EVALUATION OF AGRICULTURAL EXTENSION IN THE MAHI-KADANA IRRIGATION PROJECT

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Irrigation ushers in an era of plentiful production. But the potential gains through the use of seeds of high-yielding varieties (HYVs) of crops, fertilizers and pesticides and adoption of improved practices can become realised gains only when the farmer is helped with necessary credit to buy these critical inputs and is trained in scientific irrigation methods and cropping by agricultural extension. Command Area Development Programmes in the composite irrigation projects financed by the World Bank have been specifically designed to take care of these two basic requirements of a recurring nature along with the once-for-all provisions of infrastructure such as on-farm development works inclusive of field channels, field drains and land levelling.[1]

The objective of this paper is to examine the role of extension in irrigated agriculture in the Mahi-Kadana Irrigation Project in the western State of India, Gujarat and to assess its overall effects on production levels in the project area. The paper is organized into four sections. The first section presents a descriptive account of extension activities in the command area whereas the second section deals with the methodology of evaluation of extension employed in the study. The third section reports the results of the empirical analysis and the final section lists out some policy conclusions.

I

AGRICULTURAL EXTENSION IN THE COMMAND AREA

Mahi-Kadana Irrigation Project in Gujarat State with the dam across the river Mahi at Kadana in Panchmahal district covers a culturable command area of 0.212 million hectares in the seven talukas of Kheda district on the right bank and 0.115 million hectares in the two talukas of Panchmahals district on the left bank. The distribution system consisting of canal and distributaries is yet to be completed in the left bank. But a large part of the area in the right bank has been receiving water from the distributaries for quite some time due to the completion of the Phase I of the project, namely, the construction of weir on the Mahi river at Wanakbori in Kheda district

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1. The roles of short-term crop production credit and long-term investment credit have been dealt with by the author separately in two papers. For details, see T. K. Jayaraman, "An Assessment of Credit Facilities in Mahi-Kadana Command Area", *Vishleshan*, Vol. III, No. 4, December 1977, pp. 319-330 and "Co-operative Credit in Irrigated Agriculture: A Case Study of an Irrigation Project in Gujarat", *Margin*, Vol. 11, No. 4, July 1979, pp. 32-41.

in 1958. Therefore, the right bank is far ahead in the matter of flow irrigation facilities. Hence, it is considered more appropriate to restrict our study to the command area on the right bank in the project.

Important *kharif* crops are bajra, *kodra* (inferior millet) and pulses, thus foodgrains accountng for 60 per cent of the cropped area in the *kharif* season. Tobacco is grown extensively as the *kharif*-cum-*rabi* crop. Cotton is the next leading cash crop which is also processed in the area. The exclusive *rabi* season crop is wheat, whereas in summer, bajra and fodder jowar are grown.

There are 488 primary agricultural co-operatives (PACs) in the right bank covering 496 villages in all. This would mean almost each village has a society catering to the production credit needs of the farmers. As it stands today about 76 per cent of the cultivators in this area have been enrolled as members of the co-operatives.

Agricultural extension operating in the command area until 1978 when it was revised on the lines of Training and Visit (T & V) system had multiple objectives.[2] It sought in the main to impart the required skills to the farmers for undertaking improved agricultural operations, to make available to them timely information on improved practices in an easily understandable form suited to their level of literacy and awareness and to create in them a favourable attitude for innovation and change. Another objective was to modernize the attitude and outlook of the farmer and to make him innovative, enterprising and willing to adopt to changing situations and new technology. As the farmers' capacity to use the knowledge is limited by the availability of inputs and services, the term extension was also used to cover supply and regulatory functions. Extension was also directed to changing the nutritional standards and diet patterns of the rural community and for this purpose women's education was considered as an important aspect of the programme.

Extension activities in the command area are carried out under the control and direction of an elected local self-government institution, namely, the District Panchayat of Kheda.[3] This is the well-known system of village level workers (VLWs) with supervising officers of the rank of taluka level extension officers and taluka development officers at each taluka under the overall guidance of the District Agricultural Officer at the district level as an executive of the District Panchayat. The Command Area Development Authority operating in the district for the seven taluka secures the co-opera-

2. This is purely an historical accident. Earlier programmes like Grow More Food, Community Development and National Extension Service have over the thirty-year period since Independence contributed to the making of current system obtaining in the country. For an historical account, see Government of India: Report of the National Commission of Agriculture, 1976, Vol XI —Research, Education and Extension, Ministry of Agriculture and Irrigation, New Delhi, 1976, Chapter 54, pp. 233-236.

3. In the State of Gujarat, where the *Panchayati Raj* has been in vogue for the last 15 years agriculture has been entrusted as one of the subjects to local self-government institutions. In other States, the District Collector/Deputy Commissioner as the Chief Administrative Head of the district is also controlling the extension services. In States like Rajasthan where the Command Area Development Authorities have been set up for specific irrigation projects, the extension machinery in so far as it relates to the command areas is placed under the Command Area Development Commissioners.

tion of the extension machinery through informal channels made possible through the membership of the District Agricultural Officer and of the District Development Officer, who is the Chief Executive of the District Panchayat, in the Project Level Co-ordination Committee of the Command Area Development Authority.

Until 1978 the VLW was considered a multi-purpose worker and all the development efforts, whether they are agricultural or others at the village level, were exerted through him.[4] In order that his efforts as well as his supervisors are fully concentrated on agricultural extension, the whole scheme has been redrawn. It is now known as Training and Visit (T & V) system.[5] While the general extension functions are exercised through the local self-government institutions, specialised extension services in so far as they pertain to irrigated agriculture are operated through the Command Area Development Authority. These relate to improved methods of water and soil management with emphasis on appropriate modes of irrigation and drainage. The chief tools of transmission of knowledge are demonstration and training camps.

The Trial-cum-Demonstration (TCD) farms located at Thasra and Jinej in the right bank are educating the farmers in regard to water application and soil management under irrigated conditions. These farms are also engaged in applied research, the objectives behind which are the following: (*i*) to study the inter-relationship of irrigation and other inputs in relation to soil properties and crop requirements; (*ii*) to determine the consumptive use of irrigation by crops grown in the command area; (*iii*) to evolve methods of farm management under irrigation with a view to achieving optimum use of water and soil resources; and (*iv*) to determine the field drainage requirements for removal of excess water.

These two farms are supplied with irrigation water from the canals and they have the conveyance facilities to their farms, water measuring devices, meteorological instruments, soil testing laboratory and storage godowns.

The Farmers' Training Centre (FTC) at Thasra is located in the premises of the TCD farm. Thus, the trainees have immediate access to the farms when demonstrations are held. The FTC holds training classes both

4. Under the Community Development programme, the extension worker (VLW) and the supervisory staff are concerned with all aspects of rural development, including health, nutrition and family planning and also regulatory administration such as procurement, collection of statistics and also promotion of small savings. Guy Hunter observes that the VLW spent nearly 60 per cent of his time on credit, supply and non-technical work despite the policy that 80 per cent of his time be devoted to agriculture. For an extended discussion, see Guy Hunter: The Administration of Agricultural Development: Lessons from India, Oxford University Press, London, 1970, pp. 61-70.

Benor and Harrison note that the responsibilities assigned to the VLW were too much for any one and especially for a poorly paid and inadequately trained man. As a result, he could perform neither his agricultural duties nor his other duties effectively and had to resort to doing only these tasks which were most closely monitored (*e.g.*, reports and statistics) and so performing token service-for the most influential people in his jurisdiction. Daniel Benor and James Q. Harrison: Agricultus ral Extension: The Training and Visit System, The World Bank, Washington D.C., 1977, pp. 6-9.

5. Under the T & V system, the VLWs are to concentrate only on extension giving technical advice without being given other responsibilities. They will be assigned specific number of families whom they have to contact periodically after being imparted training at the sub-divisional headquarters by a team of subject specialists every fortnight on current problems relating to farming. See for details, Benor and Harrison: *op. cit.*, Chapter 2.

for farmers and their women-folk of the command area. The FTC, in addition to its full time staff, draws upon the services of subject matter specialists from the University College of Agriculture at Anand Campus.

The FCT holds training camps, each camp lasting five days for a batch of 25 farmers and women at a time each separately during the off-seasons. They are imparted training in water application and management in irrigation farming. The tools used are lectures, discussions, demonstration and visits.

The farm women are trained in seed treatment, preservation of grains, fruits and vegetables, kitchen gardening, use of improved seeds, fertilizers and compost and farmyard manure.

In addition to these camps, field level training camps are held during the season for a day. These camps are called one-day production-cum-demonstration camps. During these camps the farmers are taken round the villages where National Demonstration plots are organized.

In addition to these training programmes, discussion groups are organized and participants in these groups are trained by the FTC. Discussions are broadcast through the radio and problems discussed are personally brought to the group by the farmers themselves.

The local self-government institutions at the taluka level select the farmers for training through VLWs and extension officers. The FTC meets the travelling and expenditure of the participants and provides them with free accommodation and food.

Thus, extension services under the T & V system introduced from 1978 as well as specialised extension services pertaining to irrigation are in operation in the command area. In this paper we are confining ourselves to an eleven-year period from 1966-67 which signifies the beginning of HYVs of crops, to 1976-77 which marks the end of the conventional multi-purpose VLW extension system. Since the exact proportion of each year's aggregate expenditure on agricultural extension is not known, only expenditure on extension relating to water and soil management is relied upon. The assumption here is that a fixed proportion of each year's multi-purpose extension expenditure, which was mostly staff expenditure and hence constant, was spent on agricultural extension. Therefore, only expenditure on specialised extension services is considered for regression analysis.

II

A MODEL

It is very well recognized that evaluation of extension services is a complex assignment.[6] Though apparent links can be established between

6. In this paper we have a restricted objective, namely, assessment of the impact of extension on output. This may give rise to an impression that we consider extension as if no more than a purely technological input/output phenomena. Indeed the effects of extension are of diverse nature and many of them may not be measurable such as institutional and cultural effects which are presently outside the purview. Over time, evaluation studies should evolve to assess these effects. The complexities of various evaluation procedures are discussed in Michael M. Cernea and Benjamin J. Tepping: A System of Monitoring and Agricultural Extension Projects, World Bank Staff Working Paper No. 272, The World Bank, Washington, D.C., 1977, pp. 14-17.

increases in the area under specific crops, amount of fertilizers consumed per hectare, increases in production or farm incomes and extension services, it would be difficult to come to a judgement to what extent yield increases and technological improvements were due to extension alone and how much to other inputs or instruments.[7]

Guy Hunter poses the problem thus: "Strict cost-benefit analysis of the general effects of extension is appallingly difficult. Even where a sharp rise in production or farm incomes appears to be linked to an extension 'drive', it is impossible to identify single causes. A series of good seasons, a favourable price, the introduction of new variety or technique, peculiar energy, intelligence or education in the farming group affected, a pay-off from the long and apparently ineffective preceding effort in extension work, the coming of a road, or the growth of neighbouring town, all or any of these may have had critical significance. Obviously, a combination of necessary factors is involved; to weigh the importance of any one of them is not merely difficult, it is irrational. It may be possible to separate the essential factors without which nothing at all will happen from the merely helpful factors, of which formal education may be one example. But even three factors are indispensable—perhaps irrigation, a profitable market, and extension—it is impossible to give relative weights to these three."[8]

In the light of the above we may construct a model wherein all possible forces can be incorporated. For the purpose of such an analysis, it is postulated that production depends on the profitability of operation which is a reflection both on the market prospects and costs of production. The variable chosen for representing the profitability would be the agricultural price index lagged by one year.

Further, we can also assume that there is a direct relationship between gross cropped area or cropping intensity defined as the ratio of gross cropped area to culturable command area and the production level. Since rainfall sets the tone of agricultural operations in any given year, it would also be better to have it as an explanatory variable, variations in which could be hypothesized to cause variations in production.

But cropping intensity in turn would be determined by certain factors. Among them the leading causal variable would be irrigation intensity defined as the ratio of gross irrigated area to culturable command area which would encourage multiple cropping. Apart from irrigation facilities, introduction of new crops such as potatoes and new varieties of existing crops giving higher yields, and better irrigation methods resulting in saving of water and leading to greater area under cropping, also contribute to cropping intensity in the command area. The explanatory variable which represents these promotional efforts is agricultural extension service. Thus, the hypothesis

7. Benor and Harrison refer to the extension services introduced on T & V basis, and to increases in paddy area and yields per hectare based on crop-cutting experiments in the Chambal (Madhya Pradesh) Project and similar results in the Chambal (Rajasthan) Project, but are careful in coming to any firm conclusion in the absence of rigorous evaluation. For details, see Benor and Harrison: *op. cit.*, pp. 41-45.

8. Hunter: *op. cit.*, p. 14.

would be that a rise in the quantum of extension service would lead to a rise in the cropping intensity. Apart from irrigation and extension, the availability of inputs such as seeds, fertilizers, and pesticides also affects the cropping intensity. In the absence of self-financing the farmers have to depend on credit to buy these inputs. Therefore, a direct relationship between cropping intensity and disbursement of credit can be assumed to exist.

But credit itself is influenced by certain factors. Foremost among them is the profitability of agricultural operations. The hypothesis is that the higher the profitability expectations, the greater would be the demand for production loans by the farmer. However, the quantum of credit flows is adversely affected by the overdues position of the primary agricultural co-operatives (PACs) which dominate the credit structure in the command.[9] The central financing agency of the district restricts the refinancing of PACs which have accumulated overdues. It is, therefore, hypothesized that there exists a negative relationship between credit flows from the PACs and their overdues position.

These relationships can be formalised in the following functional forms:

$$Q_t = f\ (P_{t-1},\ R_t,\ CI_t) \quad .. \quad (1)$$
$$CI_t = f\ (I_t,\ X_t,\ CR_t) \quad .. \quad (2)$$
$$CR_t = f\ (P_{t-1},\ O_t) \quad .. \quad (3)$$

where

Q_t = production level in index number in period 't',
P_{t-1} = agricultural price index lagged by one year,
R_t = rainfall in millimeters (mm.) in period 't',
CI_t = cropping intensity in period 't' representing the ratio of gross cropped area in hectares to culturable command area in hectares,
I_t = irrigation intensity in period 't' expressing gross irrigated area as a ratio of the culturable command area,
X_t = expenditure on extension services in rupees at constant prices (1970-71) in period 't',
CR_t = crop production loan per hectare in rupees at constant prices and
O_t = overdues of PACs in the command area expressed as a percentage of outstanding for their members.

There are in all three endogenous variables (Q, CI, CR) and five exogenous variables (P, R, I, X, O) in this system of equations. As there is a bias of simultaneity involved in these relationships, the estimation procedure will be by Two Stages Least Squares (2SLS) method.

The estimated regression equations in linear form will be the following:

$$Q_t = a_{11} + b_{11}\ P_{t-1} + b_{12}\ R_t + b_{13}\ CI_t \quad .. \quad (1)$$
$$CI_t = a_{21} + b_{21}\ I_t + b_{22}\ X_t + b_{23}\ CR_t \quad .. \quad (2)$$
$$CR_t = a_{31} + b_{31}\ P_{t-1} + b_{32}\ O_t \quad .. \quad (3)$$

9. T. K. Jayaraman, "An Analysis of Overdues of Primary Agricultural Co-operative Societies: A Case Study of Mahi-Kadana Project in Gujarat State", *Indian Journal of Agricultural Economics*, Vol. XXXIII, No. 3, July-September 1978, pp. 21-30.

where, a_{ii}s are intercepts and b_{ii}s are parametric coefficients of the variables.

Q_t can, therefore, be expressed in terms of the exogenous variables as follows:

$$Q_t = a_{11} + b_{13}\, a_{21} + b_{13}\, b_{23}\, a_{31} + (b_{11} + b_{13}\, b_{23}\, b_{31})\, P_{t-1} + b_{12}\, R_t + b_{13}\, b_{21}\, I_t + b_{13}\, b_{22}\, X_t + b_{23}\, b_{32}\, O_t.$$

However, some of the limitations of the multiple regression analysis in terms of these variables to explain the variations in production level over a time period should be recognized. First, the model does not take into account the weather disturbances within each year such as variations in the distribution of rainfall. It rather assumes the absence of such abnormalities. Secondly, it ignores the possible repercussions due to non-timely supply of fertilizers and other inputs on production which are themselves critical. It also assumes the absence of problems of pests and diseases throughout the period of analysis. These and other limitations can be eliminated to a greater extent if the data were substantially plentiful and accurate. Despite these obvious deficiencies, the model does seem to represent the pattern of forces at work as verified by the empirical analysis in the next section.

III

RESULTS OF EMPIRICAL ANALYSIS

The model developed in the last section was applied to a time-series of data collected over a period of eleven years. While hundred per cent of villages in four out of seven talukas are fully covered by the command area, only parts of each taluka were covered in the remaining three talukas. Agricultural production data for each crop generated on the basis of annual crop-cutting experiments relate to each taluka. In the absence of micro level data for each village, taluka data were relied upon to generate the production data for the entire command area.

Though the production data are available for each major crop (bajra, paddy, wheat and tobacco), the data for two variables are in aggregate forms. The data on production credit disbursed each year from the PACs are not available cropwise for each year to evolve a consistent time-series. Similarly, the data on extension expenditure relating to irrigation and soil management are also in aggregate forms as it is not possible to trace it to a particular crop.

While the data on cropping intensity and irrigation intensity are specific to the command area, the data on rainfall and overdues of the PACs at the district level have been utilized in the absence of a consistent time-series data for the command area as such.

Since the data happened to be generally of an aggregate nature, the model sought to be estimated was constrained to be in aggregate terms. The data utilized in the model are presented in Table I. All the data are in either index numbers or percentages except the one relating to extension. The expenditure on extension is in rupees expressed at constant prices having been

TABLE I—VARIABLES UTILIZED IN THE MULTIPLE REGRESSION ANALYSIS

Year	Agri-cultural production index (1965-66 =100)	Lagged agri-cultural price index (1965-66 =100)	Rain-fall (mm.)	Crop-ping inten-sity	Expendi-ture on extension (at const-ant prices) (Rs.)	Credit per hectare (at const-ant prices) (Rs.)	Irriga-tion inten-sity	Overdues of PACs as percen-tage of outstand-ing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1966-67 ..	112·9	100·0	704	100	73,025	34·6	22·1	15·5
1967-68 ..	141·4	121·6	1,092	102	59,534	47·5	23·5	46·6
1968-69 ..	119·8	91·7	413	102	66,837	63·5	37·6	45·6
1969-70 ..	155·5	88·2	765	102	71,073	62·7	67·9	20·6
1970-71 ..	168·8	100·8	1,318	132	164,579	78·0	82·7	41·8
1971-72 ..	165·0	116·5	699	184	212,359	89·5	76·1	33·5
1972-73 ..	98·0	96·6	384	155	182,114	105·7	95·3	27·4
1973-74 ..	116·2	125·3	1,094	199	161,606	91·3	118·5	28·1
1974-75 ..	103·8	156·4	299	139	131,258	134·4	106·7	22·3
1975-76 ..	168·6	228·9	966	142	141,618	145·9	128·2	28·5
1976-77 ..	164·3	136·4	1,646	160	209,115	136·9	82·5	37·7

deflated by the wholesale price index (1970-71 = 100) so as to eliminate the influence of inflationary trends.

Since the model being a system of equations involves simultaneity, 2SLS estimation procedure was employed. Both linear and log linear forms were attempted. But only the linear form emerged as the better fit.

The estimated equations are presented below:

$$Q_t = \underset{(3.41)}{78.3412} + \underset{(1.16)}{0.1363P_{t-1}} + \underset{(3.71)}{0.0436R_t} + \underset{(0.20)}{0.0293CI}$$

$R^2 = 0.7090$ Degrees of freedom = 7.

$$CI = \underset{(6.14)}{67.3524} + \underset{(2.02)}{0.4456I_t} + \underset{(4.82)}{0.0004X_t} + \underset{(1.09)}{0.2623CR_t}$$

$R^2 = 0.9006$ Degrees of freedom = 7.

$$CR = \underset{(0.23)}{8.6273} + \underset{(3.29)}{0.667P_{t-1}} + \underset{(0.05)}{0.04080T}$$

$R^2 = 0.5776$ Degres of freedom = 8.

(Figures in brackets denote computed 't' values.)

All the three estimated equations emerge as good fits, in terms of fairly high R^2. Further, all the estimated coefficients of the explanatory variables in each equation have the theoretically expected signs. For example, the signs of lagged price, rainfall and cropping intensity are all positive, indicating that changes in these variables have positive impact on aggregate production level. However, the significance of these estimated coefficients could not be tested since the 't' values obtained through 2SLS are not very reliable.

Similarly in the second equation with cropping intensity as the dependent variable, the signs of the coefficients of credit per hectare, irrigation intensity and extension are positive. In the last equation with credit per hectare as the dependent variable, the lagged price variable, representing the profitability has the positive sign. But, the sign of the variable, the overdue position of the PACs has the negative sign, confirming adverse influence on the dependent variable.

Expressed in terms of all exogenous variables, the reduced form of the equation with aggregate production level as the dependent variable, is as follows:

$$Q_t = 82.7524 + 0.1363P_{t-1} + 0.0436R_t + 0.0131I_t + 0.000012X_t - 0.01072O_t$$

The coefficients of the variables indicate the magnitudes of their respective contribution at the margin to aggregate production. For example, a rise in the price index lagged by one year by a point, given other things, would at the margin lead to an increase in the production index by 0.14 point. Similarly, an increase in rainfall by 10 mm. in the season, other things remaining the same, would at the margin lead to an increase in production by 0.4 point. As regards extension services, an increase in expenditure by an amount of one million rupees, holding other things constant, would at the margin result in a twelve point increase in the aggregate production index. On the other hand, an increase in the overdues position of the PACs by 10 points would lead to a decline in agricultural output by 1.1 point.

IV

CONCLUSIONS

Some important conclusions emerging from the study are:

(*a*) Extension does make a positive contribution to agricultural production. In irrigated agriculture, extension should be of specialised nature such as soil and water management, popularising a suitable cropping pattern depending on soil characteristics and water availability.

(*b*) The supporting role of credit should be recognized. Involvement of other credit agencies such as commercial banks along with co-operatives is essential.

(*c*) The PACs should be provided with secretarial assistance for reducing their overdues through stepping up recoveries.

And (*d*) appropriate price incentives along with the above would also improve production.