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Extension Services and Cotton Productivity: A Case Study of Cotton Maximisation Project in Tharparkar District (Sindh) of Pakistan

Cotton is the most important cash crop in Pakistan. It provides raw material to edible oil industry and textile industry in Pakistan, which dominates the manufacturing sector. It is also an important source of foreign exchange. Given the importance of the crop, in 1976 Pakistan Central Cotton Committee with the financial assistance from the Asian Development Bank launched a special cotton maximisation project in the Provinces of Sindh and Punjab to increase cotton productivity. This study is based on the pooled data set collected for several years during the project. The purpose is to isolate the impact of extension services provided under the project.

The paper briefly reviews the literature and describes the features of the project and data. This is followed by a discussion of the model and results. The last section presents the conclusion.

Review of Literature

The literature has explored the relationship between farm productivity (or productivity per acre) and a wide range of characteristics. These include physical factors such as mechanisation, irrigation, soil type; biological factors like seed rate, cultural practices, inputs like fertiliser and pesticides; socio-economic factors like education, price responsiveness; and institutional factors like land distribution, tax/subsidy/pricing policies, role of extension agencies, etc. In spite of impressive empirical literature, several issues remain unresolved. Two issues are of particular interest to this study, namely, the relation between farm size and productivity and the impact of extension services on yield.

Many earlier studies showed a negative relationship between farm size and productivity (Rudra, 1968; Bardhan, 1973; Bhattacharya and Saini, 1972; Saini, 1979). The explanations for this observed relationship were provided in terms of higher intensity, use of relatively more efficient family labour and self-cultivation by small farmers. On the other hand, it has also been argued that the large farmers have higher productivity because they have better access to factors of production, irrigation water, credit, technical knowledge, etc. (Falcon and Gotsch, 1968; Khan, 1979). Mahmood and Haque (1981) found the small and large farmers to be more efficient than the medium size farmers. Hayami and Ruttan (1977) found no significant relationship between productivity and farm size while Hoque (1988) found the medium size farms to be the most efficient. In all the above studies, productivity was measured as gross value product which is the sum of value of all that was produced on the farm. This might have a tendency to offset the comparative advantage in one crop with the disadvantage in other crops.

The second issue which is the primary concern of this study is the effectiveness of extension services. Extension service is one factor to promote productivity, primarily by disseminating knowledge regarding cultural practices, new varieties, optimal use of agro-chemicals, irrigation, etc. The effectiveness of extension services has been evaluated in terms of (*i*) organisational efficiency and (*ii*) economic efficiency.

The literature on organisational efficiency has been very critical about the usefulness of extension services (Rice, 1971; Moris, 1966; Rahim, 1966; Kabure, 1979; Moore, 1984;

Jaiswal, 1983; Howell, 1982). Major criticism in this area focuses on institutional and logistic difficulties encountered by agents and inappropriate economic incentives to them which lead to a lack of motivation. Also weaknesses in other support institutions like credit availability, easy access to the recommended inputs, inequitable distribution of land, etc., have resulted in limiting the potential of extension services.

The literature on economic efficiency of extension services has reached mixed conclusions. Those who have used cost-benefit analysis have generally estimated high to moderate internal rates of return (Araji *et al.*, 1978; Feder *et al.*, 1987; Barletta, 1967; Akino and Hayami, 1975). Such studies, in general, tend to over-estimate the benefits because they generally do not isolate the contribution of extension services on productivity from other influences.

Another approach to evaluate the effectiveness of extension services is to relate the expenditure on research and extension to productivity improvements at an aggregate level (Evenson and Kislev, 1976; Huffman, 1978). Studies in this area generally find significant correlation between expenditure on research and extension and productivity. However, as Orivel (1983) pointed out there is a problem of identification of causality. It is not obvious whether high productivity is the result of high expenditure on research and extension or higher productivity levels could make it possible to allocate larger funds for extension and research.

The third approach is to compare the yield of a given area before and after the establishment of extension services or compare the yields between areas with and without extension services (Benor and Harrison, 1977; World Bank, 1977). These studies also generally tend to over-estimate the contribution of extension services because they do not isolate the increase in yield exclusively due to extension services.

Still another approach which has been used to evaluate the impact of extension services on productivity is to estimate production functions. These studies use the farmer as the unit of observation with special variables included in the production function accounting for the difference in productivity due to extension services. Since this approach as compared to the above three approaches, attempts to isolate the impact of extension services from other influences, the contribution seems to be rather moderate (Patrick and Kehrberg, 1973; Moock, 1973; Hong, 1975; Halim, 1976; Baidya *et al.*, 1980; Feder, 1987).

Survey Design and Data Collection

In the Province of Sindh the extension network under this project was initially established in Hala and Sakrand in 1976. Sometime later the World Bank launched a Training and Visit (T&V) project in the same area, therefore this project was shifted to another area. Tharparkar district which has about 241 thousand acres under cotton was chosen for this purpose and the extension network was established in the year 1981-82. It may be mentioned that most of the irrigated areas of Tharparkar district lie at the tail-end of the irrigation system with frequent water shortage. Groundwater in these areas is not suitable for crops. Parts of Mirpurkhas, Mirwah, Daulat Laghari, Wali Muhammad Shah and Shadi Pali talukas of Tharparkar district were covered by the project. However, after four years it was felt that the objective of the project has been achieved and it was decided to shift it to new areas in the same district. The following talukas were chosen: Mirpurkhas, Kot Ghulam Muhammad, Samaro, Umer Kot and Dhoro Naro.

The extension services designed under this project had elements of both the traditional extension services and relatively new Benor-type T&V system. The total area covered by the project was about 50,000 acres. Five cotton development officers (CDOs) were assigned 10,000 acres each. Ten field assistants were assigned to each CDO. Each of the field assistants was supposed to provide services to all farmers in his assigned area of 1,000 acres. He was required to visit each of his contact farmers once every week throughout the crop season. He was required to provide advice on all matters related to cotton production including efficient use of inputs, cultural practices, better seeds and optimal use of agro-chemicals. However, as against the traditional extension services, he was not supposed to supply credit or any other input like fertiliser, seed, pesticides, etc., to his contact farmers. CDOs were supposed to make frequent field visits and also maintain offices where contact farmers can approach them with their specific problems.

To evaluate the impact of the project, two samples of farmers were drawn: one from pre-assigned project area and the other drawn from the non-project area (within the same talukas lying adjacent to the project area). It was done to ensure that the two areas remain closely comparable with regard to ecological characteristics and cultural practices in order to facilitate direct comparison of yields. It may be mentioned here that the project area was not selected randomly. The bench-mark study reveals that the project area had some advantages over the non-project area specially in terms of availability of irrigation water. It may also be mentioned here that the selection of the cotton growing area adjacent to the project area may lead to under-estimation of the impact because of the 'spill-over' effects to the non-project area where the fellow farmers learn from the contact farmers in the neighbourhood.

In order to minimise the recall error, field interviews were conducted three times in the crop season: immediately after the first irrigation; after ball-forming; and finally after the picking operation. However, instead of repeat observations on the same set of respondents, a different set of respondents was selected at each of the three visits except for a few farmers who were covered throughout the season. Therefore, while some information was collected from a large set of farmers, information for the entire season is available only from a subset of the respondents. The data pertaining only to this subset form the basis of the present study.

The data collected for three years, *viz.*, 1983-84, 1984-85 and 1985-86 have been combined. It consists of 301 observations in all (195 from the project area and 106 from the non-project area). The farmers from the project area were selected through stratified random sampling with farm size as the stratum. However, the farmers from the non-project area could not be selected on the basis of scientific sampling because complete listing of the farmers from the non-project area was not available. Only 282 observations could be used as nineteen observations were dropped.

Model and Results

Production function is a technological relationship between output, production inputs and production environment. The yield differential between project and non-project areas could be due to increase in the use of the quantity of inputs-embodied productivity differential and because of the improvement in the knowledge of the efficient use of the inputs-disembodied productivity differential (Feder *et al.*, 1987). The disembodied productivity differential is captured by including a dummy variable for the project/non-project area in the model as the two areas are adjacent to each other and the production environment may be assumed to be ecologically comparable. Since the two areas are slightly different with regard to the accessibility to irrigation water, it has been explicitly accounted for in the model. More specifically, the following model has been estimated.

$$\begin{aligned} \text{LYIELD} = \beta_0 &+ \beta_1 (\text{LLABOR}) + \beta_2 (\text{LFERT1}) \\ &+ \beta_3 (\text{LFERT2}) + \beta_4 (\text{SPRAY}) \\ &+ \beta_5 (\text{SHARE}) + \beta_6 (\text{DAMAGE}) \\ &+ \beta_7 (\text{SIZE1}) + \beta_8 (\text{SIZE2}) \\ &+ \beta_9 (\text{IRRIG}) + \beta_{10} (\text{D}) \end{aligned}$$

where

LYIELD = log of cotton yield (maunds per acre),
LLABOR = log of man-hours input per acre,
LFERT1 = log of the quantity of nitrogen and phosphate (kg. per acre) used at sowing time and/or at *banjoo* (*i.e.*, first irrigation).
LFERT2 = log of the quantity of nitrogen and phosphate (kg. per acre) used after *banjoo*,
SPRAY = intensity of spray computed as $\left(\sum_{i=1}^{4} ASCP_i / TCOTAC\right)$, where $ASCP_i$ is the total acres sprayed i times and TCOTAC is the total area under cotton,
SHARE = ratio of share-cropped area under cotton to the total cropped area under cotton,
DAMAGE = percentage loss due to rain and/or pest attack,
SIZE1 = 1 if total area under cotton is between 12.5-25.0; 0 otherwise,
SIZE2 = 1 if the total area under cotton is greater than 25 acres; 0 otherwise,
IRRIG = 1 if the total number of irrigations is less than 3; 0 otherwise,
D = 1 if the observation belongs to the project area; 0 otherwise.

Regression estimates of the model are presented in Table I. All the variables have taken the expected signs. Fertiliser at sowing or *banjoo* time contributes more than its applications later. Spray intensity which is defined as the average number of sprays during the season turns out extremely significant.

TABLE I. REGRESSION RESULTS

Independent variable (1)	Coefficient (2)	t (3)	Sig t (4)
LLABOR	0.17737	3.239	0.0013
LFERT1	0.06991	2.790	0.0056
LFERT2	0.04049	0.841	0.4011
SPRAY	0.21767	5.519	0.0000
SHARE	-0.58152	-2.455	0.0147
DAMAGE	-0.01181	-7.448	0.0000
SIZE1	0.26349	2.235	0.0262
SIZE2	-0.11484	-1.116	0.2655
IRRIG	-0.29463	-1.470	0.2524
D_1	0.14700	1.695	0.0913
Constant	1.09287	4.263	0.0000

Adjusted R^2 = 0.34
Standard error = 0.66
Number of observations = 282

There is sizable literature on the relative efficiency of resource use under share-cropping vs other arrangements. One group of economists contend that share-cropping leads to relatively inefficient use of resources (Marshall, 1966; Bardhan and Srinivasan, 1971; Bell and Zusman, 1976; Bell, 1977). The other group argues that under certain conditions share-cropping is equally efficient compared to other institutional frameworks (Cheung, 1968; Newberry, 1973, 1975, 1977; Stiglitz, 1974; Nabi, 1986). Our results show a negative significant coefficient which means, the larger is the share-cropped proportion the smaller is the yield. Irrigation variable takes the correct sign, implying that the farmers facing irrigation problems have lower yields. However, it did not turn out significant.

The relation between cropped area and productivity indicates that the medium size farmers are more efficient while there is not much difference between the small and large farms. Most of the earlier studies show either the large farms or the small farms to be more efficient. However, a recent study by Hoque (1988) reaches the conclusion that the medium size farms are the most efficient ones. A possible reconciliation may be that the medium size farmers are the major beneficiaries of the spread of technical knowledge.

The coefficient of the dummy variable, which represents the disembodied productivity differential between the project and non-project areas, turns out positive and significant. It shows that if the farmers in the project and non-project areas use the same quantities of physical inputs and face the same production environment with regard to share-cropping, farm size, pest attack, irrigation, spray intensity as proxied by the variables in the regression equation, then the farmers in the project area have productivity which is higher by 15.8 per cent (*i.e.*, $e^{.14700} = 1.1583$) than the non-project farmers.

Conclusion

The primary purpose of the study is to 'isolate' the disembodied productivity improvement due to extension services. Cobb-Douglas type production function with constant returns to scale has been estimated with disembodied productivity differential proxied by a dummy variable. It has been found that extension services have improved the productivity of cotton by about 16 per cent. Our study also indicates that the medium size farmers are relatively more efficient than the small or large farmers.

Any productivity gains should be seen against the cost of the programme. The yearwise total costs of this programme are given below:

Year (1)	Total cost of the programme (million Rs.) (2)
1983-84	1.72
1984-85	2.00
1985-86	2.62

Source: FAO (1989).

Finally, it may be mentioned that the above results are subject to limitations and therefore should be interpreted with caution. For instance, these costs do not include the private costs which might have been incurred in improving the inputs as a result of the advice from extension services. Similarly, the knowledge imparted by the programme should have spilled over to the neighbouring areas and presumably a significant part of it would have been retained permanently.

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