CHAPTER VIII

RESPONSE OF PRODUCTION

A. Aggregate Response

While considering production response in agriculture, it is useful to distinguish between response of aggregate agricultural production and response in terms of substitution among individual crops. If we ignore the different rates at which prices of different agricultural commodities rise and consider a weighted agricultural prices index and then study how aggregate production is responding, we have the former function in view. The crux of this function is that agricultural inputs may change, technological change may occur and productivity may increase. In fine, the rate of private investment in agriculture would change. This is a fundamental problem, different from and more important than the problem of efficient allocation of given resources among different crops. In a developing economy, the urgent problem is one of increasing the production of all crops, rather than one of increasing one crop at the expense of another. It is natural to expect that aggregate response is less elastic than substitution response, because the latter is only a question of allocating given resources, whereas the former involves a change in resources themselves. Thus
a conclusion relevant to one function should not be auto-
matically made applicable to the other function.

We shall take up the first function now and assume that all agricultural prices rise proportionately, and then introduce complications resulting from difference in the price rise among commodities.

We should first make it clear that an inelastic aggregate supply by itself does not indicate economic irrationality of the farmer. Confusing the two can cloud our vision and instead of looking for economic factors that introduce inelasticity and trying to correct them, we shall only be blaming the farmer for his alleged stupidity. Even in advanced countries, aggregate supply has been found inelastic in depressions and this is explained by economists like D. Gale Johnson without abandoning the assumption of economic rationality on the part of the farmer. The

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1. Sethi points out that this is the mistake done by many empirical studies. Cf. J. B. Sethi, "Some Analytical and Quantitative Aspects of Agricultural Supply and Substitution Functions: India", IJAE April-June 1966, pp.18-19.
explanation rests mainly on flexible factor prices (so that factor-product price ratio does not move as much product prices), dominance of fixed costs and the nature of production function involving irreversibility of the supply function. In fact, the latter two factors are relevant only for a period of falling prices; it is easier to shift the supply function forward to the right and once it is done, there is no going back (except on the short run function at a level of output higher than that indicated by the former supply function) even if prices fall later. Thus except the first, these factors cannot explain inelasticity when prices are rising.

In advanced countries, we can expect greater elasticity of aggregate output with rising prices, not only because inputs are more elastic in supply, but also because they are operated with a higher level of technology than in underdeveloped countries, so that there would be greater output for any given level of inputs. There is also greater

3. This irreversibility is associated both with advancing technology (see W.W. Cochran, "Conceptualising the Supply Relation in Agriculture," JFS Dec. 1955) and with fixed capital on farm within a known technology (See Clark Edwards, "Resource Fixity and Farm Organisation," JFS Nov.1959); see also M. Branflembrunner, "An Elementary Agriculture Policy Model," I.M.R., Feb. 1959, p.18.
certainty of attaining a level of output with a given level of inputs, as there is less dependence on nature. Farmers in underdeveloped countries have to take note of this risk, so that higher levels of inputs are not wasted by hostile nature, or even pests. In a region where proper irrigation facilities are not developed or plant protection measures are not available, it would be only natural to expect a low elasticity of output with respect to rising prices.

Yet, these are not the factors that are emphasized while explaining inelasticity. The perversity hypothesis has seemed intellectually fascinating and is employed towards this end. The perversity hypothesis rests mainly on the assumption that farmers have a targeted income level. The argument can be valid only on the assumption that income needs of farmers are fixed and once the targeted income is

obtained they will prefer leisure to income. Bharm Narain has rightly questioned their hypothesis. He points out:

"The large volume of rural indebtedness known to have existed and grown throughout the period of this study is symptomatic of the fact that the needs of a large section of agricultural population have exceeded their incomes, a fact which does not reconcile with the possibility that they could have been content with their extant incomes." The needs of farmers exceed their incomes both in respect of their consumption levels and means of production. Sometimes the argument that higher prices reduce marketable surplus is used as a premise to conclude that production also must be reduced, which is quite different.

Dandekar asks, "...how does one improve knowledge among farmers and organise an aggressive extension system without offering higher standard of living to them? And how does one establish an effective and efficient credit system without improving the repaying capacity of farmers?"

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6. For example, Cf. Dr.R.Khatkhate op.cit. He clubs both production and marketed surplus together.

He asserts, "It is a sheer myth that farmers or small farmers in Underdeveloped countries respond very differently to normal economic stimuli." Whatever little increase in output that may be gained through working harder, may be more than offset by the falling prices, because they will certainly reduce farmers' capacity to save, to replenish capital in land, implements, or livestock. And it is exactly this which he is enabled to do by an increase in incomes whether it is brought about by an increase in output or an increase in prices.

We should also guard against erring on the opposite side. That is, we cannot conclude that a mere rise in the prices of agricultural commodities is sufficient to increase agricultural production. If such a rise induces, through a cost-push, a rise in the prices of agricultural inputs, much of the gain to the farmers would be nullified. What is most important is that farmers should be able to realise a reasonable margin of profits to enjoy a good standard of living over and above what they invest. It is worthwhile to remember that farmers can improve their incomes both through an increase in productivity and through better prices for their products. What they need is an assurance that their effort at improving productivity is not frustrated.

8. Ibid., p.192.
through a fall in product prices. This would mean stabilisation of agricultural prices while at the same time input costs are held down.

We may ask two questions now: were the conditions facing Indian farmers such as to provide incentives for higher rate of capital formation and input application in agriculture? Secondly, how actually have the farmers responded?

We have already noted in Chapter IV that though agricultural prices as such have increased significantly over the 15 years, commodity terms of trade did not significantly move in favour of agriculture. However, these observations cannot be considered automatically applicable to farmers' terms of trade. Whereas farmers' terms of trade may be defined as the ratio of prices received and prices paid by them, involving only the commodities dealt with by farmers, commodity terms of trade between agriculture and the rest of the economy do not have this implication. Though we do not have farmers' terms of trade on all-India basis, five States are compiling them for their respective States. They are Assam, Kerala, Orissa, Punjab and West Bengal. Punjab started the compilation since 1938-39, whereas the data for other States is available since 1950's. Due to differences in coverage and techniques, the state series are not comparable. In a study of these terms of trade, Thingalaya
converts the base periods of all the series to one base period \((1952-53 = 100)\), and shows that their movement has not been similar for all the states. In Orissa, the indexes stood above 100 for all the 7 years (except 1955-56) for which data was available (1952-53 to 1958-59); the index stood at 110.7 in 1958-59. The indexes were above 100 in 5 years out of 11 (1952-53 to 1959-60) in Punjab, and in 7 years out of 11 in Assam. In Kerala, however, the indexes were below 100 for 10 years out of 11, the eleventh being the base period \((= 100)\). Thingalaya, however, points out that "the differences are partly due to the price differences and partly due to the differences in the statistical representation of the terms of trade ratios" and that farmers' terms of trade "appear to be inversely related to the importance of share of the nonagricultural commodities in the domestic consumption or in farm-cultivation. The Orissa farmer, whose purchase of the nonagricultural commodities is the lowest, has favourable terms of trade. Since the nonagricultural prices have experienced considerable rise (as the sectoral prices indicate) during the recent years, the farmer who purchases some of these commodities has to pay a higher price. Greater reliance on the market then means a disadvantage in the farmers' relative price pattern."

This means that there has been little incentive for the farmer to improve his inputs by purchasing them from the market.

In chapter IV, we had also considered distribution of national income between agricultural and non-agricultural sectors, and found that in the period considered it did not go in favour of agriculture. A study by Shah and Rajagopal is available to show that even within agriculture, the relative position of cultivators and agricultural labourers vis-a-vis rent and interest-receivers has deteriorated, affecting both equity and incentives adversely.

Though these facts would go to show that farmers had limited capacity to purchase inputs, the situation has been improving lately. Both commodity terms of trade and distribution of national income at current prices, have gone in favour of agriculture. Another relieving factor is the long-term trend in the improvement of producer's share in the market prices, as seen in the last chapter. However, there would be no improvement in farmer's capacity to purchase inputs, unless input prices are kept down.

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Coming now to the second question raised above, it is difficult, unfortunately, to present much evidence in India regarding aggregate supply function so as to come to sound conclusions. The main hurdle is that no series of prices paid by farmers are available. Moreover, input data are scanty, especially if we try to construct series comparable between years. Actual production itself cannot be used as a dependent variable, unless the impact of weather can be isolated. However, indirect evidence is available to show, that the Indian farmers have been trying to raise productivity and capital formation, though such increase itself may not be adequate enough. What is notable is that they have tried to do this despite the lack of adequate incentives.

First we may note how far increased production has been due to increased productivity. If greater part of the increased production has been due to increased productivity rather than due to extension of area, farmers deserve credit for increased application of inputs. By fitting exponential trend we can calculate per annum per cent growth of agricultural production from the Index Numbers of Agricultural Production, and also per annum per cent increase in area under crops from the Index Numbers of Area under Agricultural Crops. If the per cent increase in area is deducted from the per cent growth in production, we get per
percent growth in production which is due to increased productivity. If productivity were constant, production would increase at the same rate as area. We may take (1) All Agricultural Commodities, (2) Foodgrains and (3) Nonfood-grain Agricultural Commodities. Since the year 1965-66 was very abnormal due to widespread droughts, we may take 15 years from 1950-51 (the year immediately preceding the First Plan period) to 1964-65.

Table 17: Annual Rate of Increase in Agricultural Production and Area Cultivated (Per cent) Period: 1950-51 to 1964-65.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Production</th>
<th>Area</th>
<th>[(2) - (3)]</th>
<th>[(4) + (2)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Agricultural commodities</td>
<td>3.302</td>
<td>1.516</td>
<td>1.786</td>
<td>.5409</td>
</tr>
<tr>
<td>Foodgrains</td>
<td>3.151</td>
<td>1.340</td>
<td>1.811</td>
<td>.5747</td>
</tr>
<tr>
<td>Nonfoodgrain</td>
<td>3.633</td>
<td>2.303</td>
<td>1.330</td>
<td>.3661</td>
</tr>
</tbody>
</table>

NOTE: The data from which these figures derived, are presented in Appendix Tables IV and X.

Table 17 here presents these calculations. Taking all agricultural commodities as a whole, we find that their

production increased by 3.302 per cent per annum and the area under them by 1.516 per cent per annum. From column (4), we can see that 1.786 per cent increase in agricultural production has been due to increase in productivity. Contribution of increase in productivity to the rate of increase in output is more than half, viz., 54.09 per cent (see column 5).

We find that contribution of productivity is even more in the case of foodgrains. Their production increased by 3.151 per cent per annum, and the area under them by 1.340 per cent. Thus, 1.811 per cent per annum increase in production has been due to increase in productivity. Contribution is 57.47 per cent in the case of foodgrains. In the case of nonfoodgrain agricultural commodities, increase in production was 3.633 per cent and increase in area 2.303 per cent per annum. Only 1.330 per cent increase in production has been due to increase in productivity. The contribution of this factor has been only 36.81 per cent towards the rate of increase in output. Whereas increase in area played a great role in the case of increase in the production of nonfoodgrain commodities, increase in productivity played a greater role in the case of increase in foodgrains' production.

Two limitations of our method above may be noted. As observed by Mallor and Lele, "Computation of the trend in
production may be biased by occurrence of a disproportionate number of good or bad years at one end of a series. We have assumed that occurrence of good and bad years is not disproportionate as between the first half and the second half of the period. But if there is a trend towards bad years (as is generally said that the First Plan had good monsoons and the Third Plan did not have this luck except for one year), inputs used must have been even more than what is indicated by Table 17, though their effect is dampened by bad weather.

Secondly, we have also assumed that on an average, the fertility of the new lands brought under cultivation is fairly the same as that of lands already under cultivation. To the extent that new lands are less fertile, the role of increase in productivity following increase in inputs must be more than is indicated by Table 17.

With these limitations in mind, and assuming that increase in area under all agricultural crops has been largely due to government efforts at land reclamation and irrigation, Indian farmers can be said to have increased

their input application. Probably he would have responded with even greater increase in productivity to increasing agricultural prices, if only the prices of agricultural inputs were stabilised and no shortages were felt in their supply. Though provision of inputs increased in India, it fell short of the targets by a wide margin.

It will also be interesting to note the share of private sector in the capital formation in Indian agriculture. Tara Shukla's study is very helpful here. Adopting the inventory approach, she has calculated both Gross capital Formation (GCF) and Net Capital Formation (NCF) in agriculture, and also the share of public sector investment in both. This share of both kinds - direct, in the form of investment in irrigation, land reclamation and tractors; and indirect, in the form of loans and subsidies made available. Table 18 below presents her estimates, which include implements, bullocks, irrigation and land but exclude investment in housing.

### Table 18: Capital Formation in Indian Agriculture - Gross and Net

(Rs. in crores at 1950-51 prices)

<table>
<thead>
<tr>
<th>Period</th>
<th>Total GCF (Rs.)</th>
<th>Share of Public Sector's Direct Investment (per cent)</th>
<th>GCF Minas</th>
<th>Total NCF (Rs.)</th>
<th>Share of Public Sector's Direct Investment (per cent)</th>
<th>NCF Minas</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td>1939-46</td>
<td>2,324</td>
<td>2.66</td>
<td>2,262</td>
<td>571</td>
<td>10.25</td>
<td>512</td>
</tr>
<tr>
<td>to 1944-45</td>
<td>1,944</td>
<td>0.82</td>
<td>1,928</td>
<td>181</td>
<td>3.15</td>
<td>175</td>
</tr>
<tr>
<td>1945-46</td>
<td>2,127</td>
<td>1.78</td>
<td>2,089</td>
<td>176</td>
<td>2.06</td>
<td>157</td>
</tr>
<tr>
<td>to 1949-50</td>
<td>3,087</td>
<td>8.28</td>
<td>2,931</td>
<td>926</td>
<td>24.06</td>
<td>726</td>
</tr>
<tr>
<td>1950-51</td>
<td>3,704</td>
<td>9.68</td>
<td>3,345</td>
<td>1,169</td>
<td>28.07</td>
<td>841</td>
</tr>
<tr>
<td>to 1960-61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Implements, Bullocks, irrigation and land.

Source: Tara S. Shackle, "Rates of Gross and Net Capital Formation in Indian Agriculture, and Factors Influencing Them," I.J.A.E., January-March 1965. Column (2) - Table 1, p.143; Column (5) - Table 2, p.149; Columns (3) and (6) - Table 3, p.151; Columns (4) and (7) Derived.
It is seen from the table that for the earlier three quinquennia, the total GOP and also the GOP with direct public sector share deducted therefrom were stagnant. In fact, they show a small decline on the whole. During the same period, total NUF and also NUF with direct public sector share deducted therefrom, have both shown a sharp decline. The period from 1950-51 onwards, however, forms an important break with the past. Both GOP and NUF show a major upward spurt as compared to the period, 1945-46 to 1950-51. This is especially so with respect to NUF. As a result, the ratio of NUF to GOP is seen to have improved. As can be seen, this spurt is not entirely due to the direct public sector investment. Capital formation done by private sector, including that resulting from loans and subsidies given by the public sector, has also shown a considerable rise, as compared with the past. Direct public sector investment accounted for only 22.7 per cent of the increase in GOP and 24.5 per cent of the increase in NUF, that took place between the 3rd and 4th quinquennium in the Table. It accounted for 16.7 per cent of the increase in GOP and 46 per cent of the increase in NUF, that took place between the 4th and the 5th quinquennium in the Table. This means that larger part of increase in GOP as well as NUF has been due to private sector investment (including loans and
It need not be thought that indirect public sector investment has been great. For both the 4th and 5th quinquennia together, the share of indirect public sector investment in the total investment has been a mere 2.35 per cent in the case of GCF and 0.77 per cent in the case NCF, according to Tara Shukla.

Tara Shukla has also shown that NCF as per cent of net agricultural income has shown a marked rise. NCF, excluding both direct and indirect contribution of government and also investment in housing, as per cent of net agricultural income was 4.23 and 4.03 during 1950/51-1955/56 and 1955/56-1960/61 respectively, as against 2.54 during 1935/36-1940/41, 0.84 during 1940/41-1945/46 and 0.70 during 1945/46-1950/51.

Though the rate of HOF is impressive as compared to the past, it is very inadequate as compared to what is required. For a sustained growth of per capita production in agriculture, Tara Shukla estimates that net investment should at least be 16 per cent of net income.

Evidence is increasingly available to show that Indian farmers are, on an average, becoming enthusiastic about innovations. Illiteracy, by itself, has not been a hindrance.

When the farmers are convinced about the profitability of a new agricultural practice, they are quite eager to adopt it.

B. Substitution Function

Unlike the case with aggregate production function, several empirical studies are available both in India and abroad on substitution function. They entirely deal with the allocation of acreage among competing crops and find that farmers take good advantage of profitabilities of different crops. The studies do not include any consideration of input changes, productivity and technology. But even within this

17. See, for example, the results of a case study of improved seeds in a South Kanara Village; 'Acceptability of Farm Innovations', in P.E.R., Nov. 1967, Vol.12, No.4. For factors governing adoption of technological change see D.K. Desai, "Technological Change and its Diffusion in Agriculture," Rapporteur's Report, IJAE, Jan-Mar. 1966, pp.221-22.

limited field, some of their findings are interesting, the
most important of which is the asymmetry in the behaviour
of cash crops and food crops in their response to relative
prices. In the words of Dharm Narain, "Similarity between
the behaviour of areas under cash crops and the prices of
these crops, corrected with reference to changes either in
an index of agricultural prices or in the prices of specific
competing crops, is in most cases so striking that price
emerges as a decisive consideration with the farmer in the
areas he sows to these crops... In the case of food crops,
however, rainfall assumes that status which price does in
the case of cash crops." Of course, even in the case of
food crops, the influence of price is not absent, but it is
less significant than rainfall. Raj Krishna's study derives
elasticities for different crops (in terms of areas sown)
not only with respect to relative price, but also rainfall
relative yield and irrigation. Two cash crops enter his
analysis - cotton (American and domestic) and sugarcane.
With sugarcane, price is the only identified variable affecting
acreage. With American cotton, elasticity with respect to
irrigation (1.28 in the short run and 2.87 in the long run)
is significantly greater than that with respect to price (0.72
in the short run and 1.62 in the long run); but with domestic

cotton, the variable identified apart from price is relative yield and is less significant than price. Among food crops, maize acreage is affected only by price and no other variable. With regard to other food crops, price is outweighed in importance by other variables. However, except jowar and gram, all other food crops show positive price elasticities.

The explanation for asymmetry in the behaviour of food and cash crops has been given in terms of subsistence requirements of farmers and uncertainty. The primary concern of farmers will be to ensure adequate foodgrains for consumption by his family, and in this he is guided by the relative yield of different food crops and rainfall. There is little scope at the production level for substitution among food crops in response to relative prices, both for this reason and also because, the different food crops being substitutes at the consumption level, their prices fairly move together. Even vis-a-vis cash crops, substitution is affected by subsistence requirements. It may be asked why they do not produce more profitable cash crops and purchase foodgrains. They may not prefer to do this mainly because of uncertainty of securing adequate foodgrains at reasonable prices during off-season periods. Sethi observes, "...Subsistence and un-

21. See Dharm Narain op.cit. and J.D.Sethi, op. cit.
certainty set a floor below which acreage of a given crop will not go and a ceiling for the corresponding subsistence crop above which the latter cannot rise. Ceiling and floor to acreage introduce non-linearities in the function." Severe fluctuations in relative prices also would induce the farmers to diversify production because past year's prices may not serve as adequate guide to the coming year. This factor militates against elastic response, even if we forget about subsistence requirements. There is one more uncertainty - that of production. If weather is uncertain and drought is feared, farmers would choose survival as their goal and grow drought-resistant millets.

We feel that even in the absence of subsistence requirements and uncertainty, the response of production to relative prices could be quite limited in the case of a few crops and significant in other crops. And the explanation lies in the different technological conditions surrounding expansion of production of different crops. The subsistence explanation is inadequate in two respects. While it can explain

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22. J.D.Sethi, op. cit., pp.21-22.
why production of foodgrains cannot fall below a point, even when relative prices are moving unfavourably to them, it is not a sufficient explanation for inelasticity when prices are moving in favour of food crops. Secondly, the explanation is inadequate also in respect of large farmers who control a greater part of our agricultural land than the small farmers. The explanation we offer below in terms of differences in technological conditions surrounding expansion, is not a rival to the explanations cited above, but is a supplement.

The situation under review is that of a change in relative prices of any two crops, coupled with a change in the absolute level of prices of both crops taken together. This can happen, for example, when the price of a crop X increases while that of Y is unchanged, or increases less than that of X. A change in relative prices here may induce a change both in the relative quantities of crops produced and total inputs employed. Here, both the substitution and

24. Thus, farmers with holdings of less than 5 acres command 16 per cent, and those with holdings of less than 15 acres command a little less than 49 per cent of the area. Vide P.S. Sharma, "A Study of the Structural and Technical Aspects of Rural Economy in the Light of the 1961 Census," Journal of the Indian Economic Association, Vol. 66, Dec. 1966, Table 1, pp. 59-60.

25. In the analysis below, factor prices are assumed constant. The aggregate supply question is assumed to arise only through a change in product prices.
aggregate supply functions may be involved. The well-known condition for producers' equilibrium as between two products \( X \) and \( Y \) is

\[
\frac{\Delta Y}{\Delta X} = \frac{P_X}{P_Y}
\]

Equation (1)

where \( P \) is price. When the producer attains this equilibrium, he must also attain equilibrium with regard to factor-product relationship. With two products, this equilibrium can be stated in terms of either of the two following equations.

\[
\frac{\rho A \Delta A}{\Delta x + \Delta y} = \frac{P_X \Delta X}{\Delta Y} + \frac{P_Y \Delta Y}{\Delta X + \Delta Y}
\]

Equation (2)

Equation (2a)

where \( A \) refers to inputs used. Equation (2) states that marginal cost must equal to revenue obtained from the marginal packet of products. Equation (2a) which is convenient to us, states the same condition in terms of factor-product price ratios being equal to the marginal rate of transformation of factors into a packet of products \( X \) and \( Y \). Of course, the packet itself has several production possibilities of combinations of the two products. In equilibrium, only one such possibility is chosen. While considering the product prices also, it is the weighted
product price at the margin which is relevant here and this is what is shown in the denominator of the left side of the Equation (2a). But it is the weighted product price when adjustment is already made along the initial production frontier which determines whether there is to be a change in inputs. If at this level there is a change in weighted product price, inputs will change. But with every addition to inputs, the former needs to satisfy simultaneously Equation (1) again and this raises the problem of the nature of successive production frontiers.

The problem may be presented diagrammatically. In a diagram with two products on two dimensions, we cannot show how inputs will be varied following changes in factor-product price ratio. We can, however, show production frontiers one above the other, indicating production possibilities at different levels of inputs. Of course, an increase in inputs may also be accompanied by a technological change so that the resultant production frontier would be higher than the one in the absence of technological change. But this will not complicate our analysis. What is relevant to us is the nature of the new production frontier given the technological conditions prevailing, for any particular dose

26. This is because adjustment along a given production frontier itself involves a change in weighted marginal product.
of inputs. That is, production possibilities for any given level of inputs are given.

At the new or higher production frontiers, it is not at all necessary that marginal rate of substitution between two crops should be the same for the given ratio of crops at the lower production frontiers. To make the problem clear, we visualise two sets of production frontiers in the Diagrams 2 and 3 below, one with constant marginal technical substitution over the given ratio of crops and the other with changing substitution. In Diagram 2 we have the former set. Taking any line from the origin such that it cuts different production frontiers, their slopes at the points of intersection are the same. Thus lines cd, c'd' and c''d'' which indicate such slopes at the same ratios of X and Y, are all parallel to each other. In this situation, suppose ab indicates the initial price ratio; consequent upon an increase in the price of X, the new ratio of the two crops produced (indicated by the slope of ON) will be the same here irrespective of whether the new equilibrium occurs on the same production frontier or at a higher one.

But in Diagram 3, the rate at which X can be technically substituted for Y (i.e. ΔY/ΔX) increases or the rate at which Y can be substituted for X (i.e. ΔX/ΔY) decreases, as more inputs are used while maintaining the proportion in
In all the diagrams, the initial price ratio is denoted by a given ratio of crops.
Production of X with increased relative price of X.
Production of Y with increased relative price of Y.
Note: In all the diagrams, the initial price ratio is denoted by the line o d, which is parallel to o'd. The initial equilibrium is denoted by point U, and the production of X with increased relative price of X is denoted by the line o d, which is parallel to o'd. The line o d represents the initial price ratio.
which crops are produced. Technical conditions are more favourable for the production of Y, as inputs increase. As such, the equilibrium does not occur at the ratio of crops which would obtain in the absence of expansion. The equilibrium path with unchanged price ratio between products is traced by the line $NN''$ in both the diagrams, but in Diagram 3 the path is to the left of the line $ON$ and equilibrium occurs at different ratios of crops. If, however, technical conditions surrounding expansion were favourable for $X$ and not $Y$, the equilibrium path would lie to the right of the line $ON.$

Thus, with a change in the relative prices of products, the change in the production of any product can be said to be compounded of two parts: the substitution effect and the expansion effect. The substitution effect can be said to refer to the adjustment along the initial production frontier, i.e. before the inputs are decided to be changed. The expansion effect is the remaining part. Thus, the increase in $X$ from $OL$ to $OL''$ in both the diagrams is composed of $LL'$ which is substitution effect, and $L'L''$ which is the expansion effect. But in Diagram 3, the expansion effect can be said to consist of two elements: increase by $L'L''$ which would have taken place if the ratio of crops at $N$ were maintained - the pure expansion effect, and the movement for $L''$ to $L''.$
due to changed $\Delta Y / \Delta X$ — the repeated substitution effect. In this instance, the latter effect is negative and reduces the increase in $X$ that would have taken place. The expansion effect as a whole is very unlikely to be negative, and it is even more unlikely to be so strongly negative as to actually reduce the production of $X$ as a result of rise in the price of $X$, by outweighing the initial substitution effect.

Though absolute production of $X$ will not fall as a result of a rise in the price of $X$, its relative production may. And this can be explained only when we allow for expansion. This situation is depicted in Diagram 4. The initial equilibrium position is on the Production Frontier 1 at the point $M$, with the price ratio indicated by $ab$. Suppose, the price of $X$ increases so that the new price ratio is represented by line $cd$. The farmer decides to expand and is in equilibrium on the Production Frontier 2 at the point $M''$, with $c'd'$ being parallel to $cd$. Even though there is increased production of $X$, its relative production has been reduced from the position indicated by the slope of $ON$ to the position indicated by the slope of $ON'$. If there had been no expansion, the equilibrium would have been at the point $M'$ on the initial production frontier, and the relative production of $X$ would have increased. The fact of expansion and the changed technical conditions associated with expansion can thus rationally explain the "negative" response of
farmers. The crucial factor is the repeated substitution effect. If it is positive, the elasticity of substitution would be positive and more than the elasticity which would obtain in the absence of expansion. If the repeated substitution effect is negative, it would reduce the elasticity of substitution obtaining in the absence of expansion.

The concept of elasticity of substitution has normally been associated with the assumption of fixed inputs, which need not be the case if the change in relative price of any two crops is coupled with a rise in the price level of the two crops considered together. Empirical studies of elasticity of substitution often ignore this fact, and authors are not quite clear if they assume inputs as fixed or variable. Thus, Sethi defines it as "a farmer's response to price changes for substituting acreage between crops with all other resource inputs being fixed or small." But later he also speaks of a crop substitution function with inputs held elastic and says that substitution elasticity with fixed inputs would be higher than the one with variable inputs. This can be true only if we are considering acreage response (and that too, with total acreage fixed) and not

27. Defined as proportionate change in the ratio of two crops produced divided by proportionate change in the ratio of prices of two crops.

28. J.D. Sethi, op.cit., p.18.

29. Ibid. p.28.
production response, and when the farmer instead of shifting acreages or shifting them only a little, relies mainly on other inputs for increasing the production of the crop whose price has risen. But if we are considering production response or, even acreage response with total acreage increasing, Sethi's statement need not necessarily be true, as it will depend mainly on the repeated substitution effect.

The possibility of changing technical substitution with expansion is a very real one. It arises, when one crop is subject to increasing costs sooner than the other crops (for any proportionate increase in production); or there may even be decreasing costs for the other crops. Or, if all inputs including land are varied, the economies or diseconomies of scale may emerge, which affect some particular crops more than the other crop. It may also well be that improved techniques are known and available for one crop and not for the other.

Some evidence is available to know that food crops are inferior to cash crops in this respect. In the 'Studies in Economics of Farm Management', production functions of Cobb-Douglas type have been derived for some crops and we have presented below in Table 19 the sum of production elasticities of inputs. We can see that in each state the sum of
Table 19: Sum of Elasticities of Production with respect to different inputs obtained from Cobb-Douglas Production Functions fitted to various crops.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Sum of elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madras, 1954-55 Cotton, Irrigated</td>
<td>1.9987</td>
</tr>
<tr>
<td>-do- Paddy, &quot;</td>
<td>0.4610</td>
</tr>
<tr>
<td>-do- Jowar, &quot;</td>
<td>1.0767</td>
</tr>
<tr>
<td>Madras, 1955-56 Cotton, &quot;</td>
<td>0.9259</td>
</tr>
<tr>
<td>-do- Paddy, &quot;</td>
<td>0.4255</td>
</tr>
<tr>
<td>-do- Jowar, &quot;</td>
<td>0.6966</td>
</tr>
<tr>
<td>Madhya Pradesh, 1955-56 Jowar, Usid-Moong combination</td>
<td>0.7000</td>
</tr>
<tr>
<td>-do- Cotton-Tur Combination</td>
<td>1.0001</td>
</tr>
<tr>
<td>Uttar Pradesh, 1954-55 Wheat, Irrigated</td>
<td>0.9292</td>
</tr>
<tr>
<td>-do-</td>
<td>0.9448</td>
</tr>
<tr>
<td>Uttar Pradesh, 1955-56 Sugar cane(planted)</td>
<td>1.0796</td>
</tr>
</tbody>
</table>

Source: 'Studies in the Economics of Farm Management', Reports for different States as mentioned in the first column above, published by Ministry of Food and Agriculture, Government of India.
elasticities in respect of cash crops is higher than that for the food crops. The productivity of food crops, however, has been increasing in recent years, as a result of which, the relative technical advantage of cash crops might have been declining.

30. See Appendix Table X.