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REGIONAL SPECIALISATION IN THE CULTIVATION OF COMMERCIAL CROPS VIS-A-VIS REGIONAL SELF-SUFFICIENCY IN FOODGRAIN PRODUCTION —A CASE OF PUNJAB

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INTRODUCTION

During the past decade or so, the Government of India has carried out various exercises in the foodgrain trade with a view to improve the distribution system of foodgrains in the country. Several times food zones were formed and abolished depending upon the exigencies of circumstances but without much economic content in these decisions. During zonal system of foodgrain trade, the zones comprised of a group of adjoining States or even single States were treated as separate zones as is the case at present. If the present policy of treating each State as a separate food zone continues, it would implicitly mean that each State should be self-sufficient in foodgrain production. Such a process of attaining self-sufficiency might affect the existing pattern of commercial crop production in various States of the country.

The present exercise develops an economic model which might help in determining the effect of imposition of constraints of regional self-sufficiency in foodgrains on the pattern of cultivation of commercial crops. The Punjab State has been taken for detailed investigation. At first instance, it might appear that such a study does not have much relevance in the case of a State like Punjab which is surplus in most of the foodgrains. But it would be of interest to know the effects of making the State self-sufficient in all those foodgrains in which it is currently deficit. Besides, no one would dispute the usefulness of the model developed here which may be used more appropriately for States/regions which are deficit in foodgrains.

The specific objectives of the present study were as under :

(*i*) to study the pattern of cultivation of foodgrain and commercial crops in the Punjab when no constraints of self-sufficiency in foodgrain production exist;

(*ii*) to develop a suitable economic model for examining the effect of imposition of State self-sufficiency constraints in foodgrains on the pattern of cultivation of commercial crops, and

(*iii*) to work out the changes in the production of various crops—foodgrain and commercial—and consequently the gain or loss in the

total value product from the crop husbandry for the State as a whole as a result of constraints of self-sufficiency in foodgrains when scarce resources like land and fertilizers were restricted to the levels of their existing use.

METHODOLOGY

The Data

Secondary data were collected from the relevant Statistical Abstracts of Punjab[1] and the Bulletin on Food Statistics.[2] The input-output, resource availability and prices data pertained to the agricultural year 1972-73 and the data on foodgrain requirements related to the year 1970-71.

The Economic Model

The simplex linear programming model was used for achieving the objectives of present study. The model used is outlined below :

$$\text{Max. } Z = C_1X_1 + C_2X_2 + \ldots\ldots\ldots\ldots + C_{19}X_{19}$$

Subject to :

$$a_{i1}X_1 + a_{i2}X_2 + \ldots\ldots\ldots\ldots + a_{i19}X_{19} \ (\leqslant, \geqslant) b_i$$

and

$$X_j \geqslant 0,\ j = 1, 2, \ldots\ldots\ldots\ldots 19 \text{ and } i = 1, 2 \ldots\ldots\ldots, 21$$

where Z = total gross returns (thousand rupees) from cropping plan to the State as a whole,

X_j = hectareages under various crops (defined as crop activities),

C_j = gross returns (in thousand rupees) per hectare from the j th crop activity,

a_{ij} = the technical coefficients indicating the qauntity of ith resource needed for the production of one unit of j th crop activity, and

b_i = resource supplies or amounts of various foodgrains just enough to make the State self-sufficient.

Gross returns per hectare, C_j, of the jth crop needs further explanation it has been estimated by multiplying the yield per hectare of a crop by its corresponding harvest price per unit of the main produce. Net income/returns might have been a better measure as compared to gross returns, but such data were not available. Since fertilizers which constitute the major part of the variable costs were considered as separate constraints in terms of N, P_2O_5 and K_2O nutrients, hence regardless of whether C_j are based on either value of the main produce or on net returns, the resulting programmed cropping plans will be highly similar, if not exactly identical.

1. Issued by the Economic and Statistical Adviser, Government of Punjab.
2. Issued by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

The various constraints used in the model are explained below :

(*i*) *Land Constraints*

Land was divided into two broad categories, *i.e.*, *kharif* and *rabi* lands. The sum total of areas under various crops considered for analysis in this study during each season was taken as constraints. The rest of the cropped area comprising 18.80 per cent of the total cropped area during the whole year, has been left out for the production of vegetables, fruits, fodders, etc., which were considered as fixed activities.

(*ii*) *Maximum Area Constraints*

Certain crops being relatively more remunerative would tend to occupy larger area. Therefore, taking into account the physical, economic and social constraints, the maximum area limits for certain crops, *i.e.*, sugarcane, groundnut, tobacco and potato, were imposed. In order to be realistic the maximum area occupied by any of these crops during the last ten years in the State was considered as the upper limit. This was under the assumption that ten years is a sufficiently long period within which economic, social and physical forces can freely interact to determine the upper limits of area under these crops.

(*iii*) *Minimum Area Constraints*

Groundnut and cotton (American) are grown on special type of lands where other crops of the same season cannot be grown profitably. In view of this, minimum area constraints were fixed considering that the area under these crops would not fall below the minimum experienced during the preceding ten years. Indirectly, this helped representing different categories of land.

(*iv*) *Fertilizer Nutrients Availability Constraints*

Constraints were imposed for the level of availability of N, P_2 O_5 and K_2O nutrients from various chemical fertilizers and farmyard manure during 1972-73 for the State of Punjab.

(*v*) *Constraints of Self-sufficiency in Foodgrains*

Self-sufficiency constraints for the State were imposed in case of ten crops, namely, wheat, barley, gram and *massar*, in the *rabi* season and rice, jowar, bajra, maize, *mash* and *mung* in *kharif* season. Self-sufficiency requirements of the State for these foodgrains were arrived at by subtracting the exports from the State from the respective production figures for the year 1970-71, the latest year for which such data were available at the time of handling the present exercise. It was assumed that by this year the foodgrain needs of the State were fully saturated and that any further increase in the

production would not lead to any increase in the consumption of foodgrains in the State. In other words, the propensity to consume foodgrains was assumed to remain unchanged at the level of 1970-71, which was considered fairly stabilized.

Two more alternative approaches, namely, splitting up of the all-India foodgrain requirement targets according to population, and marketable surplus of various foodgrains as obtained in various studies in the Punjab, were also used to arrive at the minimum requirements of foodgrains. It was found that the quantities so worked out were invariably lower as compared to those obtained through 'production less exports' approach. Hence, we favoured the 'production less exports' approach in order to be on the safe side.

Manual labour, bullock labour and tractor labour, which are the chief sources of power on the farms were not included in the system of constraints because of their large-scale under-employment and unemployment as reported by many researchers.

Activities Used in the Model

Nineteen crops including ten foodgrains (rice, jowar, bajra, maize, wheat, barley, all cereals, and *mung*, *mash*, gram and *massar*, all pulses), sugarcane, cotton (American and *desi* separately), potatoes, tobacco, and four oilseeds (sesamum, groundnut, mustard and linseed) were considered separate activities. These crops covering about 81 per cent of the total cropped area are the major contributors to the income which the State derives from its agriculture.

RESULTS AND DISCUSSION

Pattern of Cultivation of Various Crops

The existing distribution of area among different crops would depict the cropping pattern in the absence of constraints of self-sufficiency in foodgrains for the State. This has been shown in Table I.

In the existing pattern of crop production, the foodgrains accounted for 80.37 per cent of the total cropped area[3] as against 19.63 per cent under commercial crops in the State. Among the commercial crops, oilseeds covered an area of about 7.04 per cent. Groundnut and mustard were the important oilseed crops occupying areas 3.21 and 3.45 per cent respectively. Cotton (American and *desi*) was the most important cash crop covering 10.16 per cent of the total cropped area. Sugarcane, potato and tobacco were grown on 2.05, 0.38 and 0.004 per cent of the total cropped area respectively.

With constraints of self-sufficiency in foodgrains there were substantial changes in the cropping pattern which merged out as a programmed solution

3. It excludes area under vegetables, fruits and fodders.

TABLE I—CROPPING PATTERN IN THE PUNJAB WITHOUT/WITH CONSTRAINTS OF SELF-SUFFICIENCY IN FOODGRAINS : 1972-73

(thousand hectares)

Sr. No.	Crop/commodity group	Without any constraints of self-sufficiency in foodgrains		With constraints of self-sufficiency in foodgrains	
		Area	Per cent of total cropped area	Area	Per cent of total cropped area
1.	Rice	476	9.55	849.950	17.25
2.	Jowar	6.70	0.13	17.930	0.36
3.	Bajra	129	2.59	173.414	3.52
4.	Maize	562	11.28	459.903	9.34
5.	Wheat	2404	48.25	1732.157	35.16
6.	Barley	55	1.10	52.778	1.07
	Total cereals	3632.70	72.91	3485.132	66.70
1.	*Moong*	4.50	0.09	4.815	0.10
2.	*Mash*	31	0.62	40.043	0.81
3.	Gram	319	6.40	321.226	6.52
4.	*Massar*	17.41	0.35	27.703	0.56
	Total pulses	371.91	7.45	393.787	7.99
	Total foodgrains	4004.61	80.37	3679.919	74.69
1.	Sesamum	16.4	0.33	0.000	0.0
2.	Groundnut	160	3.21	82.000	1.67
3.	Mustard	172	3.45	779.173	15.82
4.	Linseed	2.7	0.05	0.000	0.000
	Total oilseeds	351.1	7.04	861.173	17.49
1.	Cotton (American) ..	235	4.72	199.000	4.04
2.	Cotton (*desi*)	271	5.44	0.000	0.00
3.	Sugarcane	102	2.05	169.000	3.43
4.	Tobacco	0.204	0.004	0.213	0.004
5.	Potatoes	18.8	0.38	16.900	0.34
	Total commercial crops, *i.e.*, non-foodgrains	978.104	19.63	1246.286	25.31
	Total cropped area	4982.714	100.00	4926.205	100.00

to the problem explained in the earlier sections. There was a marked decline in the area under foodgrains from 4005 to 3680 thousand hectares. In the programmed solution the foodgrains accounted for only 74.69 per cent of the total cropped area as compared to 80.37 per cent in the existing plan. The area under commercial crops increased to 1246 thousand in the programmed solution as compared to 978 thousand hectares in the existing plan. The percentage share of the commercial crops in the total cropped area in the State increased from 19.63 to 25.31.

In the optimum solution obtained with constraints of self-sufficiency in foodgrains, oilseeds gained relatively more area, which more than doubled from 351 to 861 thousand hectares. The percentage share of oilseeds stood at 17.49 as compared to 7.04 in the existing plan. Mustard being relatively more remunerative oilseed crop in the *rabi* season, it covered about four times more area in the new plan, accounting for 15.82 per cent of the total cropped area in the State. During *kharif*, the only oilseed crop which appeared in the plan was groundnut and that too at the minimum level fixed for this crop in the model. It now occupied only 82 thousand instead of 160 thousand hectares in the existing distribution, accounting for 1.67 per cent of the total cropped area. Sesamum and linseed, being relatively less profitable, were completely excluded from the programmed solution.

Among other commercial crops, cotton (American), sugarcane, potato and tobacco appeared in the optimal cropping scheme for the State and covered 4.04, 3.43, 0.34 and 0.004 per cent of the total cropped area respectively. It may be mentioned that while cotton (American) occupied only the minimum area, sugarcane and tobacco being highly remunerative crops, reached the limits of maximum area provided for these crops in the model. Cotton (*desi*) was completely eliminated from the programmed cropping pattern for the State.

Some important results may also be noted about foodgrains in the optimum cropping plan. In order to be self-sufficient in jowar, bajra and different pulses, the areas under these crops in the programmed solution have increased. The area under paddy has doubled from 476 to 850 thousand hectares, but that under wheat substantially declined from 2404 to 1732 thousand hectares. Maize also occupied now only 460 in place of 562 thousand hectares. Rice being relatively more profitable foodgrain crop in the State, the scarce fertilizers got diverted towards this crop, leaving behind lesser quantity of fertilizers for wheat, which is the most important foodgrain crop in the State. Therefore, the area under wheat has substantially shrunk. Mustard, which is grown in the same season and for which almost no fertilizers are used at present in the State, has occupied the area lost by wheat in the optimum plan. Maize and cotton (*desi* and American) also could not stand the test of relative profitability against paddy and hence they lost area.

Changes in Production of Various Crops as a Result of Constraints of Self-sufficiency in Foodgrains

Table II shows the consumption needs of the State for attaining self-sufficiency in all the foodgrains and the production of various crops under the existing and programmed solutions.

TABLE II—CONSUMPTION NEEDS OF FOODGRAINS AND PRODUCTION OF DIFFERENT CROPS UNDER EXISTING AND PROGRAMMED SOLUTIONS IN THE PUNJAB : 1972-73

(*thousand tonnes*)

Sr. No.	Crop/commodity group	Consumption needs* for self-sufficiency in foodgrains	No constraint of self-sufficiency in foodgrains (existing solution)	Constraints of self-sufficiency in foodgrains imposed (programmed solution)
1.	Rice (husked)	314.580	955	1705.850
2.	Jowar	8.965	3.4	9.001
3.	Bajra	145.668	108	144.974
4.	Maize	740.448	906	741.364
5.	Wheat	3110.475	5368	3867.907
6.	Barley	57.000	59	56.736
	Total cereals	4377.136	7399.4	6525.832
1.	*Mung*	2.552	2.4	2.566
2.	*Mash*	18.820	14.6	18.860
3.	Gram	268.867	267.0	268.867
4.	*Massar*	10.499	6.6	10.499
	Total pulses	300.738	290.6	300.792
	Total foodgrains	4677.874	7690	6826.624
1.	Sesamum	—	6.5	0.0
2.	Groundnut	—	153	78.556
3.	Mustard	—	107	484.646
4.	Linseed	—	1.1	0.0
	Total oilseeds	—	267.6	563.202
1.	Cotton† (American)	—	94.36	79.998
2.	Cotton (*desi*)	—	86.16	0.000
3.	Sugarcane (*gur*)	—	469.0	777.738
4.	Tobacco	—	0.338	0.353
5.	Potato	—	240.1	216.641

* Consumption needs of different foodgrains are based on data for the year 1970-71.
† In terms of cleaned cotton.

It may be noted from the table that the State was surplus in major foodgrains, *i.e.*, wheat, rice, maize and barley, the surplus being highest in the case of wheat and minimum in the case of barley. Among cereals, *jowar* and *bajra* were not produced in quantities sufficient to meet the needs of the State, and hence these had to be imported. Almost all the major pulses had to be imported into the State in varying amounts since their production too lagged behind the consumption needs of the State.

The programmed solution obtained with constraints of self-sufficiency in all the important foodgrains (cereals and pulses) resulted in a decline in the total production of foodgrains from 7690 to 6827 thousand tonnes. The production of cereals also declined from 7399 to 6526 thousand tonnes but that of pulses registered an increase from 291 to 301 thousand tonnes, just enough to meet the self-sufficiency needs of the State. The production of each cereal and pulse, except wheat, maize and barley, increased to levels required for self-sufficiency with the single exception of rice where the relative profitability nearly doubled its production. Self-sufficiency in coarse foodgrains and pulses was mainly at the cost of wheat production which declined from 5368 to 3868 thousand tonnes.

The production of oilseeds more than doubled from 268 to 563 thousand tonnes. Mustard production increased from 107 to 485 thousand tonnes but the production of each of the rest three oilseeds declined. While the production of groundnut got reduced to half, sesamum and linseed were not at all produced in the optimum plan. Among other commercial crops, sugarcane was the major gainer for which the production increased to 778 from 469 thousand tonnes of *gur* in the existing scheme. There were some shortfalls in the production of cotton (American) and potato. However, the production of cotton (*desi*) was reduced to zero.

Changes in the Total Value Product

In order to have an overall idea about the changes in the production of all crops taken together when constrainsts of self-sufficiency in foodgrains were imposed, the gain in the total value product, *i.e.*, value of the objective function increased from Rs. 8226.975 to 8690.452 millions as a result of optimization of scarce resources with the constraints of self-sufficiency in foodgrains. The gain in the total value product amounted to Rs. 463.477 millions which was to the tune of 5.63 per cent.

CONCLUSIONS

Our results while obviously having certain limitations, suggest that if Punjab State follows a policy of self-sufficiency in each of the important foodgrains, the production of foodgrains would substantially fall from 7690 to 6827 thousand tonnes. Wheat, the most important crop of the State, would now be grown only on 1732 thousand hectares instead of 2404 thousand hectares in the existing cropping scheme, causing thereby a reduction in its production from 5368 to 3868 thousand tonnes. Rice being relatively profitable, the area under it increased to 850 thousand hectares from 476 thousand hectares. Since relatively much less fertilizers are applied to oilseeds, therefore, the area under them has more than doubled from 351 to 861 thousand hectares. It might also appear profitable to shift the entire existing area under *desi* cotton to that under rice. In this scheme of optimum allocation of scarce resources with self-sufficiency constraints of foodgrains, all

the commercial crops taken together have gained about 5.68 per cent more of the total cropped area, entirely at an equal loss of area under the foodgrains.

In a country like India where the urgency is to produce more of everything, a policy of regional self-sufficiency in foodgrains accompanied by optimum allocation of scarce resources, might help in increasing the aggregate value product by 5.63 per cent for the Punjab State alone. However, it seems likely that the decrease in foodgrain production in the surplus States like Punjab will be more than compensated through increased production of foodgrains in the deficit States because of the built in mechanism in the economic model used. As such, one needs to compare the changes in the aggregate value product for the country as a whole by imposing self-sufficiency constraints in foodgrains for individual States, before arriving at any concrete conclusions.

IMPACT OF TECHNOLOGICAL CHANGE ON FACTOR INTENSITIES, YIELD AND PROFITABILITY OF DESI AND AMERICAN COTTON IN FEROZEPUR DISTRICT OF PUNJAB

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Recent technological break-through has marked a considerable change in the economic landscape of agriculture in Punjab. Two types of technological change are said to have redrawn the economic contour of Punjab's agriculture. Mechanization of farming operations and increased intensity of use of organic and inorganic fertilizers, protective chemicals and new seed are the two variants of this change.

Technological change in the form of mechanization generally yield neutral[1] in character has the effect of pushing up profitability of a crop by causing a diminution in the cost of production per unit of land. This type of change essentially involves a reduction in the cost per unit of output. The second type of technological change which generally assumes the form of a package of improved seed, fertilizer and other protective chemicals is essentially pregnant with yield increasing potentiality. This type of change causes an upward drift in the profitability of a crop through its yield increasing mechanism involving higher expenditure per unit of land and may not neces-

1. In some cases where the nature of the soil and/or crop requires deep ploughing, mechanization in the form of tractorisation, of course, is likely to lead to an increase in yield per hectare.