

**Summary:** The results of a simple fertilizer trial with N, P and K in coconut cultivators' holdings in the sandy loam soils of Thanjavur district are presented. The maximum positive response to the application of N at 0.680 kg, phosphorous at 0.227 kg and potash at 0.454 kg per palm per year with a net gain of Rs. 10.53 per palm per year has been recorded.

**Acknowledgement:** The authors thank the Indian Council of Agricultural Research for their financial assistance and Thiru K. A. Seshu, Lecturer in Statistics, Agricultural College, Coimbatore for the statistical interpretation of the data.

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<https://doi.org/10.29321/MAJ.10.A03575>

## An Assessment of Impact of Cropping Pattern on Agricultural Output in Tamil Nadu

by

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For purposes of national policy programming agricultural development, it would perhaps be useful to understand the dynamic changes that are taking place in the cropping pattern of the country, thereby assessing the trends in production of different agricultural commodities. The problem of studying the dynamic behaviour of crop mix and therefore output mix for one country with its varying agro-climatic regions and a variety of crops being raised in different regions is complex and bristled with many difficulties such as lack of relevant region-wise data. The present study was therefore, confined to Tamil Nadu.

A study of the changes in the distribution of cropped area under different crops and land utilisation in Tamil Nadu for the period from 1956-57 to 1963-64 revealed that the net area sown had increased from 14,419,692 acres to 14,962,650 acres. This increase represented 3.7 % of the net area sown in 1956-57. Correspondingly, the gross area sown had also increased by 6,26,040 acres or by 3.6 % over 1956-57. The proportion of food crops have declined from 76.9 % to 75.8% and that of non-food crops increased from 23.1 % to

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24.2% in 1963-64. Among the food crops the area under paddy had shown a rise of 3%, while the area under millets declined sharply. The proportion of area under pulses remained constant. Among non-food crops groundnut registered sharp increase of 2.1% from 10.6% in 1956-57 while for cotton there was a fall of 0.6% from 6.2%. This was perhaps due to shift in acreage from dry cotton to dry groundnut, as the proportion of area under irrigated cotton had remained unaltered during this period.

In this context, a study of over all impact of change in cropping pattern and its effect on agricultural output would be very useful to assess the pattern of changes which would provide for a view of the future in perspective of the past. The main objectives of the present study were to assess the impact of cropping pattern on the total value of the agricultural output and to isolate the components responsible for bringing the change in the value of output between 1956-57 and 1963-64, and also to estimate the changes in output due to changes in cropping pattern.

**Materials and Methods:** At present no exact measures are available to gauge the effect of change in cropping pattern on the value of agricultural output. Different methods have been attempted to arrive at the total change in agricultural output due to cropping pattern [1, 5, 6, 7, 8]. In the present study the change in output is assumed to be the net result of changes in area, yield per unit area and price per unit of individual crops. The changes in areas of individual crops are brought by (i) changes in area due to change in total area sown and (ii) changes due to shift in cropping pattern. Under these assumptions, following John (1965), change in total output is given by the following equation.

$$Y_v = \sum_j (a_{ij} b_{ij} c_{ij}) - \sum_j (a_{oj} b_{oj} c_{oj})$$

where,  $Y_v$  is the value of change in output,  $a_{oj}$ ,  $b_{oj}$  and  $c_{oj}$  are the area, yield per acre and price per unit of  $j$ th crop in 1956-57 and  $a_{ij}$ ,  $b_{ij}$  and  $c_{ij}$  are the area, yield per acre and price per unit of  $j$ th crop in 1963-64. The summation is over all the crops selected for the study.

Twenty-one crops, *viz.*, paddy, *cholam*, *cumbu*, *ragi*, *korra*, *varagu*, *samai*, bengalgram, greengram, redgram, blackgram, horsegram, chillies, sugarcane, potatoes, onion, cotton, groundnut, gingelly, betelvines and tobacco, which account for more than 9% of the total area sown in the state were taken up for the study. The actual area sown, yield per acre, and price per unit of these crops were collected for two years 1956-57 and 1963-64 from the Season and Crop Report of Madras State. The period of 1956-57 to 1963-64 was so chosen as to get comparable figures for present boundary of Tamil Nadu.

The difference in value of output  $Y_V$  was due to changes in area, yield per acre and prices of individual crops considered. This consisted of the effect of each one of these factors individually, denoted by  $Y_A$ ,  $Y_B$  and  $Y_C$ , termed as main effects, and the simultaneous variation of these factors *viz.*, area and yield per acre, area and price, yield per acre and price, and area, yield per acre and price. They are, respectively with relevant subscripts,  $Y_{AB}$ ,  $Y_{AC}$ ,  $Y_{BC}$  and  $Y_{ABC}$  and are termed as interaction effects. These main effects and interaction effects are mutually exclusive.

The effects of individual factors were estimated by partial analysis, namely, holding the other two factors constant over time. The main effects were obtained as follows:

$$Y_A = \sum_j (a_{ij} - a_{oj}) \frac{b_{oj} c_{oj}}{c_{oj}}$$

$$Y_B = \sum_j (b_{ij} - b_{oj}) \frac{c_{oj} a_{oj}}{a_{oj}}$$

$$Y_C = \sum_j (c_{ij} - c_{oj}) \frac{a_{oj} b_{oj}}{b_{oj}}$$

The interaction effects were estimated by using the following formulae:

$$Y_{AB} = \sum_j (a_{ij} - a_{oj}) (b_{ij} - b_{oj}) \frac{c_{oj}}{c_{oj}}$$

$$Y_{AC} = \sum_j (a_{ij} - a_{oj}) (c_{ij} - c_{oj}) \frac{b_{oj}}{b_{oj}}$$

$$Y_{BC} = \sum_j (b_{ij} - b_{oj}) (c_{ij} - c_{oj}) \frac{a_{oj}}{a_{oj}}$$

$$Y_{ABC} = \sum_j (a_{ij} - a_{oj}) (b_{ij} - b_{oj}) (c_{ij} - c_{oj})$$

To arrive at the total contribution of each of the factors considered for the change in agricultural output, it is necessary to assess the interaction effect ascribable to each of these factors for their simultaneous variation, in addition to their main effects. This was done by weighting the interaction effect by the main effects of the relevant factors.

In the case of interaction effects  $Y_{BC}$ ,  $Y_{BA}$  and  $Y_{BCA}$ , the change ascribable to yield per acre were derived by the following formulae.

$$Y_{B.C} = Y_{BC} \left[ \frac{Y_B}{Y_B + Y_C} \right]$$

$$Y_{B.A} = Y_{BA} \left[ \frac{Y_B}{Y_B + Y_A} \right]$$

$$Y_{B.C.A} = Y_{BCA} \left[ \frac{Y_B}{Y_B + Y_C + Y_A} \right]$$

These effects along with the main effect of yield per acre,  $Y_B$ , constitute the effect of changes in yield per acre on the value of the change in agricultural output obtained.

Similarly the changes ascribable to area and prices were estimated and the total effect of changes in area,  $Y_A + Y_{A.B} + Y_{A.C} + Y_{A.BC}$  and the total effect of changes in prices  $Y_C + Y_{C.A} + Y_{C.B} + Y_{C.AB}$  were arrived at.

The total effect of change in cropping pattern was estimated by using the formula

$$Y_P + \frac{(Y_{A.B} + Y_{A.C} + Y_{A.BC}) Y}{Y_A}$$

where  $Y_P$  = change in output due to change in cropping pattern.

$Y_P = Y_A - Y_D$  where

$Y_D$  = change in output that would have taken place if there was a mere change in area and no change in cropping pattern.

$$Y_P = \sum_j \left( \bar{a}_{ij} - a_{oj} \frac{A_1}{A_0} \right) b_{oj} c_{oj}$$

where  $A_1$  = gross sown area in 1963-64 and  $A_0$  = gross sown area in 1956-57.

This estimate using the above formula takes into account the change in output of crops due to change in cropping pattern, as well as the cropping pattern changes associated with the interaction effect of changes in area.

**Results and Discussion:** There had been an appreciable increase in agricultural output in Tamil Nadu from 1956-57 to 1963-64. The index numbers of agricultural production for the State with 1956-57 as base had risen to 121.5 in 1963-64, showing an average increase of 3.1 % per annum. The total change in the value of output of crops amounted to an increase of Rs. 184.432 crores. This change was a result of individual changes in the areas, yield per acre and price per unit (main effects) of the individual crops and simultaneous variation of these factors.

To make an assessment of the major contributing factor, for the increase in value of the output, the difference in area, yield per acre and price per unit of the different crops were tested by 't' tests. Only the difference in price per unit of the different crops was found to be significant indicating that the price influence might be the major contributing factor for the increase in value of output. The individual main effects of each of the factors was found to be of the following order.

The main effect of change in area,  $Y_A$ , was estimated to be Rs. 37.71 crores. Two-thirds of this amount resulted from the increase in area under paddy and the rest from the increase in area under chillies, sugarcane and groundnut.

The main effect of change in yield rate,  $Y_B$ , was Rs. 19.77 crores, more than half of which was due to increase in yields per acre of paddy and *cholam*.

The main effect of change in price,  $Y_C$ , amounted to Rs. 101.65 crores, which accounted for 55.12 % of the value of total change in output. This was already indicated by the 't' tests reported earlier. Increase in prices of all the commodities considered during the period unlike in the case of area and yield rate which had shown positive and negative fluctuations, accounted for this large change in the value of output.

The interaction effects due to the simultaneous variations of the factors *viz.*, area, yield per acre and price are presented in Table 1 below :

Table 1. *Interaction effects*

Interaction of area $\times$ yield per acre $Y_{AB}$	= Rs. 1.70 crores
Interaction of area $\times$ price per unit $Y_{AC}$	= Rs. 14.05 crores
Interaction of yield per acre $\times$ price per unit $Y_{BC}$	= Rs. 7.37 crores
Interaction of area $\times$ yield per acre $\times$ price per unit $Y_{ABC}$	= Rs. 1.32 crores

Among the four interaction effects feasible, simultaneous variation of area and price per unit of the crops was found to account for 57.5 % of the change in value of the output due to interaction effects.

The interaction effects ascribable to each main effect were obtained by apportioning the effects of simultaneous variations in proportion to the values of the main effects. They are presented in Table 2 along with the total effects of each factor considered.

Table 2. *Interaction effects ascribable to main effects and total effects of the factors.*

(i) *Interaction effects ascribable to change in area*

$Y_{A.B}$	= Rs. 1.112 crores
$Y_{A.C}$	= Rs. 3.802 crores
$Y_{A BC}$	= Rs. 0.313 crores
$Y_A$	= Rs. 37.711 crores ( <i>Main effects of area change</i> )
Total effect of changes in area Rs. 42.938 crores	

## (ii) Interaction effects ascribable to change in yield per acre

	$Y_{B,A}$	= Rs. 0.583 crores
	$Y_{B,C}$	= Rs. 1.200 crores
	$Y_{B,AC}$	= Rs. 0.164 crores
Main effect of change in yield per acre :	}	$Y_B$ = Rs. 19.772 crores
Total effect of change in yield per acre :		= Rs. 21.719 crores

## (iii) Interaction effects ascribable to change in prices

	$Y_{C,A}$	= Rs. 10.248 crores
	$Y_{C,B}$	= Rs. 6.172 crores
	$Y_{C,AB}$	= Rs. 0.845 crores
Main effect of change in price per unit :	}	$Y_C$ = Rs. 101.654 crores
Total effect of change in price per unit :		= Rs. 118.918 crores

Thus when the change in the value of total output between the years 1956-57 and 1963-64 for Tamil Nadu was analysed, it was observed that the price effect formed 64.67%, area change formed 23.29% and the balance of 12.24% was accounted for by the change in yield per acre.

*Changes in output due to changes in cropping pattern:* The total change in output due to changes in cropping pattern ( $Y_p$ ) alone amounted to Rs. 24.595 crores. When the effect of cropping pattern changes associated with the interaction effect of changes in the area was added, the total effect of change in cropping between the two periods amounted to Rs. 52.598 crores which was 28.52% of the total change in output of the crops observed between the two periods.

**Conclusion:** The change in the value of the output of crops due to change in area, prices and yield per acre of different crops for Tamil Nadu during 1956-57 to 1963-64 revealed that there had been an additional return to a tune of Rs. 184.432 crores. The increase in prices was found to be the major contributing factor accounting for 64.47% of the increased return from the crops, followed by changes in area of individual crops which account for 23.29% and changes in yield per acre accounting for 12.24% of the increase in returns. The change in cropping pattern and the interaction effects of yield per acre and prices associated with change in area under different crops accounted for Rs. 52.598 crores, which may be interpreted as due to shift in cropping pattern. The question of deriving optimum crop mix requires detailed information on relative costs of production and structure of real prices of products and factors. This indicates a fruitful line of work for future studies,

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