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The production function analysis of the sample farmers indicated decreasing returns to scale as well as excess use of human labour on their farms. This means that if the additional cost of input does not bring commensurate returns, alternative means for rehabilitation of the economy of small farmers like provision of non-farm employment by way of rural industrialisation and supplementary occupations to agriculture have to be explored carefully.

IMPACT OF INTEGRATED CROP AND MILK PRODUCTION ON SMALL FARMS IN PUNJAB

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It is now well accepted that the application of improved seed and fertilizer technology in crop production has mainly benefited the medium and large farmers. The small and marginal farmers have not been able to derive much advantage from the new technology due to their poor land base and scarcity of crucial resources like capital and irrigation. It is estimated that about 55 per cent of the rural population still continues to be below poverty line. In the Sixth Plan, therefore, greater emphasis is proposed to be given on the kind of technology that may result in increase in income, purchasing power and employment among landless agricultural labourers and small and marginal farmers. Integration of crop production with rearing of high-yielding milch animals has been suggested as one of the measures to solve the problem of seasonal income, under-employment, high risk and uncertainty associated with crop farming on smaller farms. It is expected that the poorer sections of the farming population would be able to supplement their income and employment potential on their own farms by keeping productive milch animals.

Technology of proven practical utility and distinct profitability is now available for making dairy enterprise a profitable venture, and if introduced with the improved crop technology it may further improve the income and employment position on the small farms. However, dairying if practised on scientific and commercial lines becomes a capital and labour intensive enterprise. It requires considerable amount of short-term working capital for the purchase of inputs such as feed, fodder and medicines, etc., besides medium-term investments are required for the purchase of high-yielding milch animals, for rearing of heifers till the age at first calving and construction of cattle sheds. The capital requirement would further increase if the improved dairy practices are introduced with the improved crop tech-

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nology. Small farmers cannot finance such investments from their own resources and, therefore, it becomes necessary to arrange institutional finance for them.

The present study aims at examining the impact of varying levels of dairy enterprise with crop farming in the context of augmenting income and employment potential of small farmers in Patiala district (Punjab). Further, optimum production plans have been derived with and without availability of credit under the existing and improved level of technology.

METHODOLOGY

The data utilized for the study were taken from a broad investigation conducted in the study area by the National Dairy Research Institute on the economics of dairy enterprise. Therefore, the sampling frame was similar to that followed by the larger enquiry. The present investigation relied on the data for 37 small farmers (farm size ranging between 1 to 3 hectares) selected from 14 villages confined to Nabha and Samana tehsils of Patiala district in Punjab. The selected area forms the milkshed for the Hindustan Milkfood Manufacturers Limited (Horlicks), Nabha and thus the organized milk marketing facility available offered good potential for development of dairy enterprise.

Data collection was done by the conventional survey method on specially structured and pre-tested schedules pertaining to the agricultural year 1975-76. The input-output coefficients for crops and milk enterprise were collected from the sample farmers. The prices of various inputs used in the production process and for the products produced were collected through careful observation and enquiry.

To examine the impact of integrated crop and milk production on income and employment and to estimate the capital and credit requirements of small farmers, the data of the sampled farms were pooled and arranged to form a synthetic farm situation with an operational holding of 1.70 hectares.

Linear programming technique was used for the analysis of data and the model used is reproduced below:

$$\text{Maximizing } Z = \sum_{j=1}^n C_j X_j \quad (j = 1, 2, \dots, n)$$

Subject to

$$\sum_{j=1}^n a_{ij} x_j \leq b_i \quad (i = 1, 2, \dots, m)$$

$$x_j \geq 0 \text{ for all } j$$

where

Z = Total returns over variable costs on the farm from all the activities,

x_j = Level of the j th real activity,

c_j = Returns over variable cost per unit of j th activity,

b_i = Availability of i th resource,

a_{ij} = Amount of the i th resource required by one unit of j th activity.

Six optimum farm plans were developed with varying levels of dairy enterprise under the existing and improved level of technology, with restricted and unrestricted capital.

A. Farm Plans under Existing Technology

The following three farm plans were developed based on the existing technology of crop and dairy production practised by the sample farmers.

(i) *Farm plan I*: This plan was developed to examine the potential increase in the farm income through optimization without the use of credit facility from any source. This situation included a single buffalo and a cow as milch animals.

(ii) *Farm plan II*: In this plan income of farm was optimized by relaxing the use of the borrowed capital at the prevailing bank rate in addition to owned capital and the number of milch animals was kept at the level of one buffalo and two cows.

(iii) *Farm plan III*: This plan represented the situation where the farmer was allowed to use the credit as in plan II, but the number of cows was increased from two to three. The number of buffaloes was kept as one as in plan II.

B. Farm Plans under Improved Technology

This category included three synthetic farm plans with the improved crop and dairy technology to ascertain the increase in farm income and employment through optimization. The plans developed under improved technology included high-yielding buffaloes and cross-bred cows. Depending upon the availability of credit or otherwise and the number of milch animals to be kept, three synthetic farm situations were developed as under:

(i) *Farm plan IV*: This plan was developed based on the improved crop and dairy technology under the situation that the farmer has to rely on his owned funds and the use of borrowed capital was not permitted. The number of milch animals was kept same as in farm plan I.

(ii) *Farm plan V*: In this plan in addition to introduction of improved technology, the farmer was allowed to borrow funds to maximize income. The number of cows and buffaloes kept was similar as that in plan II.

(iii) *Farm plan VI*: The number of milch animals in this plan was kept same as in plan III and the credit was made available.

RESULTS AND DISCUSSION

Cropping Pattern

To examine the impact of the integrated crop and dairy plans on farm income and employment, optimum farm plans were worked out which are presented in Table I. The existing cropping pattern showed that paddy followed by jowar and maize were the most important crops in the *kharif* season. These three crops, taken together, occupied about 70 per cent of the cropped area in this season. In the *rabi* season wheat alone commanded about three-fourth of the cropped area. It appears that farms in the area are more specialised in the *rabi* season as compared to the *kharif* season. This may be attributed to uncertain rainfall during the *kharif* season. The next important crop in the *rabi* season was berseem which was grown to feed the draft and milch animals kept on the farm.

The optimum farm plans developed with the existing technology and without borrowing (plan I) showed that the area under the low capital requiring crops like maize, bajra and gram increased while a decrease in the area was recorded for the high capital requiring crops like paddy, jowar, sugarcane, etc. With the relaxation of the capital restriction (plan II), crops with higher profitability potential like bajra, chillies, groundnut and wheat entered the plan. Due to the increase in the number of milch animals, the area under fodder crops increased in this plan as compared to the existing plan. In plan III because of the addition of a milch cow, the area under fodder crop further increased in both the seasons.

In the case of optimum farm plans with improved technology but without cash borrowing (plan IV), it was found that neither an improved cow nor an improved buffalo could be kept in the plan because of higher capital requirement. Therefore, it was decided to keep a local buffalo and a *desi* cow in the plan as was the case in plan I. In this plan a sizeable amount of land, i.e., 54 per cent in the *kharif* season and 22 per cent in the *rabi* season remained fallow due to lack of availability of capital which is essential for the adoption of new technology. When the capital restriction was relaxed through borrowing and one improved buffalo and two improved cows were introduced in the plan (plan V), it was found that entire area came under the crops. Bajra was completely replaced by hybrid maize and the area under fodder also registered an increase. With the increase in the number of milch cows from two to three (plan VI), there was a shift in the area from grain crop to fodder crop in both the *kharif* and *rabi* season to feed the additional milch animal.

Farm Income

The optimization of resources under different farm situations resulted in an increase in farm income over the existing plan (Table II). The maximum increase of about 116 per cent in farm income was observed in plan VI when one improved buffalo and three improved cows were introduced in the

TABLE I.—EXISTING AND OPTIMUM FARM PLANS UNDER DIFFERENT LEVELS OF TECHNOLOGY

Crop.	Existing plan						Optimum plans											
	Hec-		Per		Plan I		Plan II		Plan III		Plan IV		Plan V		Plan VI			
	tare	cent	tare	cent	Hec-	Per	Hec-	Per	tare	Per	Hec-	Per	Hec-	Per	tare	Per	Hec-	Per
<i>Kharif</i>																		
Paddy ..	0.48	28.23	0.365	21.47	0.75	44.12	0.75	44.12	0.29	44.12	0.29	17.06	0.75	44.12	0.75	44.12	0.75	44.12
Jowar (fodder) ..	0.38	22.35	0.340	20.00	0.40	23.53	0.40	23.53	0.52	30.59	0.34	20.00	0.54	31.77	0.66	38.82	0.66	38.82
Maize ..	0.31	18.24	0.445	26.18	—	—	—	—	—	—	—	—	0.26	15.29	0.14	8.24	—	—
Bajra ..	0.08	4.71	0.400	23.53	0.35	20.59	0.35	20.59	0.23	13.53	—	—	—	—	—	—	—	—
Sugarcane ..	0.03	1.76	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chillies ..	0.02	1.18	0.150	8.82	0.15	8.82	0.15	8.82	0.15	8.82	0.15	8.82	0.15	8.82	0.15	8.82	0.15	8.82
Maize + bajra ..	0.01	0.59	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cotton ..	0.14	8.23	—	—	0.05	2.94	0.05	2.94	0.05	2.94	—	—	—	—	—	—	—	—
Groundnut ..	0.02	1.18	—	—	1.70	100.00	1.70	100.00	1.70	100.00	0.78	45.88	1.70	100.00	1.70	100.00	1.70	100.00
Sub-total ..	1.47	86.47	1.700	100.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Kharif fallow</i> ..	0.23	13.53	—	—	—	—	—	—	—	—	0.92	54.12	—	—	—	—	—	—
Total ..	1.70	100.00	1.700	100.00	1.70	100.00	1.70	100.00	1.70	100.00	1.70	100.00	1.70	100.00	1.70	100.00	1.70	100.00
<i>Rabi</i>																		
Wheat ..	1.23	72.35	1.304	76.71	1.38	81.18	1.38	81.18	1.30	76.46	1.055	62.06	1.32	77.65	1.24	72.94	1.24	72.94
Berseem ..	0.30	17.65	0.270	15.88	0.32	18.82	0.32	18.82	0.40	23.53	0.270	15.88	0.38	22.35	0.46	27.06	0.46	27.06
Sugarcane ..	0.03	1.76	0.000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oats ..	0.02	1.18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Gram ..	0.01	0.59	0.126	7.41	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sub-total ..	1.59	93.53	1.700	100.00	1.70	100.00	1.70	100.00	1.70	100.00	1.325	77.94	1.70	100.00	1.70	100.00	1.70	100.00
Fallow land ..	0.11	6.47	—	—	—	—	—	—	—	—	0.375	22.06	—	—	—	—	—	—
Total ..	1.70	100.00	1.700	100.00	1.70	100.00	1.70	100.00	1.70	100.00	1.700	100.00	1.70	100.00	1.70	100.00	1.70	100.00
Buffaloes (No.) ..	1.40	—	1.0	—	1.0	—	1.0	—	1.0	—	1.0	—	1.0	—	1.0	—	1.0	—
Cows (No.) ..	0.50	—	1.0	—	2.0	—	2.0	—	3.0	—	1.0	—	2.0	—	3.0	—	3.0	—

TABLE II—ANNUAL FARM INCOME FROM EXISTING AND OPTIMUM FARM PLANS

Particulars	Existing plan	Optimum plans					
		Plan I	Plan II	Plan III	Plan IV	Plan V	Plan VI
(a) Return (Rs.)..	5,692.07	7,004.94	7,363.69	7,456.87	6,274.99	11,803.29	12,275.41
(b) Change over existing plan (Rs.) ..	—	1,312.87 (23.06)	1,671.62 (29.37)	1,764.80 (31.00)	582.92 (10.24)	6,111.22 (107.36)	6,583.34 (115.66)
(c) Change over previous plan (Rs.) ..	—	1,312.87 (23.06)	358.75 (1.12)	93.18 (1.26)	—1,181.88 (—15.85)	5,528.30 (88.10)	472.12 (4.00)

(Figures in parentheses indicate the change in percentage.)

plan with the improved crop technology. On the other hand, the minimum increase in farm income was noticed in plan IV due to the scarcity of capital which resulted in low intensity of cropping on the farm. Interestingly, the percentage increase in farm income indicated an increasing trend with the level of dairy enterprise under both the existing and improved technology. This indicated that the dairy enterprise can play an important role in increasing farm income on the small farms. However, the introduction of improved milch animals would require provision of credit facilities.

Employment

The optimum farm plans developed with the existing level of technology with the varying number of milch animals under different capital availability conditions resulted in increased human labour employment (Table III).

TABLE III—LABOUR UTILIZATION IN DIFFERENT PERIODS IN DIFFERENT PLANS

(man-hours)

Periods	Existing plan	Optimum plans					
		Plan I	Plan II	Plan III	Plan IV	Plan V	Plan VI
Period I (April to mid-May) ..	844.22	918.93	1,072.00	1,262.91	633.94	769.40	795.38
Period II (mid-June to July) ..	647.61	704.33	1,432.12	1,022.43	406.74	679.40	718.98
Period III (early September to late October) ..	756.11	814.07	1,028.46	1,211.42	514.31	817.94	918.51
Period IV (early November to late December) ..	800.28	781.16	1,093.71	1,311.98	609.60	826.90	908.83
Period V (early January to late March) ..	1,363.31	1,354.28	1,737.44	2,073.00	1,133.29	1,413.10	1,574.13
Total ..	4,411.53	4,572.77	6,363.73	6,821.74	3,297.88	4,506.74	4,915.83
Change over existing plan ..	—	161.24 (3.65)	1,952.20 (44.25)	2,410.67 (54.64)	—1,113.19 (—25.23)	95.21 (2.15)	504.30 (11.43)
Change over previous plan ..	—	161.24 (3.65)	1,790.96 (39.16)	458.61 (7.19)	—3,523.86 (—51.65)	1,208.86 (36.65)	409.09 (9.07)

(Figures in parentheses indicate the change in percentage.)

It may also be noted that the employment of human labour is higher under all the farm plans with improved technology as compared to the existing plan, except in plan IV due to lack of capital availability resulting in a part of the area under fallow land. The level of employment showed an increasing trend with the increase in the milch animal under both the existing and improved level of technology. This indicates that to increase the employment potential on the small farms which hardly have any off-farm employment opportunity, keeping of milch animals would prove to be a good proposition.

Capital and Credit Needs

The above analysis indicated that there is lot of potential to increase the income and employment on the farm through optimum crop and dairy plans under the existing and improved technology. It was also observed that an increase in income and employment potential can only be realised if the credit facility is available to the farmers. Therefore, it is essential to have an estimate of capital and credit needs for crop and dairy enterprise under different farm plans.* The short-term capital and credit for crop and dairy enterprise and the medium-term capital and credit for the purchase of milch animals were estimated and are presented in Table IV. As expected, the capital and credit needs for improved technology were much higher as compared to the existing technology. This is because the improved tech-

TABLE IV—CAPITAL AND CREDIT REQUIREMENTS

(Rs.)

Particulars	Existing plan	Optimum plans						
		Plan I	Plan II	Plan III	Plan IV	Plan V	Plan VI	
(a) Capital								
Short-term								
<i>Kharif</i> crops ..	809.47	809.29	998.50	1,036.18	809.15	1,824.19	1,784.17	
<i>Rabi</i> crops ..	1,827.58	1,827.22	1,978.48	2,034.14	1,826.89	2,365.99	2,418.55	
Dairy ..	222.28	208.05	284.70	361.35	208.05	1,599.67	2,137.44	
Medium-term (dairy)	2,548.99	2,130.35	2,612.02	3,093.68	2,130.35	7,400.00	9,900.00	
(b) Credit								
Short-term								
<i>Kharif</i> crops ..	0	0	189.03	226.71	0	1,014.72	972.24	
<i>Rabi</i> crops ..	0	0	150.90	206.56	0	538.41	590.97	
Dairy ..	0	0	62.42	139.07	0	1,377.39	1,915.16	
Medium-term (dairy)	0	0	63.03	544.69	0	4,851.01	7,351.01	

* It was difficult to make direct estimates of capital availability. The existing level of variable expenses incurred by the farmers were, therefore, considered equivalent to capital available during the two seasons, *kharif* and *rabi*.

nology is more capital intensive as compared to the existing technology adopted in the area. The capital and credit requirement showed an increasing trend with the increase in the number of milch animals under both the existing and improved level of technology. This indicates that to increase the number of milch animals on the farms, sufficient facilities should be made available to provide short-term and medium-term credit.

CONCLUSIONS

It may be concluded from the above analysis that the integrated crop and dairy plans can play an important role in increasing income and employment on the small farms. Dairying, however, is a capital intensive enterprise and the requirement of capital increases manifold with the introduction of improved technology. With the existing meagre resources of the small farmers it is not possible to increase the number of milch animals and to adopt the improved crop and dairy technology. Therefore, to help the farmers in harvesting the benefit of the integrated crop and dairy production together with the adoption of improved technology, the financial institutions should provide adequate short-term and medium-term credit on easy terms to the small farmers.