developed countries taken together have resulted from increase in fertilizer use, nearly one-third from land extension, while fixed capital formation served mainly to offset the negative effect of labour outflow.

When the situation is examined from the viewpoint of the "margin" of agricultural growth rates over the population growth rates (*i.e.*, the extent to which agricultural growth rates exceeded the population growth rates), the developed countries presented a more favourable picture than the developing countries. Starting from below, in the group of countries with "very low" agricultural growth rates, the margin was negative for both the developed and the developing countries (*i.e.*, population growth rate exceeded the agricultural growth rate). In the group of countries with "low" growth rates, all the developing countries showed a negative margin, but the developed countries showed a positive margin of more than 1 per cent (U.S.A. is an exception). In the group of countries with "average" growth rates, the developing countries showed a margin of below 1 per cent, but the developed countries had a margin of 1 to 3 per cent, the average being 1.75 per cent. In the "high" agricultural growth rate group, which included almost entirely the developing countries, the margin was only 1 to 2 per cent. It was only in the group with "exceptionally high" agricultural growth rates that the developing countries showed a margin of more than 2 per cent. Even here, Israel with agricultural growth rate of 9.6 per cent had a population growth rate of 7.54 per cent (as a result of immigration apart from the natural growth in population), leaving a margin of only 2.06 per cent.

COMPONENTS OF GROWTH RATES

The rate of growth of total agricultural production in a country consists of various components including

A. *Crop Production*

1. Rate of growth in land area.
2. Rate of growth in area sown more than once.
3. Rate of growth in per hectare yield proper.
4. Rate of growth in overall crop productivity due to shift from low yield or low priced crops to high yield or high priced crops.

B. *Animal Production*

5. Increase in the number of animals.
6. Increase in the per animal yield of each product, including meat, milk, etc.
7. Shift from low value products per animal to high value products per animal.

Different factors would affect different components in varying degrees. Fertilizers would affect component 3, while prices and returns may influence component 4. Irrigation would influence components 2, 3 and 4, and so on. The splitting up of the rate of growth of agricultural production into its components can help, *inter alia* in determining the influence of various factors more clearly.

The data required for splitting up the rate of growth of animal production are generally not available, but in the case of crop production the position is not so bad. Therefore, an attempt has been made to split up the growth rate of crop production for as many countries as possible.

Crop production is the product of area under the crop and its productivity. In the case of a single crop, productivity means yield rate. But when several commodities are involved and it is intended to determine components of the growth rate for total production, the use of index numbers is called for. The index number of production can be broken down into various components.

$$\text{Index of Production} = \frac{\sum Q_{ti} P_{oi}}{\sum Q_{oi} P_{oi}}[5] = \frac{\sum Y_{ti} A_{ti} P_{oi}}{\sum Y_{oi} A_{oi} P_{oi}} = \frac{\frac{\sum Y_{ti} A_{ti} P_{oi}}{\sum A_{ti}} \cdot \sum A_{ti}}{\frac{\sum Y_{oi} A_{oi} P_{oi}}{\sum A_{oi}} \cdot \sum A_{oi}}$$

$$= \frac{\sum Y_{ti} A_{ti} P_{oi} / \sum A_{ti} \cdot \sum A_{ti}}{\sum Y_{oi} A_{oi} P_{oi} / \sum A_{oi} \cdot \sum A_{oi}} = \frac{\sum Y_{ti} R_{ti} P_{oi}}{\sum Y_{oi} R_{oi} P_{oi}} \cdot \frac{\sum A_{ti}}{\sum A_{oi}}$$

where the subscripts t and o refer to the current and the base periods and i refers to the commodity. Q is output of the commodity, P price, Y yield rate, A the acreage and R the ratio of the area under a crop to total area under all crops ($A_i/\sum A_i$).

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5. The alternative expression for index of production is $\frac{\sum \left[\frac{Q_{ti}}{Q_{oi}} \cdot Q_{oi} P_{oi} \right]}{\sum Q_{oi} P_{oi}}$.

According to the first formula, the value of output in the current period (at base period prices) is divided by the value of output in the base period. In the second, the "relatives" of output for each commodity are worked out and the weighted average of these relatives is calculated, the weights being the value of output in the base period.

Thus we get two expressions of productivity: One is $\frac{\Sigma Y_{ti} A_{ti} P_{oi}/\Sigma A_{ti}}{\Sigma Y_{oi} A_{oi} P_{oi}/\Sigma A_{oi}}$ which represents the index of output divided by the index of area. The second is $\frac{\Sigma Y_{ti} R_{ti} P_{oi}}{\Sigma Y_{oi} R_{oi} P_{oi}}$ which is the weighted average of the value of per acre yields (at the base period prices) of different crops, the weights being the proportion of total crop area occupied by individual crops in *respective* years.

It is important to recognize that productivity is an average concept. It represents the average value of output per acre and is not quite synonymous with per acre yield rates. Changes in productivity may be due to changes in yield rates and to changes in the cropping pattern. There may be a decline in productivity, despite an increase in the yield rates of all crops, if the cropping pattern has shifted in favour of low yield crops. The formulae for determining the changes in cropping pattern and changes in yield rates can be derived from the formula for the index of productivity. Thus

$$\frac{\Sigma Y_{ti} R_{ti} P_{oi}}{\Sigma Y_{oi} R_{oi} P_{oi}} = \frac{\Sigma Y_{ti} R_{ti} P_{oi}}{\Sigma Y_{ti} R_{oi} P_{oi}} \cdot \frac{\Sigma Y_{ti} R_{oi} P_{oi}}{\Sigma Y_{oi} R_{oi} P_{oi}}.$$

The first term on the right hand side above expression represents changes in R, as Y and P are the same in the numerator and the denominator. R, as already defined, is the ratio of area under individual crops to total cropped area; in other words, this term represents changes in the cropping pattern.

The second term represents changes due to yield rates because R and P are the same in the numerator and the denominator. Thus the output index is broken up into the area index, cropping pattern index and the yield rate index

$$\frac{\Sigma Y_{ti} A_{ti} P_{oi}}{\Sigma Y_{oi} A_{oi} P_{oi}} = \frac{\Sigma A_{ti}}{\Sigma A_{oi}} \cdot \frac{\Sigma Y_{ti} R_{ti} P_{oi}}{\Sigma Y_{ti} R_{oi} P_{oi}} \cdot \frac{\Sigma Y_{ti} R_{oi} P_{oi}}{\Sigma Y_{oi} R_{oi} P_{oi}}.$$

It is also pertinent to know how the growth rate for cropped area (*i.e.*, per cent increase in cropped area) is divided between an increase in arable land and double cropping. Such a division is important because an increase in double cropping represents an increase in productivity, although it is counted as an increase in cropped area. It is simple to calculate the contribution of double cropping to the growth rate of output. Suppose the total cropped area has increased from 60 units to 80 units. Of this increase of 20 units, 5 units represent an increase in arable land and 15 units an increase in the area cropped twice in a year. Of the total contribution of 33.3 per cent made by cropped area to the increase in output, one-fourth or 8.3 per cent would be attributable to arable land and 25 per cent to double cropping. Symbolically, the share of double cropping can be worked out by the formula

$$\frac{d}{G} \cdot r$$

where d and G stand for double cropped and total cropped area in the initial year, and r represents the per cent increase in double cropped area.[6]

This method is applied to determine the components of growth rates of crop output in different countries. It may be clarified that this model is applicable to binary comparisons (*i.e.*, changes between any two periods). The components have been worked out for 12 countries and are shown in Table II.

In *India*, the increase in area, brought about to some extent by double cropping, has contributed somewhat more than the increase in yield rate to the overall growth in crop output of 3.9 per cent. The contribution made by the improvement in cropping pattern has been very little. There was a shift in the cropping pattern from millets (jowar, *ragi* and small millets) and from sesame and castor seed, which have low value of output per acre to crops like wheat, maize, groundnuts, rape/mustard and sugarcane, which have relatively high value of output per acre. But its good effect was neutralized by a decline in the proportion of area under rice which has relatively high value of output per acre. There are crops like tobacco, jute, black pepper, tea and coffee which have high value of per acre output but have registered no *relative* increase in acreage under them. This shows that a considerable scope for improvement in the cropping pattern has not been exploited.

In *Thailand*, about one-third of the increase in total crop output has come from the increase in cropped area. Estimates of double cropping are not available, but it is generally known to be not very significant. There has been considerable extension of cultivation to new lands. The remaining two-thirds of the increase in crop output is due to higher yields and improvement in the cropping pattern. Rice, which has relatively low value of output per hectare (partly because of Government control on prices—and this is contrary to the position in India where rice is a relatively high valued crop) registered a decline in the proportion of area under it.[7] On the other hand, crops like maize, sugarcane, kenaf, coconuts, groundnuts which have much higher value of output per hectare, showed a *relative* increase in area sown to them. It is necessary to point out that the shift of acreage away from rice to other crops amounts to an improvement in the cropping pattern in the Thai economy, partly because of the heavy Government taxation on rice exports which keeps the domestic prices of rice low, consequently

6. This formula can be derived as under:

$G = n + d$ where G is total cropped area, n is arable land and d is double cropped area in the initial period.

$$\triangle G = \triangle n + \triangle d$$

$$\triangle G/G = \triangle n/G + \triangle d/G$$

$$= \left(\frac{\triangle n}{n} \cdot \frac{n}{G}\right) + \left(\frac{\triangle d}{d} \cdot \frac{d}{G}\right)$$

$$= \frac{n}{G} \cdot b + \frac{d}{G} \cdot r$$

where b and r are the per cent increase in arable land and double cropped area respectively, over the period under review.

7. It is significant to note that the proportion of area under rice declined both in India and Thailand. But this decline led to an improvement in the cropping pattern in Thailand, but a deterioration in the cropping pattern in India, because of the difference in inter-commodity price relationships and yield relationships in the two countries.

TABLE II—AVERAGE ANNUAL INCREASE IN CROP OUTPUT AND ITS COMPONENTS : VARIOUS COUNTRIES

Country	Period	Per cent increase in total crop output*	Per cent increase in components				
			Area			Yield rate	Improvement in cropping pattern
			Gross total	Net	Double cropping		
India	Triennium ending 1951-52 to triennium ending 1961-62	3.9	1.9	1.5	0.4	1.6	0.1
Thailand	Triennium ending 1952-53 to triennium ending 1960-61	5.0	1.8	—	—	1.2	1.5
Spain	Biennium ending 1953 to biennium ending 1960	2.6	0.4	—	—	1.0	1.1
China-Taiwan	Triennium ending 1952 to triennium ending 1961	4.7	0.8	0.2	0.6	3.8	—0.1
Greece	Triennium ending 1952 to triennium ending 1960	6.4	1.5	—	—	3.2	0.9
Turkey	Triennium ending 1952 to triennium ending 1961	4.9	4.6	4.6	neg.	0.1	neg.
Sudan	Triennium ending 1953-54 to triennium ending 1961-62	12.1	8.8	8.8	neg.	1.4	0.5
Egypt	Triennium ending 1952 to triennium ending 1960	2.4	1.1	0.2	0.9	1.5	—0.7
Mexico	Triennium ending 1952 to triennium ending 1962	7.9	3.7	—	—	3.7	—0.5
Jordan	Triennium ending 1954 to triennium ending 1962	3.0	—0.4	—	—	—0.7	4.6
Pakistan	Triennium ending 1952 to triennium ending 1960	2.4	0.9	0.5	0.4	1.0	0.3
Chile	Triennium ending 1952 to triennium ending 1960	4.2	2.6	—	—	0.5	0.8

Sources : The data on areas, production, yield, prices and value of crops needed for determining the components of growth rates have been collected from the following sources:

India : Directorate of Economics and Statistics. "*Agricultural Situation in India*," August, 1961 and January, 1963

Thailand : Agricultural Statistics of Thailand, 1960.

Spain : Espana-Anuario Estadistico 1962 and earlier years.

China-Taiwan: Taiwan Agricultural Yearbook 1962, Department of Agriculture and Forestry, Provincial Government of Taiwan.

Greece : Bulletin Agricole—Production Agricole de la Greece 1959 e 1960, Athens, 1963.

Turkey : Summary of Agricultural Statistics, State Institute of Statistics, 1941-62. Prices taken from "Conjuncture, Ministry of Commerce, 1960, *Direction de la Conjuncture et des Publications*."

Sudan : Agricultural Statistics, 1960-61 and 1961-62, Department of Agriculture, Agricultural Economics Division, Statistics Section.

Egypt : Ministry of Agriculture (Southern Region), *Monthly Bulletin of Agricultural Economics, Statistics and Legislation*, issued by Department of Agriculture, Division of Economics and Statistics, January, 1961.

Mexico : Concumes Aparuntes 1925-62, Direccion General de Economia Agricola, Departamento de Programa Agricola, Ganadiro y Forestal.

Jordan : The Hashimite Kingdom of Jordan : Statistical Yearbook 1962 and earlier years, Department of Statistics.

Pakistan : Land and Crop Statistics of Pakistan, March 1959, Ministry of Food and Agriculture, Directorate of Agricultural Economics and Statistics, Government of Pakistan, Karachi. Statistical Yearbook of Pakistan 1955.

Chile : Agricultura e Industrias Agropecuarias 1960-61, ano 1961 Direct. de Estatistica y Censos, Chila.

* These growth rates, worked out on the basis of averages for the initial and final trienniums (or bienniums) are generally higher than those computed by the least squares method, reflecting accelerated growth in the later years of the period. The least squares method takes into account the information for all the years, while the growth rates given on page 229 are worked out from information for the terminal trienniums.

reducing the value of per hectare output of rice in comparison with that of many other crops. If the Government export tax is added to the domestic price of rice, the value per hectare of rice output would be considerably appreciated,[8] and the contribution of "improvement in cropping pattern" to overall output, based on shift of area from rice to other crops would considerably go down. This would, in turn, bring down the overall growth rate in agricultural output.

In *Spain*, the role of area in the overall growth of crop output was small, but yield rates and cropping pattern improvements made significant contributions. The improvement in the cropping pattern represented a shift from rye, oats, wheat, chickpeas, pulses (*i.e.*, the foodgrains group) with low value of output per hectare to potatoes, vegetables, cotton, maize and forage crops with high value of output per hectare. Sugarbeet has exceptionally high value of per hectare output but there has been no shift of area towards it.

The expansion of overall crop output in *China-Taiwan* came partly from an increase in cropped area but mainly from an increase in the yield rates. The increase in cropped area was mostly due to double cropping which made significant contribution to the increase in output, compared to other countries. Cropping pattern showed rather some deterioration and, therefore, made a negative contribution to the overall increase in crop output. Rice with per hectare output value higher than the average for all crops, registered a relative decline in area. Sugarcane with very high value of per hectare yield also declined in relative importance in the cropping pattern. But crops like soybeans, other beans, corn, peanuts, sesame and rapeseed with low value of per hectare yield recorded a relative increase in area sown with them. The improvement in the relative importance of these low valued crops may have been due to double cropping of rice lands with these crops. Double cropping led to an increase in the total cropped area but a given per cent increase in cropped area did not result in the same per cent increase in output, as the value of per hectare output of these crops was less than that of rice. The difference is reflected in a deterioration in the cropping pattern.

In *Greece*, more than half of the rapid increase in crop output has been due to the increase in yield rates, the remainder being shared by an increase in cropped area and improvement in the cropping pattern. The area pattern shifted from crops like rye, barley, oats, maize, sorghum, etc., to mainly wheat, cotton and forage crops. The value of per hectare output of wheat, cotton and forage crops, though not high, is better than that of the various millets mentioned above. That is why the cropping pattern registered considerable improvement, leading to an increase in overall output. There are many other crops like various vegetables, beets, groundnuts, tobacco, which have very high value of per hectare yield but have not attracted a larger proportion of total cropped area.

In *Turkey*, almost the entire increase in output has resulted from an increase in cropped area brought about by the extension of cultivation to grass lands.

8. In 1960 Government "Rice Premium" amounted to 621 Baht and the export tax to 119 Baht, or a total of 740 Baht per ton of milled rice (it differs from variety to variety of rice and according to the content of "brokens"), against the domestic wholesale price of about 750 Baht per ton. On the basis that 20 per cent of rice produced in the country and about half of the quantity marketed is exported, the real value of per hectare output of rice would increase by about one-third if allowance is made for Government levies on export.

Multiple cropping seems to be insignificant. There was practically no improvement in yield rates or the cropping pattern. There was some shift in area from coarse grains like rye, oats, barley, millets, etc., with low value of output per hectare to wheat which had higher value per hectare. But the order of shift or difference in value of yields was not such as to have any significant impact. There were minor shifts among other crops, with little overall effect. Crops like rice, tobacco, potatoes, beets, cotton, which have far more value of per hectare yields than wheat and coarse grains, have shown no significant gain in their relative importance in the cropping pattern. The importance of cotton rather showed some decline.

The very large increase in crop output in the *Sudan* came mostly from an increase in cropped area and to some extent from an improvement in yield. Improvement in the cropping pattern made little contribution. The increase in cropped area was the result of extension of cultivation to new area, double cropping being practically non-existent. There has been some shift in the cropping pattern from millet to sesame and groundnuts, contributing somewhat to the increase in overall crop output. Egyptian cotton, and even American cotton, yields several times higher value per hectare than all other crops in the country. But there is not much scope for increasing the area under Egyptian cotton except when additional irrigation facilities become available. In the rain-fed lands there is good scope for shifting from sorghum and millet to oilseeds and even American cotton. This change in the cropping pattern can lead to a considerable increase in overall value of crop output.

The growth rate of crop output in *Egypt* was shared almost equally by the increase in area and improvement in yield rates. The cropping pattern instead of improving showed some deterioration. The contribution of area was mostly due to an increase in double cropping. Egypt seems to be the country with almost the largest increase in multiple cropping. The level of multiple cropping has already been high there. The deterioration in the cropping pattern is largely the result of a decline in the relative importance of cotton in the area pattern. The reason seems to be similar to that explained in the case of China-Taiwan, where too the increase in double cropping led to some deterioration in the cropping pattern.

In *Mexico*, the very rapid increase in crop output was shared equally by the increase in cropped area and the improvement in yield. The cropping pattern registered some deterioration.

In *Jordan*, both the area and yield rate declined, but the large improvement in the cropping pattern not only offset this but also led to a growth rate of 3 per cent per annum for crops as a whole. The improvement in the cropping pattern was the result of an increased share of vegetables in the whole cropped area, at the expense of some cereals. Yield rates of vegetables also increased substantially, but this was more than offset by a sharp decline in the yield rates of wheat and most other grains, so that for crops as a whole the per hectare yield suffered a setback. The role played by vegetables in the improvement of cropping pattern can be judged from the fact that of the increase of about 4.5 million Jordan Dinars in the total value of crop output, 2.8 million Jordan Dinars came from tomatoes which occupied only 1/30th of the total cropped area.

In *Pakistan*, additions to cropped area and higher yield rates played about an equal role in the increase in total crop output, with relatively small contribution from improvement in the cropping pattern. The increase in cropped area was partly the result of increased double cropping. The improvement in the cropping pattern was largely due to an increased share of sugarcane in the total cropped area as against a decline in the share of millets, etc. However, the change was but small.

In *Chile*, nearly two-thirds of the increase in crop output was the result of additional cropped area, while the remaining one-third was shared by higher yields and better cropping pattern, mainly as a result of increased share of potatoes in the total cropped area at the cost of wheat.

This review for a limited number of countries shows that on the whole, very high growth rates are difficult to achieve without some increase in arable land. Where the scope for extension of cultivation to new areas is limited, considerable increase in the total cropped area can be achieved by double cropping. This has been the case in countries like Egypt and China-Taiwan, where double cropping has been the main source of increase in the cropped area. In both these countries, extension to new areas has been the minimum. On the other hand, countries like the Sudan and Turkey which had large scope for extension of cultivation to new lands, double cropping has been negligible. This suggests that agricultural communities tend to increase their effort at double cropping as the scope for extending cultivation to new areas diminishes. Until now, however, double cropping has, on the whole, played a much less important role than extension to new areas. As for yield rates proper, their contribution to growth rates has been substantial though, on the whole, less than of extension of cultivation. The position is, however, different from country to country. Efforts to improve yield rates also seem to have been inversely related with the scope for extension of cultivation. A potentially important source of enhancing growth rates in output seems to be improvements in the cropping pattern. Countries like Jordan, Thailand and to a lesser extent Spain, Greece and Chile have achieved substantial increases in output as a result of shift to better yielding crops. But a large scope for improvements in the cropping pattern has not yet been exploited in most countries.