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INTENSIVE DEVELOPMENT APPROACH TO AGRICULTURAL DEVELOPMENT : ROLE OF IRRIGATION AND CROPPING PATTERN IN AGRICULTURAL DEVELOPMENT

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"Development or growth refers to the process whereby the people of a country or region come to utilize the resources available to bring about a sustained increase in per capita production of goods and services."[1] With this definition in view, agricultural development should aim at a sustained increase in per capita production of goods and services and also consider utilization of the available resources. It is said that in developing countries the farmers always speak about scarcity of certain resources but never try to utilize existing resources to the best possible manner or consider the possibility of developing new resources and to substitute them for the scarce ones.

Investigations made into various studies may prove to be of practical utility to see the extent to which development can be brought about by using various available resources and to explore the possibility of developing some new ones. It is proposed to study from cross-sectional data, the extent of growth that can be achieved from development of well irrigation and changes in the cropping pattern.

IRRIGATION AND WATER SUPPLY

Farming is a struggle over nature[2] and the success is neither easy for the peasants nor for those who want to help them. Except the heavy rainfall coastal zones and the Indo-Gangetic plains, the deficiency in rainfall causes harm to land and cattle and several times leads to occasional famines.

Irrigation has therefore a significant part to play in shaping of the agricultural economy of India. Only 15.5 per cent of the total tillable area is reported to be under irrigation. Roughly 53 per cent of the irrigated area is fed by canals, 11 per cent by tanks, 25 per cent by wells and 11 per cent by other sources. A regional analysis of the proportion of the area irrigated to total area sown reveals the unsatisfactory situation in the various States in respect of irrigation facilities. The area under wells and other sources is capable of rapid expansion. In Maharashtra, irrigation from wells is the largest source but over one lakh wells were not in use.[3] There is also a great possibility of utilizing the flows of several rivers which could very well be utilized for generation of electric power and irrigation by way of canals. Construction of dams like Bhakra Nangal, Koyna, Hirakud, etc., has provided immense resources both for irrigation and small scale industries.

1. H. F. Williamson and J. A. Buttrick (Eds.): Economic Development, Principles and Patterns, Prentice-Hall, New York, 1954, p. 7.
2. L. D. Schwing, "Agricultural Problems of Middle East," *Journal of Farm Economics*, Vol. 35, 1953, pp. 582-594.
3. Season and Crop Report, Maharashtra State 1960-61, pp. 38-39.

The power generated will be useful for lifting underground water at a reasonable cost and thus bring more area under secured irrigation.

Irrigation aids directly and indirectly in agricultural production. It permits changes in cropping pattern and introduction of more profitable crops. To add to that, it reduces the uncertainty of depending entirely on nature for rainfall and permits to accept the up-to-date technology of using manures, fertilizers, insecticides, pesticides, hybrid seed and machinery to the optimum extent. The risk is greatly minimized in using the recent technology. It permits intensive use of labour and capital and also aids in capital formation as can be seen from the following studies.

SOURCES OF DATA

The data collected in the Farm Management Scheme of the Planning Commission, Government of India, in the Nasik district during 1954-57 by the cost accounting method were used by the author for his Ph.D. dissertation work at the Kansas State University, Manhattan (U.S.A.). The same has been presented here to reveal the quantitative levels of agricultural development. The data collected under the departmental research schemes, *viz.*, "Socio-Economic Survey of Nhavari Village"[4] and "Blasting of Wells by Air Compressor Units"[5] have also been used in this paper for similar purpose.

Consider an average farmer in the Nasik district having 8.4 acres of dry land, 1.6 acres of irrigated land, 110 days of October-November family labour, 74 days of June-July bullock labour and Rs. 404 of working capital with limitations of growing a specified quantity of foodgrains and fodder for use of his family members and for a pair of bullocks. The cropping plans for the three years with optimum level of working capital are given in Table I. Using the technique of multi-period programming, plans for various years will be as follows. The plan for the first year yields a net profit of Rs. 1,423 after deduction of all variable costs. Shadow prices of dry and irrigated lands are Rs. 64.71 and Rs. 578.74 respectively per acre. The marginal productivity for one acre of irrigated land is very high and it induces the farmer to increase acreage under irrigation by deepening of well and borrowing money from government for the purchase of oil engine for lifting water from the well. All the available family labour is not used for crop production and hence it can very well be used for deepening of a well.

During the second year, the irrigated area under the command of well be extended to 3 acres. Providing optimum working capital of Rs. 573 for the cropping plans, the net revenue realized is Rs. 2,114. This is about $1\frac{1}{2}$ times the net revenue of the first year and the farmer will be in a position to repay a part of the loan and can also spend additional amount on consumption. All the home labour is fully used and additional demand for few more days, both of human and bullock labour, is met by hired labour. The shadow price of one acre of irrigated land is still to the extent of Rs. 563.29 and the farmer can profitably increase the area under irrigation to the maximum possible extent of 5 acres, *i.e.*, half of the holding under irrigation.

4. Report submitted to AGRESCO, May, 1965 by Agricultural Economics Section and Extension Wing, College of Agriculture, Dhulia. (Unpublished.)
5. R. S. Savale, "Economics of Blasting of Wells by Air-Compressor Units" *Magazine* of the College of Agriculture, Dhulia, January, 1965.

TABLE I—FARM PLANNING IN RELATION TO VARIOUS LEVELS OF IRRIGATION ON A TEN-ACRE MODAL CLASS FARM IN THE NASIK DISTRICT

Year	Land (acres)		Level of working capital (Rs.)	Net returns (Rs.)	Optimum cropping plans		Labour hiring* (days)	Bullock hiring (days)	Marginal net returns to one unit of				
	Irrigated	Dry			(crops)	(acres)			Capital (Rs.)	Irrigated land (Rs.)	Dry land (Rs.)	Human labour (Rs.)	Bullock labour (Rs.)
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.6	8.4	404	1,423	Lucerne	1.6	—7.22	0.24	0	578.74	64.71	—	1.25
					Bajri (K)	7.22							
					Gram (R)	7.22							
					Groundnut	1.18							
2	3.0	7.0	573	2,114	Lucerne	2.90	2.72	7.44	0	563.29	168.21	1.0	1.25
					Bajri (K)	7.00							
					Gram (R)	7.00							
					Vegetables	0.10							
					Wheat (R)	0.10							
3	5.0	5.0	839	2,904	Lucerne	3.94	11.88	19.87	0	563.29	168.21	1.0	1.00
					Bajri (K)	5.00							
					Gram (R)	5.00							
					Vegetables (K)	1.06							
					Wheat (R)	1.06							

* Unused labour. K=*Kharif*. R=*Rabi*.

The third year cropping plan having 5 acres of dry land, 5 acres of irrigated land and other resources being the same, will need for optimum plan Rs. 839 of working capital. The net returns realized will be Rs. 2,904. There is no further physical limit for increased irrigation. Even with this plan, the net returns have greatly increased (from Rs. 1,423 to Rs. 2,904). The farmer will be in a position to repay all loans taken for the purchase of oil engine within a period of 4 to 5 years and increase his level of consumption and general standard of living. The growth is not temporary but is of permanent nature. With increased irrigation facilities and utilizing the existing resources fully, it is possible to double the net revenue of the farmer within a short period. With multi-period programming model,[6] it is possible to give a long range programme of farm plans by considering capital accumulation in previous period. It is therefore possible to utilize his resources in the best possible manner.

COMPARISON OF BENEFITS FROM DRY AND IRRIGATED FARMS

The data from Farm Management Scheme referred above have been used for framing input-output coefficients and plans were worked out on 1620 IBM by linear programming method. All plans are with optimum level of working capital and hence marginal net returns to additional unit of capital are zero.

With optimum capital, when the minimum restriction of growing crops producing required quantity of grain and fodder is fulfilled, the crops included in the plan remain the same, but the acreage under the most profitable crop increases with increase in the size of farm. A comparison of dry and irrigated farms (Table II) indicates that the cropping on irrigated farms is both capital and labour intensive. The total net returns realized and the net returns per rupee of capital invested on irrigated farms are comparatively more. A comparison of same size of dry and irrigated farms, say of 10 and 20 acres, reveals that the expected net returns from 10-acre irrigated farm are Rs. 4,853 while the same size of dry farm can yield only a sum of Rs. 535. In the case of 20-acre farm, the irrigated and dry farms promise a sum of Rs. 10,363 and Rs. 1,159 respectively of net returns. Thus the net returns are almost nine times more in case of irrigated farms. The table also reveals that the net returns from 7.5 acres of irrigated farm are almost equal to a 60-acre dry farm, showing a large potential for irrigation in agricultural development.

Net returns per rupee of capital invested in different sizes of dry and irrigated farms also reveal that the investment in irrigated farms is paying 1½ to 2 times as compared to dry farms. Not only that, investment in every size of irrigated farm shows better returns as compared to any size of dry farms.

The value of shadow prices obtained from final non-basis output during programming of farm plans reveals that if other factors like labour and capital are available in plenty, addition of one acre of dry land will yield a net revenue of Rs. 166 to 187 on different sizes of irrigated farms. On the other hand, one more acre of irrigated land added to the holding would add a sum of Rs. 547 to 594 as net returns. A comparison of shadow prices on dry farms however reveals that the

6. R. S. Savale, "A Multi-period Programming Model showing the Possibilities of Capital Formation in Farming in Maharashtra Area," *Indian Journal of Agricultural Economics*, Vol. XX, No. 4, October-December, 1965, pp. 29-38.

TABLE II—COMPARISON OF BENEFITS FROM DRY AND IRRIGATED FARMS

Plan No.	Land (acres)		Working capital	Expected returns	Cropping patterns		Marginal net returns		Additional labour employment*	
	Irrigated	Dry			Cropping	Net returns per rupee of capital	Irrigated land	Dry land	Human (days)	Bullock (days)
			(Rs.)	(Rs.)		(Rs.)	(Rs.)	(Rs.)		
1	2	3	4	5	6	7	8	9	10	11
1.	—	10	225	535	Groundnut	2.37	—	75	—19	—8
2.	—	13	327	790		2.41	—	57	5	15
3.	—	20	661	1,159	Bajri	1.75	—	57	60	69
4.	—	30	1,158	1,667	Gram	1.44	—	57	139	145
5.	—	40	1,505	2,324		1.54	—	57	218	221
6.	—	50	2,247	2,286		1.15	—	57	296	298
7.	—	60	2,377	3,460		1.45	—	57	375	376
8.	—	—	719	2,006	Lucerne	2.77	594	187	—20	—17
9.	7.5	—	1,091	3,464	Vegetables	3.18	569	177	3.5	20
10.	10	—	1,531	4,853	Wheat	3.17	553	166	62	51
11.	12.5	—	1,976	6,238		3.15	553	166	124	83
12.	15	—	2,421	7,623		3.14	553	166	186	114
13.	20	—	3,340	10,363		3.10	547	166	340	177
14.	25	—	4,263	13,099		3.07	547	166	498	240

*The negative sign indicates unused home labour.
Note : Rounding of figures is done.

addition of one acre of dry land would add only a sum of Rs. 53.82 to 74.27 on various sizes of farms. Even the shadow prices of dry lands on irrigated farms are more due to the fact that the resources could be utilized in suitable manner on irrigated farms.

Extent of Employment of Human and Bullock Labour

Employment of human and bullock labour is comparatively less on dry farms. In the area under study, October-November is a period of intensive human labour employment, while a large part of bullock labour is employed during June-July. It is however seen that even during these periods of intensive work, out of 110 days of available family labour and 74 days of owned bullock labour, 19.33 days of family labour and 7.67 days of bullock labour on a 10-acre dry farm remained idle. A study of labour employed on a 10-acre irrigated farm however reveals that it could not only utilize all the available human and bullock labour during the above periods, but also hire additional units of 62 days of human labour and 52 days of bullock labour for the optimum cropping plan.

On a 20-acre dry farm, it was necessary to hire 59.56 days of human labour and 68.82 days of bullock labour. A similar size of irrigated farm has to hire human and bullock labour to the extent of 340 and 177 days respectively. The irrigated farm could thus employ almost $5\frac{1}{2}$ times more human labour and $2\frac{1}{2}$ times more of bullock labour as compared to similar size of dry farm. The intensification of irrigation facilities would therefore provide openings for employment to a large part of the rural population.

ECONOMICS OF BLASTING OF WELLS BY AIR COMPRESSOR UNITS

Deepening of wells is one of the ways of making increased supply of water available for irrigation. Blasting by air compressor units has helped directly in this regard. Several wells could not be deepened by the local method of blasting due to several practical difficulties. Air compressor blasting has helped to overcome these difficulties. This investigation reveals the extent to which this new method has helped in increasing agricultural production and in bringing out the extent of additional costs and employment. The investigation was carried out in the Dhulia district. A randomly selected sample of 51 farms revealed that the water supply in the existing wells has increased by blasting with air compressor units to the extent of irrigating 113.61 acres. The original acreage irrigated was only 195.25 acres. There was thus an increase of 58.1 per cent in the irrigated area. The actual annual increase in production due to creation of increased irrigation facilities is shown in Table III.

The average expenditure per well for blasting worked out to Rs. 254.6; while the gross produce realized even during the first year after blasting from each well came to Rs. 556. Considering the net income figures for various crops as worked out in the socio-economic survey of Nhavari village, the average net income per acre worked out to Rs. 119 and the net income from crops grown on each well was estimated at Rs. 266. During subsequent years there is no additional expenditure of blasting and the resource becomes a continuing one. It is therefore a boon both to the individual farmer and to the nation. It contributed largely to increased production of food and other raw materials.

TABLE III—EXPECTED INCREASE IN PRODUCTION DUE TO BLASTING OF WELLS ON 51 FARMS IN THE DHULIA DISTRICT

Crops	Additional		Value of produce	
	Irrigated area (acres)	Production (quintals)	Rate per quintal (Rs.)	Value (Rs.)
Wheat	56.58	141.45	75	10,608
Combodia cotton	32.25	80.62	150	12,093
Chillies	9.25	55.50	50	2,775
Vegetables	3.00	60.00	10	600
Onions	7.50	141.00	10	1,410
Fodder crops	0.80	69.76	12	837
Other miscellanous crops	4.58	11.45	75	859
Total	113.51	559.78		29,182

CHANGES IN CROPPING PATTERN

Changes in cropping pattern are effected in course of time, due to changes in technology, price structure and other factors. This however requires very considerable period. Table IV indicates a natural, substantial change in cropping pattern at village Nhavari in the Dhulia district, effected during a period of 30 years.

TABLE IV—CROPPING PATTERN IN NHAVARI VILLAGE

Crops	Area in acres		Change	
	Year		(Positive)	(Negative)
	1930	1962-63		
Bajri	181	330	149	—
Jowar	72	265	193	—
Groundnut	52	190	138	—
Virnar cotton	440	111	—	329
Combodia cotton	—	37	37	—
Chillies	9	16	7	—
Wheat	20	2	—	18
Vegetables	2	3	1	—
Pulses	63	28	—	35

Source : Revenue records of the village.

The changes in cropping pattern indicate special feature of decrease in area under dry cotton, which has been replaced by groundnut, irrigated cotton and grain crops. The recent change in prices from 1963-64, more in favour of grain crops, would bring increased areas under crops like bajri, wheat and jowar.

The costs and benefits for various crops studied during the socio-economic survey of the above village were as shown in Table V.

TABLE V— PER ACRE COSTS AND RETURNS FROM VARIOUS CROPS

Crops	Cost A (Rs.)	Cost B (Rs.)	Value of output (Rs.)	Profit with	
				Cost A (Rs.)	Cost B (Rs.)
Combodia cotton	328	386	482	154	96
Wheat	164	208	239	75	31
Chillies	289	360	369	80	19
Groundnut	60	93	114	54	21
Bajri	46	78	86	40	8
Cotton (dry)	85	125	111	26	—14
Jowar	65	99	66	1	—33

The net returns per acre realized from the crops play an important role in bringing out changes in the cropping pattern. The net value of growth for current year therefore can be worked out in relation to any base year, when this type of data are available.

To include a new crop enterprise or bring out changes in cropping pattern is one of the effective means of bringing out agricultural development. Even with existing resources, it is possible to bring out a large increase in the net revenue of the farmers by programming of farm plans. The following production plans[7] given in Table VI on selected farms in the Nasik district will illustrate this fact.

The optimum production plans worked out by the use of linear programming technique indicates that even with existing resources but with reorganization and modifications in cropping plan, it is possible to increase the value of production almost 100 per cent. The feasibility of cropping plans and their stability under different price structures have also been confirmed by the author.

Even with simple budgeting procedure for farm planning, it was observed that with existing resources a few changes in the present cropping plan at village Nhavari would yield about Rs. 11,080 more. Increase in irrigation facilities and adoption of proper cropping plan seem to have a great potential in the growth of agricultural business.

7. D. K. Desai : Increasing Income and Production in Indian Farming, Indian Society of Agricultural Economics, Bombay, 1963, pp. 109-110.

TABLE VI—DIFFERENCE IN ACTUAL AND OPTIMUM PRODUCTION PLANS IN THE NASIK DISTRICT

Crops	Actual production plan on selected farms		Optimum production plans for the same farms	
	Quantity (maunds)	Value (Rs.)	Quantity (maunds)	Value (Rs.)
Food Crops				
Bajri	279.92	4,595	210.51	3,460
Wheat	75.12	1,514	23.63	423
Paddy	59.2	1,096	54.57	1,015
Nagali	53.53	589	79.90	907
Other cereals	28.13	397	—	—
Grams	79.80	1,057	117.10	1,552
Hulga	106.68	1,157	37.45	405
Other pulses	21.67	368	—	—
Total food crops	703.87	10,773	522.80	7,762
Cash Crops	—	—	—	—
Groundnut	153.34	2,722	537.96	9,480
Niger	18.96	377	53.64	1,068
Cotton	16.06	547	—	—
Sugarcane (*gur*)	99.29	1,390	—	—
Lucerne	679.71	2,277	5739.10	19,247
Vegetables	648.99	3,731	—	3,220
Total cash crops		11,044		33,015
Total Food and Cash Crops		21,817		40,777

Source : D. K. Desai, *Op. cit.*