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to reap all the benefits of bulk sales. Pooling of the produce also enables the co-operatives to grade their members' produce before offering the same for sale. The regional units of SFDA may consider the possibility of promoting co-operation among small farmers. The Agricultural Produce Market Committees could exempt the lots offered for grading from the payment of grading fee so that this can act as an incentive to the small farmers to take to grading. Besides, propaganda and publicity regarding the benefits of grading may be stepped up by the market committees so that the small farmers could grade their produce at the farm level itself.

The warehousing corporations may consider the reduction of storage charges to small lots so that the small farmers may be enabled to hold their produce for a better market by storing it in warehouses. Bank advances on easy terms may also be extended against warehouse receipts to the farmers who use warehouses for storing small lots.

Among the buyers in a regulated market, there are always some whose turnover is small and who are interested in buying small lots. The market committee could consider the proposition of arranging direct sales (without the seller having to engage the services of a commission agent) of small lots to the buyers. For this purpose, special platforms may be earmarked in the market yard for such sales. On these platforms, the market committees could also grade and group the small lots belonging to particular grades for sale, which will give the small farmers the benefits of bulk sale and also grading.

COMPARATIVE ANALYSIS OF SMALL FARMERS ADOPTING NEW TECHNOLOGY AND NON-ADOPTERS IN WEST GODAVARI DISTRICT*

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In India, farming is the major occupation supporting about 75 per cent of the working force. But the average size of the operational holding is small and the distribution is uneven. The number of small holdings of 2 hectares and less is about 62 per cent of the total number. But the area cultivated is less than 20 per cent of the total cultivable area. Thus, the numerically strong but economically weak section of our rural community consists of small farmers owning less than 2 hectares. With modern technology, it is now possible to convert even small farmers into economically viable units by use

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of the inputs like fertilizers and by diversifying the farmers' activities. The problems faced by the small farmers differ from area to area. But, on the whole, fragmentation of holdings, insecurity of tenure, lack of sufficient credit facilities for inputs and arrangements for marketing and storage are the common difficulties standing in their way in deriving the benefits of the improved technology.[1]

The Fourth Five-Year Plan emphasized the participation of small and marginal farmers and agricultural labourers in the process of development and to share its benefits. In pursuance of this objective, two projects, namely, Small Farmers' Development Agency (SFDA) and Marginal Farmers and Agricultural Labourers (MFAL) were initiated. These two projects are supposed to extend assistance to the small farmers and marginal farmers to take up schemes like land development, soil conservation, minor irrigation, horticulture, subsidiary occupations like dairy, poultry, piggery, etc., and for adoption of improved agricultural practices. Some economists[2] felt that these agencies are not really helping the small farmers, instead they are helping the better off farmers at the cost of the small farmers. The performance of the SFDA programme indicates that the projects included in the early stages of the SFDA programme were inadequate to solve the problems of the small farmers; these have since then improved upon. The National Commission on Agriculture had also presented a few interim reports on programmes to be taken up for the small and marginal farmers and agricultural labourers in the Fifth Plan.

The new technology revolving around the use of high-yielding varieties of seeds is most suitable for the adoption in those parts of the country where there are reliable irrigation facilities or the rainfall is reasonably assured. However, there are conflicting views on the adoption of new technology and its effect on different size of holdings and even within the same size of holding. On the one hand, it is argued that in areas where it is feasible to propagate new technology, its extensive coverage in terms of spread over all the farms, irrespective of the size, is advocated because new technology is assumed to be neutral to scale and there are some who contend that basically the new technology is neutral to the scale of farming as large holdings are not needed in the interests of higher production.[3] On the other hand, many studies concluded that the size of holding was a significant factor affecting the adoption of new technology.[4] Some writers expressed their fears about new technology

1. M. A. Quraishi, "New Vistas for the Small and Marginal Farmers," *Agricultural Situation in India*, Vol. XXIX, No. 5, August, 1974, pp. 287-288.
2. For example, see N. S. Jodha, "Special Programmes for the Rural Poor—The Constraining Framework," *Economic and Political Weekly*, Vol. VIII, No. 13, March 31, 1973, pp. 633-639, and H. Laxminarayan, "Small Farmers Development Agency—A Note," *Economic and Political Weekly*, Vol. VIII, No. 17, April 28, 1973, pp. 306-307.
3. For example, see M. L. Dantwala, "Towards an Efficient and Just Land Systems," *Yojana*, Vol. XIII, No. 23, November 30, 1969.
4. For example, see Rapporteur's Report on "Institutional Credit for Agriculture," *Indian Journal of Agricultural Economics*, Vol. XXVI, No. 4, October-December, 1971, pp. 451-586.

being responsible for widening the gap between the small and large farmers.[5] In this study, an attempt is made to compare the performance of the small farmers adopting new technology and the non-adopter small farmers.

Objectives

More specifically, the objectives of this study are (1) to compare the performance of small farmers adopting new technology in 1967-68 with those in 1970-71 and also with the non-adopters; and (2) to compare the resource use efficiency between the adopters and non-adopters in 1970-71.

METHODOLOGY

Data[6]

The data were taken from the Benchmark and Assessment Surveys of the IADP district of West Godavari, conducted in 1967-68 and 1970-71. The former was selected because 1967-68 was the year when the impact of new agricultural strategy launched in 1966-67 was visible on the farm front. The latter was selected because 1970-71 was the latest year for which the data were available. Moreover, both the years were normal years with respect to weather.

Sampling Design

The surveys used a stratified multi-stage random sampling. In the first stage of stratification, the entire district was stratified into 8 strata which correspond the fieldman circles in the district. In the second stage of stratification, all the 8 fieldman circles were further stratified into 16 homogeneous strata which correspond to the existing community development blocks in the district. Then 4 to 6 villages were selected randomiy from each of the blocks. Finally, eight farmers were selected at random from each of the sample villages. The sample farmers were interviewed by trained research investigators during both the *kharif* and *rabi* seasons every year and details of information relating to their farms obtained. In the selected stratified random sample of 400 farmers in each year, the small farmers[7] constituted 177 in 1967-68 and 170 in 1970-71.

Tabular analysis is used to compare the position of the adopter and non-adopter small farmers[8] for both the years in the district. To compare

5 See Rapporteur's Report on "Economic Aspects of High-Yielding Varieties Programme," *Indian Journal of Agricultural Economics*, Vol. XXIII, No. 4, October-December, 1968.

6. The data originally collected and analysis made for the author's Ph.D. thesis, "Income Distribution and Employment Effects of the New Agricultural Technology in the IADP District, West Godavari" is used for this paper.

7. Small farmers as defined by the Assessment Surveys are those having upto 5 acres of cultivable land.

8. Adopters are those farmers who had grown the high-yielding varieties of paddy during the reference years and non-adopters are those farmers who had not grown the high-yielding varieties of paddy during the reference years.

the factor-product relationships and efficiency in the resource use, production function technique was used. Both linear and Cobb-Douglas production functions were fitted on two sets of data :

(A) $Y=a+bX+u$ .. .. (1)

$Y=aX^b\ u$ .. ..(2)

where

Y= gross income from crop production,

X= total cost (excluding family labour and the rental value of the land),

a= constant term,

b= regression coefficient to be estimated, and

u= a random variable.

(B) $Y=a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5+u$ .. (3)

$Y=aX_1^{b_1}\ X_2^{b_2}\ X_3^{b_3}\ X_4^{b_4}\ X_5^{b_5}u$ .. (4)

where Y, a, b_1 and u have the same meaning as above and

X_1= expenditure on seed (Rs.),

X_2= expenditure on fertilizers (Rs.),

X_3= expenditure on irrigation (Rs.),

X_4= expenditure on plant protection (Rs.), and

X_5= expenditure on hired labour (Rs.).

In order to examine the interaction between different inputs, simple correlation matrices for all independent variables are worked out.

RESULTS AND DISCUSSION

Tabular analysis is used to compare the selected characteristics of the adopter small farmers of 1967-68 with those of 1970-71 (Table I). A comparison between the adopters and non-adopters in each year and between these years is also provided by the same analysis.

In 1967-68, the number of adopters was 128 in the selected stratified random sample of 177 small farmers. In 1970-71, the number was 142 out of 170 sample small farmers. The number of non-adopters decreased from 49 in 1967-68 to 28 in 1970-71. About 84 per cent of the small farmers have adopted the new technology in 1970-71 whereas in 1967-68 only 72 per cent of the small farmers had adopted the new technology (Table I). This indicates that adoption has increased from 1967-68 to 1970-71.

TABLE I—COMPARISON OF SELECTED CHARACTERISTICS OF SMALL FARMERS (ADOPTERS AND NON-ADOPTERS) IN 1967-68 AND 1970-71

Particulars	1967-68		1970-71	
	Adopters	Non-adopters	Adopters	Non-adopters
Per cent of small farmers selected from the sample	72	28	84	16
Average size of holding (acres)	2.75	2.00	4.50	3.15
Average cropped area (acres)	4.00	2.50	7.50	4.25
Per cent of area sown more than once	45.45	25.00	66.67	34.92
Per cent of area irrigated	65	52	96	65
Per cent of area under HYV paddy	55	—	92	—
Total current expenditure (Rs./acre) ..	321	202	490	274
Gross income (Rs./acre)	570	309	889	415

Land is the most important resource of the farmers irrespective of the size of holding or the level of technology. As can be seen from Table I, there was no marked difference in the average size of operational holdings of the adopters and the non-adopters within the period, but between the two years there is a marked increase both for the adopters and non-adopters. In 1967-68, the average size of holding was 2.75 acres and 2.00 acres for the adopters and non-adopters respectively. But in 1970-71, it was 4.50 acres and 3.15 acres for the adopters and non-adopters respectively. However, there was a marked difference between the adopters and non-adopters within the year and between the years in the average cropped area. The average cropped area in 1967-68 was 4 acres for the adopters and 2.50 acres for the non-adopters. In 1970-71, it was 7.50 acres for the adopters and 4.25 acres for the non-adopters. The adopters have cultivated their land more intensively than the non-adopters in both the years. In 1970-71, the adopters cultivated more intensively than in 1967-68 (about 67 per cent of their land was grown more than once in 1970-71 whereas in 1967-68 it was only 45 per cent). The area irrigated by the adopters was more than by the non-adopters in both the

years and the area irrigated by the adopters rose to 96 per cent in 1970-71, while it was only 65 per cent in 1967-68.

The area put under HYV of paddy in 1967-68 is only 55 per cent whereas in 1970-71, it was about 92 per cent. This shows that the proportion of area under the HYV paddy on the small farms has been rising, which indicates a reduction of the differences in the proportions of HYV paddy area to the total paddy area between the small and large farms.[9] It is logical to assume that, in the initial years of the programme, it will be the more innovative and enterprising groups (mostly large farmers) who will come forward. By and by, others (small ones) will join in.[10]

The per acre total cost was higher for the adopters in both the years when compared to the non-adopters. There was about 52 per cent increase in the per acre total cost of the adopters from 1967-68 to 1970-71, whereas for the non-adopters it increased by 35 per cent. As expected, the per acre gross income was more for the adopters when compared to the non-adopters for both the years. The adopters' gross income per acre was Rs. 889 in 1970-71 and Rs. 570 in 1967-68, whereas for the non-adopters it was Rs. 309 and Rs. 415 for 1967-68 and 1970-71 respectively.

The above discussion indicates that the small farmers in the study area who adopted the new technology devoted more area under the HYV varieties, spent more money and received more income, in comparison to the non-adopters. This implies that, on the average, the adopters are economically superior to the non-adopters in this district. A comparison of the adopters between the two years indicates that the performance of the adopters in 1970-71 was far better than in 1967-68 and the adoption also increased from 1967-68 to 1970-71. This may be due to the demonstration effects of the HYVP in terms of benefit-cost ratio for individual crops which might have induced more number of small farmers from 1967-68 to 1970-71 to adopt the new technology and raise their incomes.[11]

PRODUCTION FUNCTION ANALYSIS

Comparison of Input-Output Relationship and Resource Use Efficiency

The results of both the linear and Cobb-Douglas functions that were fitted for data set (A), *i.e.*, between gross income from crop production as independent variable and total cost excluding family labour and rental value of land as dependent variable for both the adopters and non-adopters are presented in Table II.

9. C. Muthiah, "The Green Revolution—Participation by Small versus Large Farmers," *Indian Journal of Agricultural Economics*, Vol. XXVI, No. 1, January-March, 1971, p. 57.
10. P. K. Mukherjee, "The HYV Programme—Variables that Matter," *Economic and Political Weekly*, Vol. V, No. 13, March 28, 1970.
11. V. T. Raju, "Income Distribution and Employment Effects of the New Agricultural Technology in the IADP District, West Godavari." unpublished Ph.D. thesis, Department of Agricultural Economics, G. B. Pant University of Agriculture and Technology, Pantnagar, 1973, p. 114.

TABLE II—RESULTS OF LINEAR AND COBB-DOUGLAS PRODUCTION FUNCTIONS FOR ADOPTERS AND NON-ADOPTERS FOR 1970-71

Particulars	Constant(a)	X	R^2
Linear function			
Adopters	1.1052	12.0065*** (4.7084)	0.85
Non-adopters	5.4871	4.5072** (2.4005)	0.61
Cobb-Douglas function			
Adopters	1.5227	2.7951*** (0.6202)	0.87
Non-adopters	6.7963	0.9504** (0.4527)	0.65

Note : Figures in brackets are the standard errors of the coefficients.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
X = Total cost of crop production (excluding family labour and rental value of land).

It is evident from the above table that total cost is significantly related to gross income for the adopters as well as the non-adopters. The estimated coefficients have the expected sign in all cases. While the coefficient is significant at the one per cent level for the adopters in both the functions, for the non-adopters it was significant at the 5 per cent level. It means that the coefficient of total cost is more significantly related to gross income for the adopters when compared to the non-adopters. The coefficient of determination (R^2) shows that 85 per cent (linear) and 87 per cent (Cobb-Douglas) of variation in the gross income of the adopters is explained by the effect of the independent variable, whereas in the case of non-adopters, 61 per cent (linear) and 65 per cent (Cobb-Douglas) of variation in the gross income is explained by the effect of independent variable, that is, total cost.

The elasticity of production in the Cobb-Douglas function and the marginal value productivity of inputs in the linear function are given in Table III.

TABLE III—ELASTICITY OF PRODUCTION AND MARGINAL VALUE PRODUCTIVITY OF INPUT FOR ADOPTERS AND NON-ADOPTERS

Particulars	Adopters	Non-adopters
Elasticity of production	2.7951	0.9504
Marginal value productivity	12.0065	4.5072

The coefficient of Cobb-Douglas function directly gives the elasticity of production, which indicates the percentage change in output if input is increased by one per cent. Thus with one per cent change in the total inputs, the estimated gross income for the adopters is more than that for the non-adopters. For instance, the increase in the gross output for the adopters with one per cent change in inputs, comes to 2.80 per cent whereas for the non-adopters it is only 0.95 per cent. The coefficient of linear function directly gives the marginal value product for inputs, which reveals that on the adopters' farms, the marginal return for each rupee spent on inputs is higher as compared to the marginal return on the non-adopters' farms. Based on these results it is concluded that the resource use is more efficient on the adopter small farmers than on the non-adopters.

In order to see the influence of different inputs, *viz.*, seed, fertilizer, irrigation, plant protection and hired human labour on gross income, functions were fitted taking these as independent variables and total gross income as dependent variable and the results are presented in Table IV.

TABLE IV—ESTIMATES OF LINEAR AND COBB-DOUGLAS FUNCTIONS OF DIFFERENT INPUTS ON OUTPUT FOR ADOPTERS AND NON-ADOPTERS FOR 1970-71

Particulars	Constant (a)	X_1	X_2	X_3	X_4	X_5	R^2
Linear function							
Adopters	1.0075	2.9087† (1.0259)	3.7590† (1.2075)	3.0625† (1.1005)	1.9506‡ (0.9572)	2.0400‡ (0.9975)	0.81
Non-adopters	4.5805	0.9572 (1.4605)	1.0720* (0.6475)	0.8900* (0.4995)	0.0567 (0.8409)	0.7504 (0.9085)	0.64
Cobb-Douglas function							
Adopters	1.2709	1.1198† (0.3905)	2.5025† (0.2079)	1.9567† (0.7505)	0.8402‡ (0.3004)	0.9054† (0.3175)	0.85
Non-adopters	5.0524	0.4502 (1.0725)	0.5210‡ (0.2570)	0.4905‡ (0.2395)	0.0275 (0.1906)	0.5045 (0.7970)	0.67

Note : Figures in brackets are the standard errors of the coefficients.
† Indicates the significance level at 1 per cent.
‡ Indicates the significance level at 5 per cent.
* Indicates the significance level at 10 per cent.
X_1, X_2, X_3, X_4, X_5, represent expenditure on seed, fertilizer, irrigation, plant protection and hired human labour respectively.

As can be seen from Table IV, all the coefficients exhibited the expected positive sign for both the linear and Cobb-Douglas functions of the adopters and non-adopters. The coefficient for seed (X_1) both in the linear and Cobb-Douglas functions is statistically significant at the one per cent level for the adopters. In the case of non-adopters it is not significant. The coefficient of fertilizer (X_2) is statistically significant at the one per cent level for the adopters while it is significant at the 10 per cent level (linear) and 5 per cent level (Cobb-Douglas) for the non-adopters. The coefficient of irrigation (X_3)

has similar significance level as that of fertilizer. The coefficient for plant protection (X_4) is significant at the 5 per cent level for the adopters while it is not significant in the case of non-adopters. The coefficient of hired human labour (X_5) is statistically significant for the adopters at the 5 per cent level in the linear function and at the one per cent level in the Cobb-Douglas function. But it is not significant for the non-adopters.

The above discussion reveals, that all the inputs included in the function, *viz.*, seed, fertilizer, irrigation, plant protection and hired human labour contributed significantly for the gross income of the adopters. The high R^2 values 0.81 in the case of linear and 0.85 in the case of Cobb-Douglas indicate that most of the variation in the gross income is explained by these inputs. In the case of non-adopters, mainly fertilizer and irrigation contributed for the gross income. The coefficient of determination (R^2) for the non-adopters shows that 64 to 67 per cent of the variation in the gross income is explained by the inputs included in the function.

The high multi-collinearity between fertilizer and irrigation (0.75) in the case of adopters indicates high complementarity between these two variables. Multi-collinearity is not necessarily a problem unless it is high relative to the overall degree of multiple correlation (R) among all variables simultaneously.[12] In this case the value of simple correlation coefficients (r) between fertilizer and irrigation which is 0.75 is smaller than the value of coefficient of multiple correlation which is 0.92. So the functions can be taken as not marred by multi-collinearity and may be used for analysis without apprehensions regarding spurious results.

Similar to Table III, Table V records the elasticity of production and marginal value productivity of inputs which are taken directly from the coefficients of Cobb-Douglas and linear functions respectively.

TABLE V—ELASTICITY OF PRODUCTION AND MARGINAL VALUE PRODUCTIVITY OF INPUTS FOR ADOPTERS AND NON-ADOPTERS

Particulars	X_1	X_2	X_3	X_4	X_5
Adopters					
Elasticity of production	1.1198	2.5025	1.9567	0.8402	0.9054
Marginal value products	2.9087	3.7590	3.0625	1.9506	2.0400
Non-adopters					
Elasticity of production	0.4502	0.5210	0.4905	0.275	0.5045
Marginal value products	0.9572	1.0720	0.8900	0.0567	0.7504

12. L. R. Klein: An Introduction to Econometrics, Prentice Hall, Inc., Englewood Cliffs, N. J., U.S.A., 1973, p. 101, and C. F. Christ : Econometric Models and Methods, Wiley Eastern Pvt. Ltd., New Delhi, 1970, pp. 387-390.

The data in Table V show that with one per cent increase in seeds the production will increase by 1.1 per cent for the adopters and by 0.4 per cent for the non-adopters. One per cent increase in fertilizer will increase the output by 2.5 per cent for the adopters and by 0.5 per cent for the non-adopters. If irrigation is increased by one per cent the adopters are going to get an increase of about 1.9 per cent in their output whereas the non-adopters will get only 0.5 per cent increase. In the case of plant protection one per cent increase will increase the output by 0.8 per cent for the adopters and by 0.03 per cent for the non-adopters. One per cent increase in hired labour will increase the output of the adopters by 0.9 per cent and by 0.5 per cent for the non-adopters. The marginal value productivities of all the inputs indicates that on the adopters' farms the marginal return for each rupee spent on all inputs, namely, seed, fertilizer, irrigation and plant protection is higher compared to the marginal return on the non-adopters.

CONCLUSIONS AND POLICY IMPLICATIONS

Based on the results of this study, the following conclusions are made:

(1) The rate of adoption of new technology by the small farmers was increased from 1967-68 to 1970-71 in West Godavari district. (2) The small farmers who adopted the new technology were economically better off when compared to the non-adopters. And (3) the resource use was more efficient in the case of the small farmers who adopted the new technology than the non-adopters.

The above conclusions suggest that through the adoption of new technology the small farmers may improve their economic position. However, it is necessary to bear in mind that the results presented and conclusions drawn are based on the study of IADP district where the Government took special interest and invested much on infrastructure facilities and other services such as tubewells, fertilizers, credit, marketing, extension and training, etc., which enabled all size-groups of farmers to benefit from the new technology. Since these facilities and services increased both in quantity and quality from 1967-68 to 1970-71, inequality in the rates of adoption of new technology between the small and the big farmers dropped.[13] This may not be true in the non-IADP areas. So it is necessary to see the performance of small farmers adopting new technology in such areas. Before advocating the adoption of new technology for increased production and for improvement of economic position in poor areas, the provision of irrigation, fertilizers, improved seeds, timely and adequate availability of credit should be assured especially for the small farmers.

13. V. T. Raju, *op. cit.*, p. 112.