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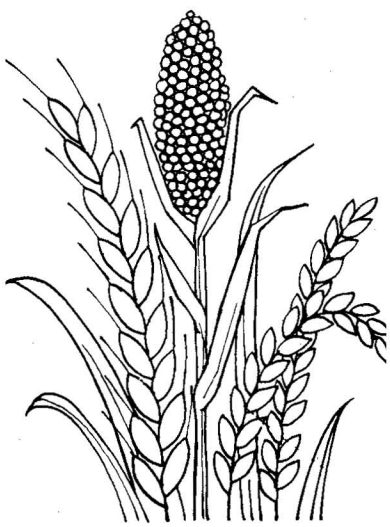

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AN ECONOMIC ANALYSIS OF DAIRY ENTERPRISE VIS-A-VIS CROP CULTIVATION IN PUNJAB (A CASE STUDY)

K. C. Dhawan and S. S. Johl

Dairy buffaloes are an important farm activity around the urban centres in the Punjab. Although rural families maintain buffaloes and cows primarily to meet their own consumption needs, they do sell small quantities of milk to the milk collectors who pool these small lots and carry it in bulk to the town markets. There are, however, a few cultivators who maintain dairy buffaloes on a commercial scale too. It is, however, doubtful whether the dairy buffaloes are a paying proposition in comparison with the crop enterprises. If it is not a paying enterprise in comparison to crop cultivation, it is not known how much price advantage would be required so that this activity becomes profitable and gets included in the production programmes.

Studies conducted so far have given conflicting results due to the differences in their locale and the assumptions made. One study by the authors at Ludhiana[1] found dairy buffaloes to be a profitable proposition. Here the assumption was that wheat straw was to be consumed on the farm and gram was considered as an intermediate product. This assumption though based on usual local practice placed wheat enterprise at a relative disadvantage to dairy enterprise. As a result, dairy entered the production plan. Assumptions being different, an other study[2] in the same area, however, showed that dairy was not profitable compared to crop cultivation. But, dairy enterprise does not seem to be such an unimportant enterprise that could be ignored outright from the production plans of the cultivators. There is a necessity, therefore, to explore the breakeven point where dairy becomes a paying concern.

The urban population is expanding and money incomes of the people are increasing and demand for protective foods, such as milk and milk products being much more income elastic, is increasing fast. In fact, in most of the cities milk supply at present has gone short of actual requirements at prevailing price and price of milk as a result is rising continuously. Another important point is that income flowing from this enterprise is well spread throughout the year and the risks involved in this enterprise are less compared to those in the cultivation of commercial crops. Considering the importance of dairy animals from this angle, the analysis on the earlier situation[3] was further extended to locate the breakeven point to which the relative milk price would have to be increased so that dairy animals get included in the production programme of the farmers.

Specifically this study aimed at

(*i*) locating the price of milk at which dairy enterprise would start paying in comparison to the crop cultivation.

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1. S. S. Johl, A. S. Kahlon and K. C. Dhawan,"Economics of Dairy Buffaloes in the Sub-urban Area of the Punjab (A Case Study), *Journal of Research*, Vol. II, No. 3, December, 1965, Punjab Agricultural University, Hissar.

2. K. C. Dhawan and S. S. Johl, "Comparative Profitability of Dairy Enterprise in Relation to Crop Cultivation on Sub-urban Farms in Punjab," *Indian Journal of Agricultural Economics*, Vol. XXII, No. 1, January-March, 1967.

3. K. C. Dhawan and S. S. Johl, *ibid.*

(*ii*) Finding the levels of dairy enterprise in the production programmes of the farmers at different levels of milk price.

The analysis was done using the price variable programming technique first with the same input-output coefficient as in the earlier study (1964-65 level) of price to find out the price of milk at which dairy enterprise would enter the production programme of the farmer. In order to make comparison over time, the analysis was repeated with input-output coefficients at technological level and prices of the year 1968. The new problem matrix included all the latest high-yielding crop varieties made available to the farmers in the Punjab. In this problem matrix, another activity for purchasing of farmyard manure which restricted the acreage under sugarcane, maize and cotton, was also included.

Optimum plans were developed through simplex method of linear programming analysis. The model used was :

$$B_i \sum_{j=1}^{k} b_{ij} X_j$$

Where Bi represents resource levels running from 1 to n, X_j represents activities running from 1 to k and b_{ij} represents input coefficients of X_j activity.

The resources needed for fixed activity of growing fodder for bullocks and other farm animals as well as resources needed for miscellaneous purposes were deducted from total available resources so as to arrive at the resources available for commercial enterprise.

The existing production plan of the cultivator as in 1964-65 was obtained as under :

Kharif Season	(acres)
Local maize	3.50
Sugarcane	0.50
Groundnut unirrigated	10.00
Paddy (*Jhona*)	0.50
Fodder (*Chari*)	2.50
Fallow	4.00
Rabi Season	
Wheat irrigated (local)	3.00
Wheat unirrigated (local)	4.00
Gram unirrigated	3.00
Fodder (berseem)	2.50
Fallow	8.50
Returns to fixed farm resources (Rs.)	9,115.00

The plan of the farmer showed that wheat crop was major *rabi* enterprise and so was the maize in *kharif* season. Cropping scheme was a diversified one. A few acres were kept fallow which resulted in the under-utilization of fixed farm resources. This resulted in low returns to fixed farm resources which could be increased through proper allocation of these scarce farm resources to more profitable enterprises.

OPTIMUM PLANS WITH IMPROVED TECHNIQUES OF PRODUCTION AS IN 1964-65

The optimum plan with resource use alternatives and input-ouput coefficients as they were in 1964-65 (Table I) showed that the dairy enterprise did not enter the production plan as a competitive enterprise compared to crop cultivation. Price variable programming analysis was, therefore, used to locate the minimum milk price at which dairy activity would enter the production plan (the final iterations of the successive normative plans are given in Appendices I to VII).

The effect of an increase in the price of milk (returns from dairy buffalo) as shown in Table II indicated that when the price of milk was Re. 0.70 per litre (market rate), the return from the dairy enterprise worked out at Rs. 300 per animal. At this price of milk, dairy was not a profitable enterprise in comparison to crop cultivation and it did not get included in the production programme. It is only when the price of milk was increased to Re. 0.77 per litre, with the return to fixed farm resources at Rs. 428.80 per animal, the dairy enterprise figured in the optimum plan. The analysis thus brought out that the minimum price of milk essential to incorporate dairy activity in the farmers' production plans on a competitive basis, other things remaining the same, should have been Re. 0.77 per litre at 1964-65 relative price levels. This price signifies the breakeven point at which the dairy enterprise would be able to replace some crop enterprises without any change in incomes. As the price of milk was increased further, the returns also increased correspondingly and the level of dairy enterprise also increased, as in Table II.

When the price of milk was Re. 0.70, the optimum plan did not have any buffalo. As the price of milk was increased from Re. 0.70 to 0.77 per litre, dairy activity found a place in the production programme with only one animal. When the price of milk was raised from Re. 0.77 to 0.78 per litre, the number of buffaloes figured two. A further increase of one paise per litre (*i.e.*, Re. 0.79 to 0.80), dairy buffaloes numbered at 27. This was a significant increase. When price of milk reached Re. 0.81, the number of buffaloes was 32 and there was no scope to increase the number of animals further through price increase.

As the price of milk reached Re. 0.81 per litre, the return per animal stood at Rs. 481.62 and the returns to fixed farm resources amounted to Rs. 16,449.39. At this stage the price of milk touched a ceiling and with the given resources, the income could not be increased further. Some resources such as land, became so limiting that there was no further scope to increase the level of dairy enterprise through the incentive of price rise. After this point, therefore, there would occur no changes in the product-mix and a price rise would only add to the absolute gains.

TABLE I—INPUT-OUTPUT MATRIX, IMPROVED TECHNIQUE OF PRODUCTION : 1964-65

	Cj———→		629	512	342	422	314	700	545	467	531	325	630
Zj	Fixed farm resources	Re-source levels	Wheat after fallow P1	Wheat after *kharif* crop P2	Wheat after fallow unirri-gated P3	Gram after *kharif* crop P4	Gram after fallow unirri-gated P5	Ber-seem after *kharif* crop P6	Ame-rican cotton after fallow P7	Ame-rican cotton after *rabi* crop P8	*Desi* cotton after *rabi* crop P9	*Chari* fodder after *rabi* crop P10	Hybrid maize after *rabi* crop P11
0 P_{24}	Wheat land irrigated (acres) ..	10.00	1	1	0	1	0	1	1	0	0	0	0
0 P_{25}	Gram land irrigated (acres) ..	3.50	0	0	0	1	0	0	0	0	0	0	0
0 P_{26}	Berseem and sugarcane land (acres)	6.50	0	0	0	0	0	1	0	0	0	0	0
0 P_{27}	Wheat-gram land irrigated (acres)	10.00	0	0	1	0	1	0	0	0	0	0	0
0 P_{28}	Cotton, maize and fodder land (acres)	9.50	1	0	0	0	0	0	1	1	1	1	1
0 P_{29}	Paddy, sugarcane land (acres) ..	6.00	0	0	0	0	0	0	0	0	0	0	0
0 P_{30}	Groundnut land irrigated (acres) ..	3.50	0	0	0	0	0	0	0	0	0	0	0
0 P_{31}	Groundnut land unirrigated (acres)	10.00	0	0	1	0	1	0	0	0	0	0	0
0 P_{32}	Mid-April—end April labour (man-hours) (i)	2.50	16	16	16	16	16	12	12	12	12	0	0
0 P_{33}	Mid-October—mid-November labour (man-hours) (ii)	492	22	22	16	0	0	18	0	0	0	0	0
0 P_{34}	Mid-November—mid-March labour (an-mhours) (iii)	584	68	68	16	34	0	72	30	30	30	0	30
0 P_{35}	*Rabi* cash (Rs.)	1,200	60	60	25	35	20	125	0	0	0	0	01
0 P_{36}	*Kharif* cash (Rs.)	1,000	0	0	0	0	0	0	60	60	35	40	95
0 P_{37}	Farmyard manure (tons)	60	0	0	0	0	0	0	0	0	0	0	10
0 P_{38}	Sugarcane maximum (acres) ..	1	0	0	0	0	0	0	0	0	0	0	0

(Contd.)

TABLE I—(*Concld.*)

C_j ——→		421	1700	593	367	302	156	300	—1.045	—1.045	0	0	0
Z_j	Fixed farm resources	*Desi* maize after *rabi* crop	Sugar cane (gur)	Ground-nut after *rabi* crop irrigated	Ground-nut after fallow unirri-gated	Pady after *rabi* crop (*Jhona*)	Paddy after *rabi* crop (*Basmati*)	Dairy one buffalo	Cash borrow-ing in *rabi* season	Cash borrow-ing in *kharif* season	Lab-our hir-ing (i)	Lab-our hir-ing (ii)	Lab-our hir-ing (iii)
		P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	P_{21}	P_{22}	P_{23}
0	P_{24} Wheat land irrigated (acres) ..	0	1	0	0	0	0	.20	0	0	0	0	0
0	P_{25} Gram land irrigated (acres) ..	0	0	0	0	0	0	0	0	0	0	0	0
0	P_{26} Berseem and sugarcane land (acres)	0	1	0	0	0	0	.20	0	0	0	0	0
0	P_{27} Wheat-gram land irrigated (acres)	0	0	0	1	0	0	0	0	0	0	0	0
0	P_{28} Cotton, maize and fodder land (acres)	1	1	1	0	1	1	.30	0	0	0	0	0
0	P_{29} Paddy, sugarcane land (acres) ..	0	1	0	0	1	1	0	0	0	0	0	0
0	P_{30} Groundnut land irrigated (acres) ..	0	0	1	0	0	0	0	0	0	0	0	0
0	P_{31} Groundnut land unirrigated (acres)	0	0	0	1	0	0	0	0	0	0	0	0
0	P_{32} Mid-April—end April labour (man-hours) (i)	0	24	0	0	0	0	16	0	0	—1	0	0
0	P_{33} Mid-October—mid-November labour (man-hours)	0	12	16	16	0	0	32	0	0	0	—1	0
0	P_{34} Mid-November—mid-March labour (man-hours) (iii)	30	526	30	30	30	30	120	0	0	0	0	—1
0	P_{35} *Rabi* cash (Rs.)	0	290	0	0	0	0	65	—1	0	1	.375	.375
0	P_{36} *Kharif* cash (Rs.)	75	85	60	50	150	150	65	0	—1	0	0	0
0	P_{37} Farmyard manure (tons)	10	15	0	0	10	10	0	0	0	0	0	0
0	P_{38} Sugarcane maximum (acres) ..	0	1	0	0	0	0	0	0	0	0	0	0

TABLE II—EFFECT OF MILK PRICE INCREASE ON LEVEL OF DAIRY ENTERPRISE AND FARM INCOME IN THE OPTIMUM PRODUCTION PLANS:1964-65 PRICE LEVELS

Price of milk per litre (Re.)	Level of dairy buffaloes	Returns from dairy buffalo (Rs.)	Returns to fixed farm resources (Rs.)	production plan Percentage increase in income over existing income
0.70	—	300.00	15,930.53	74.70
0.77	1	428.81	15,930.53	74.70
0.78	2	440.08	16,038.82	75.96
0.79	3	452.33	16,059.23	76.18
0.80	27	472.23	16,183.48	77.54
0.81	32	481.62	16,444.39	80.47

EFFECT ON CROP-MIX

As the price of milk was increased from Re. 0.70 to 0.77 per litre, there occurred a minor shift in the cropping plan (Table III). The acreage under berseem (commercial crop), *desi* cotton and groundnut unirrigated was decreased while wheat irrigated, sugarcane, groundnut irrigated and hybrid maize remained unaffected. A further increase in the price of milk by Re. 0.01 per litre eliminated *desi* cotton from the cropping scheme leaving the acreage under other enterprises almost unaffected. At a price of Re. 0.79 per litre of milk, acreage under berseem (commercial), wheat unirrigated and groundnut irrigated started decreasing and acreage under groundnut unirrigated began to increase, while acreage of wheat irrigated, sugarcane and hybrid maize was not affected. When the price of milk was Re. 0.80 per litre, berseem (commercial), wheat unirrigated and groundnut irrigated were eliminated and acreage of hybrid maize was decreased and groundnut unirrigated increased to the maximum limit set by soil suitability but sugarcane acreage remained the same. At Re. 0.81 price of milk per

TABLE III—EFFECT OF MILK PRICE INCREASE ON CROPPING SCHEME, 1964-65 CROP PRICES, SUB-URBAN OF LUDHIANA

Price of milk per litre (Re.)	Number of dairy buffaloes	Wheat (acres)	Berseem (acres)	Sugarcane (acres)	Wheat unirrigated (acres)	*Desi* cotton (acres)	Groundnut (acres)	Groundnut unirrigated (acres)	Hybrid maize (acres)
0.70	—	3.50	5.50	1.00	4.80	0.50	3.50	5.20	4.50
0.77	1	3.50	5.35	1.00	5.64	0.27	3.50	4.36	4.50
0·78	2	3.50	5.17	1.00	5.08	—	3.50	4.92	4.50
0.79	3	3.50	4.82	1.00	3.62	—	2.98	6.38	4.50
0.80	27	3.50	—	1·00	—	—	—	10.00	0.25
0.81	32	3.50	—	—	—	—	—	10.00	—

litre, all other crop enterprises were eliminated except wheat irrigated and groundnut unirrigated because dairy activity did not compete with these two enterprises for land use. Land required by these two activities was not suitable for fodder growing.

Since the increase in the price of milk resulted in an increase of the number of dairy animals which required larger amounts of working capital, labour and land, these resources became more scarce and limiting to the production of remaining enterprises. Some of the imbalances in resource-use were removed by introducing the activities of borrowing short-term capital in the *rabi* and *kharif* seasons and hiring human labour.

A study of resource use pattern at different levels of milk price and dairy buffaloes is given in Table IV. This table shows that land, *kharif* cash and mid-November to mid-March labour were fully utilized and some of mid-October to mid-November and mid-April to end April labour was left unused. There was a shortage of Rs. 131 in *rabi*. As the price of milk was raised from Re. 0.70 to 0.79 per litre and dairy enterprise entered the programme, all the surplus resources disappeared and there was a demand for credit to the extent of Rs. 366 and Rs. 230.90 in the *rabi* and *kharif* seasons respectively. Over 407 man-hours were to be hired in mid-November to mid-March period. A further increase in the price of milk from Re. 0.79 to 0.80 per litre necessitated hiring of labour and borrowing of cash but farmyard manure was rendered surplus to the tune of 42 cart loads. At the price of Re. 0.81 per litre of milk, the whole quantity of farmyard manure was rendered surplus but there was a huge demand on labour and working capital.

TABLE IV—EFFECT OF MILK PRICE INCREASE ON RESOURCE USE AND DEMAND FOR ADDITIONAL RESOURCES

Price of milk per litre (Re.)	Number of dairy buffaloes	Farmyard manure (cart loads)	*Rabi* cash* ± (Rs.)	*Kharif* cash ± (Rs.)	Labour mid-October to mid-November ± (man-hours)	Labour mid-November to mid-March ± (man-hours)	Labour mid-April to end April ± (man-hours)
0.70	—	—	−131.41	—	+88.10	− 63·79	+21.20
0.77	1	—	−206.96	—	+66.06	−126.66	—
0.78	2	—	−264.03	−76.62	+40.68	−220.78	—
0.79	3	—	−366.47	−230.90	—	−407.77	—
0.80	27	+42.48	−2,740.66	−1,395.83	−636.79	−2,786.42	−269.89
0.81	32	+60.00	−2,850.76	−1,564.10	−752.26	−2,965.36	−314.62

* Plus (+) surplus resources, negative (−) resources to be hired or borrowed.

PRODUCTIVITY OF RESOURCES

As the price of milk changed, the productivity of resources also changed. $Z_j—C_j$ rows of all the final iterations of the answer matrix provided marginal value productivity of the fixed farm resources.

The marginal value productivity (MVP) of land in the *rabi* season was Rs. 422 per acre at the milk price of Re. 0.70 per litre (Table V). Land fit for growing of sugarcane and berseem had an extra MVP of Rs. 118 per acre, thus the MVP of sugarcane and berseem land was Rs. 541 per acre. The MVP of *kharif* land was Rs. 487 per acre. As sugarcane and berseem land had an extra MVP, similarly, groundnut irrigated land had an extra MVP of Rs. 39 per acre. Labour was surplus in all the periods. The whole quantity of farmyard manure was exhausted and its MVP was Rs. 4.42 per cart load.

As the price of milk was raised from Re. 0.70 to 0.77 per litre, the MVP of fixed farm resources remained unaffected. A further increase in the price of milk lowered the MVP of all the resources except mid-April to end April labour which increased from zero to Re. 0.41 per man-hour and the MVP of mid-October to mid-November labour was still zero. As the price of milk was raised from Re. 0.79 to 0.80 per litre, the MVP of some resources became constant and remained so throughout the further analysis. These resources were wheat land irrigated, wheat land unirrigated, groundnut land unirrigated, and farmyard manure. These resources were not needed by dairy enterprise. The constant productivity of labour and capital was due to hiring and borrowing activities. There was a great fluctuation in the productivity of sugarcane and berseem land.

TABLE V—MARGINAL VALUE PRODUCTIVITY OF FIXED FARM RESOURCES AT SIX LEVELS OF PRICE OF MILK

(*in rupees*)

Farm resources	Different levels of milk price per litre (Re.)					
	0.70	0.77	0.78	0.79	0.80	0.81
Wheat land irrigated (acres)	422.56	422.56	415.98	415.98	397.21	397.21
Gram land irrigated (acres)	0	0	0	0	0	0
Sugarcane and berseen land (acres)	541.01	541.01	536.07	536.07	521.42	512.42
Wheat land unirrigated (acres)	309.57	309.57	303.00	303.00	296.72	296.72
Maize and cotton land (acres)	487.27	487.27	477.73	518.55	518.00	549.28
Sugarcane and paddy land (acres)	0	0	0	0	0	0
Groundnut land irrigated (acres)	526.45	526.45	518.55	0	0	0
Groundnut land unirrigated (acres)	309.57	309.57	303.00	303.00	296.72	296.72
Mid-October-Mid-November labour (man-hour)	0	0	0	0	0.39	0.39
Mid-November-Mid-March labour (man-hour)	0.39	0.39	0.39	0.39	0.39	0.39
Mid-April-end April labour (man-hour)	0	0	0.41	0.41	1.045	1.045
Rabi liquid capital (Rs.)	1.045	1.045	1.045	1.045	1.045	1.045
Kharif liquid capital (Rs.)	0.91	0.91	1.045	1.045	1.045	1.045
Farmyard manure (cart load)	4.42	4.42	4.13	0	0	0
Sugarcane maximum (acres)	18.02	18.02	15.89	36.30	31.28	—

This was necessitated due to the adjustment of the resources for different enterprises when the level of the dairy enterprise increased.

PRODUCTION PROGRAMME WITH TO-DATE COEFFICIENTS

As agricultural technology is developing at a fast rate and farmers are adopting it with a speed in the Punjab, all the input-output coefficients of various enterprises have radically changed. A new problem matrix was, therefore, set up to incorporate improved technology. The price structure of various products also changed because of expanding population and increasing income. All this necessitated getting revised picture of the situation.

This analysis was done by using input-output coefficients based on the latest packages of practices for different crop enterprises and up-to-date resources position on the farm (Table VI). This matrix gave somewhat different results. With to-date input-output coefficients (price of milk at Re. 1 per litre and other product and input prices also at higher levels), the dairy enterprise found a place in the farmers' production plans. This analysis showed that now dairy was a paying enterprise in comparison to crop cultivation but its level was only four animals (buffaloes). The analysis further showed that the price of milk increased more as compared to the prices of other competing enterprises. Also the feed cost of dairy animals did not rise as much as the price of milk. A further critical examination of costs showed that prices of inputs for other competing enterprises went up more compared to the costs of inputs used in the production of milk (Appendix 8).

Dairy enterprise replaced *desi* cotton and groundnut irrigated in the *kharif* season and berseem (commercial) in the *rabi* season. The actual normative production programme was obtained as under :

	(acres)
Sugarcane	1.50
Wheat K 227	3.50
Wheat unirrigated	1.50
Berseem fodder (commercial)	4.20
Hybrid maize	6.70
Groundnut unirrigated	8.50
Dairy buffaloes	4.00

This cropping scheme required purchase of 31 cart loads of farmyard manure, borrowing of Rs. 115 *rabi* cash and hiring of 1076 man-hours of human labour in mid-November to mid-March.

The analysis, thus, showed that the changed input-output price relationships have turned out to be favourable in recent years and dairy is figuring up as a profitable farm enterprise in the sub-urban areas of Punjab. The results point to a very significant development which might take place in the future. With the grain production increasing fast and relative product price levels changing in favour of milk and milk products, the dairy enterprise will be expanding, making a shift in the production patterns and improvement in the food consumption patterns in the progressive States of India.

TABLE VI—INPUT-OUTPUT MATRIX WITH UP-TO-DATE COEFFICIENTS AND RESOURCE POSITION ON THE FARM : 1968

C_j ——→			996	1295	1480	750	932	534	562	514	403
Z_j ↓	Fixed farm resources	Resource levels	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
			Lerma Rajo	PV18 wheat	K227 wheat	C-273 wheat	C-306 wheat	Unirriga-ted wheat	*Desi* gram	*Kabli* gram	Gram un-irrigated
0	P_{31} Wheat land irrigated (acres) ..	10.00	1	1	1	1	1	0	1	1	0
0	P_{32} Gram land irrigated (acres) ..	3.50	0	0	0	0	0	0	1	1	0
0	P_{33} Berseem and sugarcane land (acres)	6.50	0	0	0	0	0	0	0	0	0
0	P_{34} Wheat and gram land unirrigated (acres)	10.00	0	0	0	0	0	1	0	0	1
0	P_{35} Cotton, maize and fodder land (acres)	9.50	0	0	0	0	0	0	0	0	0
0	P_{36} Paddy and sugarcane land (acres) ..	6.00	0	0	0	0	0	0	0	0	0
0	P_{37} Groundnut land irrigated (acres) ..	3.50	0	0	0	0	0	0	0	0	0
0	P_{38} Groundnut land unirrigated (acres)	10.00	0	0	0	0	0	1	0	0	1
0	P_{39} April 15 to end April labour (man-hours) (i)	3.80	32	32	32	32	32	32	16	16	16
0	P_{40} October 15 to November 15 labour (man-hours) (ii)	748	30	30	30	30	30	30	0	0	0
0	P_{41} November 15 to March 15 labour (man-hours) (iii)	2,544	106	106	106	94	94	16	28	28	16
0	P_{42} *Rabi* cash (Rs.)	4,000	343	348	363	187	187	119	108	151	62
0	P_{43} *Kharif* cash (Rs.)	4,000	0	0	0	0	0	0	0	0	0
0	P_{44} Farmyard manure (tons)	100	0	0	0	0	0	0	0	0	0
0	P_{45} Sugarcane maximum (acres) ..	1.50	0	0	0	0	0	0	0	0	0

(*Contd.*)

TABLE VI—(*Contd.*)

C_j ⟶		1356	570	824	643	502	3220	666	460	675	596
Z_j ↓	Fixed farm resources	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}
		Ber-seem	Bar-ley	*Sar-son*	Ground-nut irrigated	Groundnut unirrigated	Sugar-cane	American cotton	*Desi* cotton	Dairy one buffalo	Paddy (*Jhona*)
0	P_{31} Wheat land irrigated (acres) ..	1	1	1	0	0	1	0	0	.20	0
0	P_{32} Gram land irrigated (acres) ..	0	0	0	0	0	0	0	0	0	0
0	P_{33} Berseem and sugarcane land (acres)	1	0	0	0	0	1	0	0	.20	0
0	P_{34} Wheat and gram land unirrigated (acres)	0	0	0	0	1	0	0	0	0	0
0	P_{35} Cotton, maize and fodder land (acres)	0	0	0	1	0	1	1	1	.30	1
0	P_{36} Paddy and sugarcane land (acres) ..	0	0	0	0	0	1	0	0	0	1
0	P_{37} Groundnut land irrigated (acres) ..	0	0	0	1	0	0	0	0	0	0
0	P_{38} Groundnut land unirrigated (acres)	0	0	0	0	1	0	0	0	0	0
0	P_{39} April 15 to end April labour (man-hours) (i)	12	0	0	0	0	24	6	6	32	0
0	P_{40} October 15 to November 15 labour (man-hours) (ii)	24	14	12	24	24	18	22	22	64	0
0	P_{41} November 15 to March 15 labour (man-hours) (iii)	96	34	28	110	40	802	30	30	240	30
0	P_{42} *Rabi* cash (Rs.)	244	90	90	0	0	430	0	0	80	0
0	P_{43} *Kharif* cash (Rs.)	0	0	0	209	152	100	184	100	80	204
0	P_{44} Farmyard manure (tons)	0	0	0	0	0	20	20	20	0	0
0	P_{45} Sugarcane maximum (acres) ..	0	0	0	0	0	1	0	0	0	0

(*Contd.*)

TABLE VI—(*Concld.*)

C_j ——→		457	709	810	527	514	0	0	0	—1·04	—1·04	0
Z_j ↓	Fixed farm resources	P_{20}	P_{21}	P_{22}	P_{23}	P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}
		Paddy (*Basmati*)	Paddy T.N.I.	Hybrid maize	*Desi* maize	*Chari* fodder	Labour (*i*) April 15 to end April	(*ii*) Oct. 15 to Nov. 15	(*iii*) Nov. 15 to March 15	*Rabi* cash	*Kharif* cash	Farmyard manure
0	P_{31} Wheat land irrigated (acres) ..	0	0	0	0	0	0	0	0	0	0	0
0	P_{32} Gram land irrigated (acres) ..	0	0	0	0	0	0	0	0	0	0	0
0	P_{33} Berseem and sugarcane land (acres)	0	0	0	0	0	0	0	0	0	0	0
0	P_{34} Wheat and gram land unirrigated (acres)	0	0	0	0	0	0	0	0	0	0	0
0	P_{35} Cotton, maize and fodder land (acres)	1	1	1	1	1	0	0	0	0	0	0
0	P_{36} Paddy and sugarcane land (acres) ..	1	1	0	0	0	0	0	0	0	0	0
0	P_{37} Groundnut land irrigated (acres) ..	0	0	0	0	0	0	0	0	0	0	0
0	P_{38} Groundnut land unirrigated (acres)	0	0	0	0	0	0	0	0	0	0	0
0	P_{39} April 15 to end April labour (man-hours) (i)	0	0	0	0	0	—1	0	0	0	0	0
0	P_{40} October 15 to November 15 labour (man-hours) (ii)	0	0	0	0	0	0	—1	0	0	0	0
0	P_{41} November 15 to March 15 labour (man-hours) (iii)	30	40	40	30	0	0	0	—1	0	0	0
0	P_{42} *Rabi* cash (Rs.)	0	0	0	0	0	1·25	·625	·625	—1	0	0
0	P_{43} *Kharif* cash (Rs.)	273	344	306	173	85	0	0	0	0	—1	5
0	P_{44} Farmyard manure (tons)	0	0	16	10	0	0	0	0	0	0	—1
0	P_{45} Sugarcane maximum (acres) ..	0	0	0	0	0	0	0	0	0	0	0

APPENDIX I

FINAL ITERATION—PLAN I

	C——→ 0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z	Resource	levels	P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}
531	P_9	.50															
0	P_{25}	[3.50															
700	P_6	5.5															
——→	P_{23}	63.79	67.99	0	4.00	16.00	20.20	0	—7.00	0	0	0	—1	0	0.28	1.68	435.16
593	P_{14}	3.50															
	P_{29}	5.00															
512	P_2	3.50															
	P_{31}	0															
	P_{32}	21.21															
	P_{33}	88.00															
—1.045	P_{19}	131.41															
342	P_3	4.80															
367	P_{15}	5.20															
630	P_{11}	4.50															
1700	P_{13}	1.00															
Z_j—C_j		15930.53	422.56	0	118.45	309.57	487.27	0	39.18	0	0	0	0.39	1.045	0.91	4.42	18.02

N. B.: For the explanation of notations, see Table I.

APPENDIX II

FINAL ITERATION—PLAN II

	C→	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z	Resource levels		P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}
531	P_9	0·27															
0	P_{25}	3.50															
700	P_6	5.35															
0	P_{23}	126.66															
593	P_{14}	3.50															
0	P_{29}	5.00															
512	P_2	3.50															
0	P_{31}	0															
300+128.81	P_{18}	.77	—0.58	0	0.14	—0.58	—0.85	0	0.15	0	0.04	0	0	0	0.01	—0.03	—0.19
0	P_{33}	66.06															
—1.045	P_{19}	206.96															
342	P_3	5.64															
367	P_{15}	4.36															
630	P_{11}	4.50															
1700	P_{13}	1.00															
$Z_j—C_j$		15930.53	422.56	0	118.45	309.57	487.27	0	39.18	0	0	0	0.39	1.045	0.91	4.42	18.02

N.B.: For the explanation of notations, see Table I.

APPENDIX III

FINAL ITERATION—PLAN III

	C→	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z	Resource levels		P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}
—1.045	P_{20}	76.62	49.99	0	—12.51	50.00	358.30	0	—298.30	0	—3.13	0	0	0	—1	—26.32	159.08
0	P_{25}	3.50															
700	P_6	5.10															
0	P_{23}	220.78															
593	P_{14}	3.50															
0	P_{29}	5.00															
512	P_2	3.50															
0	P_{31}	0															
300+140.09	P_{18}	1.67	0	0	0	0	3.3	0	—3.33	0	0	0	0	0	0	—0.33	1.67
0	P_{33}	40.68															
—1.045	P_{19}	264.03															
342	P_3	5.08															
367	P_{15}	4.92															
630	P_{11}	4.50															
1700	P_{13}	1.00															
Z_j—C_j		16038.82	415.98	0	120.09	303.00	477.73	0	40.82	0	0.4	0	0.39	1.045	1.045	4.13	15.89

N.B.: For the explanation of notations, see Table I.

APPENDIX IV

FINAL ITERATION—PLAN IV

	C——————→	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z	Resource levels		P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}
—1.045	P_{20}	230.90															
0	P_{25}	3.5															
700	P_6	4.82															
0	P_{23}	407.77															
593	P_{14}	2.98															
0	P_{29}	5.00															
512	P_2	3.50															
0	P_{31}	0															
300+152.00	P_{18}	3.39	—0.93	0	0.17	—0.67	—0.68	0	0	0	0	0.04	0	0	0	0.07	—0.08
0	P_{30}	0.52	—0.28	0	0.05	—0.20	—1.20	0	1	0	0	0.01	0	0	0	0.12	—0.53
——————→																	
—1.045	P_{19}	366.47															
342	P_3	3.62															
367	P_{15}	6.38															
630	P_{11}	4.50															
1700	P_{13}	1.00															
$Z_j—C_j$		16059.23	415.98	0	120.10	303	518.55	0	0	0	0.41	0	0.39	1.045	1.045	0.4	36.30

N.B. : For the explanation of notations, see Table I.

APPENDIX V

FINAL ITERATION—PLAN V

	C→	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z	Resource	levels	P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}
—1.045	P_{20}	1395.83															
0	P_{25}	3.50															
0	P_{37}	42.49	0	0	15.00	0	—10.00	0	0	0	0	0	0	0	0	1	—20.00
0	P_{23}	2786.42															
0	P_{21}	269.89															
0	P_{29}	5.00															
512	P_2	3.50															
0	P_{31}	0															
472.23	P_{18}	27.49	0	0	5.00	0	0	0	0	0	0	0	0	0	0	0	—5.00
0	P_{30}	3 50															
—1.045	P_{19}	2740.66															
0	P_{22}	636.79															
367	P_{15}	10.00															
630	P_{12}	0.25															
1700	P_{13}	1.00															
Z_j—C_j		16183.48	397.21	0	124.21	296.72	518.00	0	0	0	1.045	0.39	0.39	1.045	1.045	0	31.28

N.B. : For the explanation of notations, see Table I.

APPENDIX VI

FINAL ITERATION—PLAN VI

	C→	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z	Resource	levels	P_{24}	P_{25}	P_{26}	P_{27}	P_{28}	P_{29}	P_{30}	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}
—1.045	P_{20}	1564.10															
0	P_{25}	3.50															
0	P_{37}	60.00															
0	P_{23}	2965.36															
0	P_{21}	314.62															
0	P_{29}	6.00															
512	P_2	3.50															
0	P_{31}	0															
481.62	P_{18}	31.67	0	0	0	0	3.33	0	0	0	0	0	0	0	0	0	0
0	P_{30}	3.50															
—1.045	P_{19}	2850.76															
0	P_{22}	752.26															
367	P_{15}	10.00															
0	P_{38}	1.00															
700	P_6	0.17	0	0	1	0	—0.67	0	0	0	0	0	0	0	0	0	0
——→																	
Z_j—C_j		16449.39	397.21	0	124.21	296.72	549.28	0	0	0	1.045	0.39	0.39	1.045	1.045	0	0

N.B. : For the explanation of notations, see Table I.

APPENDIX VII

FINAL ITERATION WITH UP-TO-DATE COEFFICIENTS—PLAN VII

	C——→	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z	Resource	levels	P_{31}	P_{32}	P_{33}	P_{34}	P_{35}	P_{36}	P_{37}	P_{38}	P_{39}	P_{40}	P_{41}	P_{42}	P_{43}	P_{44}	P_{45}
1480	P_3	3.50															
0	P_{32}	3.50															
0	P_{34}	0															
0	P_{26}	0.28															
1356	P_{10}	4.16															
0	P_{36}	4.50															
0	P_{37}	3·50															
675	P_{18}	4.20															
534	P_6	1.50															
—1.04	P_{28}	115.09															
502	P_{24}	8.50															
0	P_{27}	1076.72															
0	P_{30}	30.99															
810	P_{22}	6.73															
3220	P_{15}	1.50															
Z_j—C_j		28896.47	1022.97	0	12.06	0	570.41	0	0	342.11	0.27	0.06	0.65	1.04	0.56	2.80	526.27

N.B. : For the explanation of notations, see Table I and Table VI.

APPENDIX VIII

VARIABLE COST AND PRICE RELATIONSHIP

(in rupees)

Enterprises	Cost per acre in 1964-65	Cost per acre in 1967-68	Percentage increase in cost over 1964-65 cost	Price per quintal in 1964-65	Price per quintal in 1967-68	Percentage increase in price over 1964-65 price
Dairy (one buffalo) ..	1,012.00	1,100.00	8.69	70.00	100.00	42.85
Berseem (fodder)	214.00	243.00	13.52	3.25	4.50	38.47
Desi cotton	93.00	105.00	12.89	100.00	125.00	25.00
Groundnut irrigated ..	117.00	194.00	65.81	70.00	90.00	28.59