# SOME ASPECTS OF THE SUITABILITY OF HIGH YIELDING RICE AND BAJRA VARIETIES FOR THE SMALL FARM, THANJAVUR AND MEHSANA DISTRICTS, INDIA

By

Michael G. G. Schluter

and

Richard W. Longhurst

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## I.

## Introduction

In the mid 1960's, newly-developed high-yielding varieties of seed of all the basic food grain crops were introduced in India. The new strains had been developed as part of a national effort to raise production of basic food grain crops. In order to evaluate farmers' response to the new rice and bajra varieties, the Indian Institute of Management at Ahmedabad undertook an intensive study of two districts -- Mehsana District in Gujarat for a study of hybrid bajra, and Thanjavur District in Tamil Nadu, for a study of ADT-27, a new high-yielding rice variety. In each district, use of inputs, yields and prices were collected from approximately 60 farmers who had adopted the new varieties of seed on some part of their acreage, and approximately 40 who had grown only the traditional varieties. The Institute has kindly made the data from these surveys available for additional analysis. The main findings are summarized in earlier publications (1,3).

The available data are used here for three purposes. In section II, we use a regression framework to examine factors affecting the extent of adoption of ADT-27 in Thanjavur. This is supplemented in Section III by comparative production function analysis of ADT-27 and traditional rice varieties. In section IV, hybrid and local bajra are compared, again with production function analysis. In the final section, we assess ADT-27 and hybrid bajra as to their suitability for the small farmer.

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[1] Department of Agricultural Economics, Cornell University and Economics Department, World Bank, respectively. The views expressed and the facts stated in this publication are the sole responsibility of the authors and do not necessarily represent the views of the above organizations. Thanks for the development of this paper are gratefully accorded to Professors John Mellor, Timothy Mount, and William Tomek of Cornell University and to Dr. D. K. Desai, Indian Institute of management, Ahmedabad.

II.

## FACTORS AFFECTING THE EXTENT OF ADOPTION OF ADT-27 RICE VARIETY IN THANJAVUR IN 1966-67

### Background

The district of Thanjavur is part of a highly fertile deltaic tract of the River Cauvery in Tamil Nadu State in South India and was the District chosen from the State to be part of the Intensive Agricultural District Programme. The high-yielding rice variety, ADT-27, was first introduced in 1965. Two blocks were selected purposefully for study from within the District to reflect differences of soil type, irrigation availability, and transport and communication facilities in the State. The favorable conditions in Kumbakonam block were contrasted with those in Sethubavachatram block. A good and a 'problem' village in each block were selected, based on multiple criteria such as previous familiarity with the strain, farmers' response and officials judgment on their good or otherwise (3, pp.2-4).

### The Regression Model

The dependent variable used was the proportion of the operational holding planted to ADT-27. In a monoculture situation and in an area so intensively cultivated as the Cauvery Delta, this was felt to be reasonable, rather than using the proportion of ADT-27 with respect to the area under all varieties of rice.

The independent variables were selected on the basis of those socioeconomic characteristics of the farmer and his situation, thought to be important as indicated by previous studies (6), and as supplied by the data.

Hence the selected independent variables were:

(1) Operational size of holding, as a measure of extensiveness of farm operation (measured in acres).
(2) The proportion of the operated area which is owned by the farmer, as a measure of the influence of tenancy.
(3) The age of the farmer.
(4) The number of years of education of the farmer.
(5) The number of people in the family labor force: this was thought to be important as there is a period of intensive labor activity over harvesting if double cropping is to be achieved. A measure of hired labor was not used since this may be an ex-post (to adoption) variable.
(6) A dummy variable reflecting the existence of the farmer's nonagricultural source of income; whether he was totally dependent on agriculture or not. (1 = totally dependent, 0 = not totally dependent).

(7) The maximum amount of credit available from the cooperative society in rupees.
(8) The proportion of the farm that is irrigated.

Other variables were examined but not included. It was thought that land revenue and irrigation charges might be a good indicator of the quality of the land. However, such charges are only paid on land owned, so for those farmers who were tenants or leased-in (or out) land, this did not indicate the quality of the holding. Some measure of contact with the extension agent (or village level worker) as an indication of the role of communication media was thought to be desirable and it was thought that whether a farmer had used a farm plan or not might indicate this. However, all who had adopted had made out a farm plan with the village level worker whereas the nonadopters had not. Adopting the new variety was a prerequisite of making such a plan.

The source of irrigation was considered as a variable since Moorti had found that in Uttar Pradesh farmers with private tube well had adopted high yielding wheat varieties more extensively than farmers with only state tube well irrigation (4). However, only three out of the 100 farmers had used a well so this variable was not included in view of the limited information it would provide.

In all villages at least 50 percent of the respondents had adopted ADT-27 so lack of awareness in any one village was not important.

## Results

A log function rather than a linear function was used as it gave a considerably better fit ($r^2 = .45$ as opposed to $r^2 = 0.27$ for the linear function). However, even with a log function less than half the variation in the dependent variable is explained. Therefore, these results must be accepted with some caution.

Table 1

ESTIMATED LOG REGRESSION FUNCTION FOR THE FACTORS INFLUENCING THE EXTENT OF ADOPTION OF ADT-27 IN THANJAVUR DISTRICT, TAMIL NADU IN 1966[1]

| Factor | Regression Coefficient | Standard Error of Coefficient | t Value |
|---|---|---|---|
| Log Farm Size | - 0.3650 | 0.0920 | - 3.9694* |
| Log Farm Ownership | - 0.0624 | 0.0469 | - 1.3308 |
| Log Farmer's Age | 0.0057 | 0.2212 | 0.0257 |
| Log Farmer's Education | - 0.0016 | 0.0332 | - 0.0469 |
| Log Family Labor Force | - 0.1232 | 0.0395 | - 3.1174* |
| Log External Occupation (Dummy) | - 0.1694 | 0.0891 | - 1.9010** |
| Log Credit Limit | 0.0056 | 0.0157 | 0.3587 |
| Log Irrigation | 0.4247 | 0.3640 | 1.1670 |
| Constant | - 0.2088 | | |

$r^2$ = 0.45
* Significant at 0.5 percent level
** Significant at 5 percent level

1 See Table 5 in the Appendix for the results of the linear regression model.

First, it is clear that the proportion of acreage under ADT-27 decreases as farm size increases. A number of explanations may be advanced to explain this finding.

Large farmers may have been facing problems in obtaining labor. Adoption of ADT-27 is most attractive under conditions in which it facilitates a change to double cropping. In 1967 alone, 0.88 lakh hectares of land out of 3.6 lakh hectares under Sambha were converted to double-cropping. The possibility of changing from a single rice crop to a double crop through adoption of ADT-27 has been spelled out in the Fourth Report of the I.A.D.P:

"As ADT-27 matures in about 105 days, the crop could be followed by another short duration variety of rice. The conversion of Sambha lands which are under a long duration variety of rice requiring 5-6 months to mature into double-cropped land becomes possible with the adoption of ADT-27 variety. The district (Thanjavur) had also identified short duration varieties which were to follow on the Sambha lands" (8).

The change to double-cropping requires an intensive input of labor at the period of harvesting the first crop and sowing the second. Large farmers in Thanjavur may have faced severe problems in obtaining the large amounts of labor necessary to put a substantial acreage under ADT-27, or may have felt there would be acute problems of labor supervision.

If labor shortage is the critical constraint to adoption of ADT-27 on large farms, the introduction of tractors or some other form of mechanization may have the effect of not only increasing gross agricultural output, by facilitating adoption of ADT-27, but may lead to an increase in the annual employment of agricultural laborers. Presumably reallocation of land to the landless could have the same effect. Demand for labor at the peak period would probably not shrink sufficiently to result in a labor surplus at that period, but demand would be increased at other times of the year; weeding and intercultivation, for which tractors are seldom used, have to be perfomred twice instead of once on acreage under ADT-27. This also points to an advantage of ADT-27 for the small farmer, who may increase the utilization of family labor in the nonpeak periods, for weeding and intercultivation.

The significant negative coefficient for family size is rather surprising if the above argument holds, since it indicates that the larger the family size, the smaller the proportion of acreage under ADT-27, with other factors held constant. However, a large family size is a mixed blessing. It certainly provides a greater labor supply for work on the farm, but with more mouths to feed, the head of a household may be less willing to face the additional uncertainty involved in adoption of a new variety. It must also be stressed that the variable used is somewhat inadequate. The number of family workers, without indication of the age-sex structure, gives inadequate information either about the labor equivalent available, or about the size of the family consumption requirements, which may determine the farmer's attitude towards uncertainty.

The significant coefficient for external occupation is best understood in the context of uncertainty. In 1966-67, a considerable degree of uncertainty surrounded adoption of ADT-27. In this year, the variety was introduced for the first time in two of the villages surveyed. Farmers had no experience of

methods of cultivation, and therefore the outcome of adoption must have seemed very uncertain, although the variety was to show its toughness in the poor conditions of this year, 1966-67 (8, p.13).

Against this background, it is particularly interesting to find that those with an external occupation adopted on a significantly greater proportion of their acreage then those without. Those with a nonagricultural job have a steady source of income which is unrelated to their farming activity, and thus are far better equipped to face fluctuations in their farm income.

Other variables in the regression model were not significant in explaining variation in the proportion of acreage put under ADT-27.

## III.

## PRODUCTION FUNCTION ANALYSIS OF ADT-27 vs. TRADITIONAL PADDY VARIETIES IN THANJAVUR IN 1966-67

Further light is thrown on the characteristics of the two varieties by simple production function analysis. We estimated two Cobb-Douglas production functions of the form

$$Y = AX_1^{b_1} X_2^{b_2} X_3^{b_3} \ldots e$$

where

$Y$ = yield of the main product (in kgs.)

$X_1$ = dummy variable for Block (Sethubavachatram/Kumbakonam) = 1 = 2

$X_2$ = Land (in acres)

$X_3$ = Quantity of Seed (in kgs.)

$X_4$ = Quantity of Manure (in 100 kg. units)

$X_5$ = Family Labor (measured as number of family workers)

$X_6$ = Hired Labor (in days)

$X_7$ = Number of Irrigation

$X_8$ = Quantity of Nitrogen (in kgs. of ammonium sulphate nutrient equivalent)

$X_9$ = Quantity of Superphosphate (in kgs.)

$X_{10}$= Quantity of Mixture (in kgs.)

$X_{11}$= Quantity of Pesticides (in kgs.)

The Cobb-Douglas function was selected for ease of economic interpretation. This form implies that unless all inputs are used, yield will be zero, which is clearly unrealistic. For example, some farmers in the sample did not use pesticides, but this did not result in zero yield. However, by attributing to such farmers an extremely small use of pesticides, this difficulty was overcome without serious violation of the data.

Data Availability

Data for all inputs and output were collected in the cross-section survey of 1966. One or two variables needed adjustment for use in a regression framework.

For nitrogen use, data was given in kilograms of ammonium sulphate and kilograms of urea. A kilogram of urea was converted into the quivalent, in nutrient pounds, of ammonium sulphate, by multiplying by a constant which reflected their different nutrient contents. It would have been more satisfactory to have converted urea, ammonium sulphate, superphosphate and mixed fertilizer into their N, P and K equivalents, to have examined the effects of different nutrients on yields. However, at the time of analysis, these data were not available.

The data for use of irrigation water was unsatisfactory. Data indicating the quantity of irrigation water used would have allowed a more precise estimate of the contribution of irrigation water to yields of the two varieties. The number of irrigations also gives no indication of the timing of the irrigation.

Results

The estimated production functions for both the traditional and high-yielding varieties are shown in Table 2.

Table 2: Estimated Cobb-Douglas Production Functions for ADT-27 and Traditional Varieties of Paddy in Thanjavur District, Tamil Nadu, in 1966

| | ADT-27 | | | Traditional | | |
|---|---|---|---|---|---|---|
| Input | Reg 'n Coeffi-cient | Standard Error of Coeffi-cient | t Value | Reg 'n Coeffi-cient | Standard Error of Coeffi-cient | t Value |
| Block | 0.016 | 0.033 | 0.498 | 0.090 | 0.097 | 0.920 |
| Land | 1.103 | 0.106 | 10.337** | 0.261 | 0.171 | 1.525 |
| Seed | -0.137 | 0.095 | - 1.439 | 0.333 | 0.157 | 2.107* |
| Manure | 0.009 | 0.028 | 0.340 | 0.119 | 0.133 | 0.895 |
| Family Labor | -0.055 | 0.026 | -2.117* | 0.016 | 0.085 | 0.184 |
| Hired Labor | -0.104 | 0.064 | -1.637 | 0.249 | 0.122 | 2.042* |
| Irrigation | 0.009 | 0.036 | 0.248 | 0.188 | 0.250 | 0.753 |
| Ammonium sul-phate equiv-alent | 0.042 | 0.024 | 1.784* | 0.005 | 0.043 | 0.112 |
| Super phos-phate | 0.023 | 0.015 | 1.567 | -0.009 | 0.045 | -0.196 |
| Mixture | 0.019 | 0.014 | 1.295 | 0.016 | 0.042 | 0.370 |
| Pesticides | 0.025 | 0.017 | 1.457 | -0.025 | 0.055 | -0.445 |
| Constant | 3.280 | | - | 1.120 | | - |

* Significant at 5 percent level (one-tailed test)

** Significant at 0.5 percent level (one-tailed test)

$r^2$ (unadjusted) = 0.96 $r^2$ (unadjusted) = 0.75

The estimated coefficients for both land and nitrogen are significant at the 5 percent level. The latter result reflects the well-known characteristic of high-yielding varieties, that they respond well to high doses of chemical fertilizers. The coefficient for land is large, as it suggests that a 10 percent increase in acreage under ADT-27, with the same number of irrigations and all other inputs held constant, would lead to an 11 percent increase in yields.

The negative coefficients for seed and hired labor, both rather disconcerting at first sight, must be taken together. As Malya and Madappa commented in the initial report.

> "The reduced seed input (ADT-27) is a measure of the extent to which line planting is accepted. Only when a farmer decides to do line planting does he reduce his seed rate" (3).

Thus we may expect higher yields with less use of seed, other inputs held constant.

This same point is relevant in explaining the negative coefficient for hired labor. Those who had adopted line planting will require less human labor for weeding than those who had sown broadcast. Thus, higher yields are associated with less human labor, with all other inputs held constant.

Line planting was not adopted for the traditional varieties, and thus we find that the coefficients for both seed and human labor are significant. Also, as expected, the traditional varieties do not show a significant response to chemical fertilizers.

ADT-27 is more labor-intensive than traditional varieties, although it is the latter which have a significant coefficient for hired labor in the estimated functions. As noted above, the picture for ADT-27 is clouded by partial adoption of the technique of line planting. If we assume that adoption of ADT-27 is associated with a change to double-cropping, and line-planting is or is not used for both varieties, the total labor input is more than doubled when ADT-27 is adopted, and the utilization of family labor on small farms is doubled.

ADT-27 also involves considerably greater costs of cultivation. This has been found to be true in general for all high yielding varieties (2). Additional capital is required for the purchase of chemical fertilizers, which the estimated functions have shown to respond better on ADT-27. The capital required in this respect will be more than doubled if there is change from a single crop of a traditional variety to double-cropping with ADT-27. The new

seed variety is also more expensive than the old variety. A change to double-cropping will also double or more than double the capital needed to finance hiring of labor for planting and harvesting, though not for weeding and intercultivation since this operation is less time-bound, and may be considerably reduced if line-planting is adopted.

Finally, ADT-27, involves a lesser degree of uncertainty than traditional varieties. The most striking finding of the estimated equations is that 96 percent of the yield variation of ADT-27 is 'explained' by variation in the levels of the physical inputs. Only 75 percent of the yield variations of traditional variations is explained by the model. This suggests that yields of ADT-27 are relatively less prone to fluctuations arising from disease and other factors, which is corroborated by the fourth report of the I.A.D.P. (8, p.13). Small farmers are anxious to reduce the level of uncertainty associated with their agricultural operations, and this makes ADT-27 particularly attractive to them.

## IV.

## PRODUCTION FUNCTION ANALYSIS OF HYBRID VS. TRADITIONAL VARIETIES OF BAJRA IN MEHSANA DISTRICT, GUJARAT IN 1966-67

Hybrid varieties of bajra were first made available on a large scale to farmers in Gujarat State in the kharif season of the 1966-67 crop year. Two talukas in Mehsana district, and two villages from each taluka, were selected purposefully for study on the basis of their demand for credit for use on hybrid varieties. Only four villages in the whole district had at least 15 participants who had demanded credit to grow hybrid bajra. Two of the villages were in Kalol taluka and two in Visnagar. All four villages were included in the survey.

In Kalol, a long period of drought following the early rains resulted in many farmers ploughing under the new seed. Those who did not plough under saved their crop by irrigation. The situation was further aggravated by the appearance of a new pest, locally known as "Dori", which destroyed a large part of the crop.

Hybrid bajra gave 1½ to 2 times the yield of traditional varieties grown by participants in the high-yielding varieties programme. The average size of holding of participants was uniformally greater than of that for nonparticipants. This can be seen in Table 3.

Table 3: Details of Operational Holdings in Four Villages of Mehsana District, Gujarat in 1966-67

| | Kalol | | | | Visnagar | | | |
|---|---|---|---|---|---|---|---|---|
| | Soja | | Mokhasan | | Kamana | | Kansanakuj | |
| | P | NP | P | NP | P | NP | P | NP |
| Average Size | 10.33 | 7.00 | 12.15 | 5.02 | 12.50 | 9.83 | 9.21 | 4.60 |
| Percent owned | 80.77 | 69.14 | 96.35 | 97.60 | 90.06 | 72.35 | 86.55 | 96.30 |
| Percent Irrigated | 69.93 | 51.12 | 73.06 | 83.93 | 35.84 | 34.92 | 42.96 | 44.38 |

P = Participants
NP = Nonparticipants

Source: Derived from (1), pp.38 and 40.

Data Availability

Exactly the same model is used as in Section III, except that two variables - those for fertilizer 'mixture' and pesticides - have been omitted in this model since so few farmers had used them. Also the variable for phosphoric fertilizer was omitted in the equation for traditional bajra since only three farmers had used it. The only other differences is that since data were not available as to the size of the family labor force, a proxy variable was derived from data on the number of family workers by farm size in each taluka, taken from the Census of India, 1961.[2] This may be unsatisfactory; the variable for family labor may be biased downward on small farms, and upward on large farms, since family workers may be expected to put in a greater number of hours of work on small farms. However, family workers on small farms may spend part of their time working as casual labor on other people's farms, which would offset this.

[2] The data is shown in Appendix Table 6.

Table 4: Estimated Cobb-Douglas Production Functions for Hybrid and Traditional Varieties of Bajra in Mehsana District, Gujarat, in 1966

| | Hybrid | | | Traditional | | |
|---|---|---|---|---|---|---|
| Input | Reg'n Coeffi-cient | Standard Error of Coeffi-cient | t Value | Reg'n Coeffi-cient | Standard Error of Coeffi-cient | t Value |
| Taluka | 0.164 | 0.176 | 0.932 | -0.211 | -0.0868 | -2.432** |
| Land | 0.294 | 0.248 | 1.186 | 0.570 | 0.238 | 2.395** |
| Seed | 0.307 | 0.227 | 1.352 | 0.312 | 0.219 | 0.601 |
| Manure | 0.052 | 0.097 | 0.548 | 0.059 | 0.035 | 1.724* |
| Family Labor | 0.672 | 0.654 | 1.028 | 0.015 | 0.581 | 0.025 |
| Hired Labor | 0.017 | 0.094 | 0.185 | 0.014 | 0.051 | 0.278 |
| Irrigation | 0.008 | 0.024 | 0.323 | 0.101 | 0.046 | 2.178** |
| Ammonium Sul-phate equiv-alent | 0.048 | 0.040 | 1.207 | 0.042 | 0.048 | 0.375 |
| Super Phos-phate | 0.020 | 0.029 | 0.684 | - | - | - |
| Constant | 14.29 | - | - | 34.88 | - | - |

* Significant at 5% level

** Significant at 0.5% level

(unadjusted) $r^2$ = .31 (unadjusted) $r^2$ = .59

Results

A far greater degree of uncertainty surrounded the cultivation of the new variety than traditional varieties. A much lower proportion of variation of yields is explained by the regression for the hybrid relative to the traditional varieties (.3 relative to .6). The low R-Squared for the hybrid varieties suggests that yields fluctuated widely between farmers using similar input levels, which in turn suggests that knowledge about methods of cultivation was lacking. The relative uncertainty with respect to yields of the new varieties may be one reason why the average farm size of participants was greater than that of nonparticipants (7).

Several additional points may be made about the labor and capital requirements for hybrid bajra. Desai and Patel in their earlier work with these data found that hybrid bajra did not require markedly greater expenditure on hired labor (1). The only reason why the hybrid variety may require additional labor is for harvesting and threshing the additional yield. This is similar to the finding for the paddy varieties in Thanjavur, and Parikh and Sevak have shown that this also applies for high-yielding wheat varieties in Kaira District (5,pp. 48-50). However, as mentioned earlier, small farmers may obtain employment on other farms at the time of harvesting, so hybrid bajra may not increase his overall annual employment. Also, since harvesting of crops is often time-bound owing to fear of theft or spoilage, even a small farmer may have to hire labor to harvest the increased field.

Hybrid bajra involves higher costs of cultivation for two additional reasons. To obtain high yields, a greater input of both irrigation water and chemical fertilizers is necessary. The greater cash expenditure on hybrid relative to traditional bajra varieties in Mehsana in 1966-67 can be seen in Appendix Table 7.

The second of the estimated equations shows very much what we would expect for traditional varieties grown under partly irrigated conditions. Acreage under the crop, the number of irrigations, and the quantity of manure applied are all significant variables in explaining yield variation between farmers. Chemical fertilizers are not significant, although we must add that the level of use was extremely small. The coefficient for hired labor is not significant, although it was for traditional paddy varieties, which suggests that the labor input is not as critical for bajra as for paddy, or that the impact of additional labor on the yield level is less precisely identified.

Finally, we may note that for the traditional varieties, yields were significantly higher in Kalol than in Visnagar taluka, by a margin of about 20 percent. Unfortunately, no data are available to explain this finding.

V.

## CONCLUSIONS

The two innovations under study, ADT-27 in Thanjavur and hybrid bajra in Mehsana, are totally different when evaluated on three criteria of suitability for the small farmer.

### Uncertainty

For bajra, the hybrid variety involved a higher degree of uncertainty than the local variety whereas for paddy, the opposite is of the case. We may also note that the paddy varieties both involve less uncertainty than the bajra varieties. This is probably due to lack of water control for growing the latter. In Thanjavur, all farmers have access to canal irrigation facilities, whereas in Mehsana there is no canal irrigation and many farmers are dependent only on rainfall. The low assets and incomes of small farmers make it difficult for them to sustain fluctuations in their income. Thus, the uncertainty involved in adoption of new varieties like hybrid bajra may have been an important factor in the relatively slow adoption on small farms.

The finding that farmers with external sources of income are likely to adopt more extensively also underlines the fact that uncertainty may be a factor in adoption behavior.

### Labor Intensity

ADT-27 is potentially very labor-intensive, since it makes possible a change to double-cropping. Total utilization of family labor in a given crop year may be doubled due to change to double-cropping since a single crop of ADT-27 uses the same amount of labor as a single crop of traditional varieties. In contrast, the only additional labor required for hybrid bajra is for harvesting and threshing. Since this is often a time-bound operation owing to the fear of theft or spoilage, it is likely to lead to additional use of hired labor rather than family labor. The harvesting season is also the period when employment is available on other farms. Thus, although hybrid bajra is labor-intensive, it is unlikely to allow a small farmer to increase family labor utilization on his own farm, although it may increase his employment as an agricultural laborer.

### Cost of Cultivation

ADT-27 involves greater costs of cultivation than traditional varieties, especially owing to the greater response of the former to large doses of chemical fertilizers. Also, where ADT-27 leads to a

change to double-cropping, the cost of hired labor will be doubled, and labor forms a large part of the total costs of paddy cultivation in this area (35-50 percent) (3, p.86). On the other hand, credit may be less of a problem than this suggests, because for the second crop the farmer can probably use funds obtained from sale of the first crop. The shorter duration of ADT-27, resulting in smaller loans being necessary to finance consumption during the growing season, may have been an important factor leading to rapid adoption of ADT-27 by small farmers. Hybrid bajra also involves a greater outlay of capital. Cash expenditure for hybrid bajra was $1\frac{1}{2}$ to 3 times that on the traditional variety in the year under study. The main items of additional expenditure were fertilizers and irrigation. For hybrid bajra, though not for ADT-27, we may say unequivocably that the new variety requires a greater capital input than tradtional varieties.

In the period 1966 to 1968, adoption of hybrid bajra in Gujarat was almost exclusively amongst the large farmers (7), whereas in the same period most of the small farmers in Thanjavur adopted ADT-27 (8,p. 13). In the light of the foregoing analysis, the behavior of the small farmer may be seen as quite rational. He hesitates to commit himself to an innovation which involves a high degree of uncertainty, and which offers him no special advantages in terms of his resource endowments, but commits himself readily enough in a situation of lower uncertainty and an opportunity to make use of what is probably his most underutilized resource-labor.

Appendix Table 5: Estimated Linear Regression Function for Factors Influencing the Extent of Adoption of ADT-27 in Thanjavur District, Tamil Nadu in 1966

| Factor | Regression Coefficient | Standard Error of Coefficient | t Value |
|---|---|---|---|
| Farm Size | -0.0056 | 0.0031 | -1.7725* |
| Farm ownership | -0.0032 | 0.0764 | 0.0424 |
| Farmer's age | 0.00003 | 0.0018 | 0.0184 |
| Farmer's education | 0.0043 | 0.0074 | 0.5849 |
| Family labor force | -0.0183 | 0.0168 | -1.0902 |
| External occupation (Dummy) | -0.1544 | 0.0742 | -2.0802** |
| Credit limit | -0.000003 | 0.00001 | -0.2321 |
| Irrigation | 0.2912 | 0.1747 | 1.6663 |
| Constant | 0.2394 | | |

(Unadjusted) $R^2 = 0.27$

With these results, ownership, farmer's age and credit availability were dropped to achieve the following:

| Factor | Regression Coefficient | Standard Error of Coefficient | t Value |
|---|---|---|---|
| Farm size | -0.0057 | 0.0030 | -1.9237* |
| Farmer's education | 0.0046 | 0.0069 | 0.6609 |
| Family labor force | -0.0178 | 0.0152 | -1.1703 |
| External occupation | -0.1566 | 0.0718 | -2.1827** |
| Irrigation | 0.3024 | 0.1536 | 1.9690* |
| Constant | 0.2233 | | |

(Unadjusted) $R^2 = 0.27$

* Significant at 10% level
** Significant at 5% level

Appendix Table 6: Average Family Labor Force by Farm Size For Visnagar and Kalol Talukas, Mehsana District, Gujarat

| Acres Farm Size | Visnagar | Kalol |
|---|---|---|
| 0.5 | 1.34 | 1.26 |
| 1.0 | 1.44 | 1.32 |
| 1.5 | 1.53 | 1.39 |
| 2.0 | 1.60 | 1.44 |
| 2.5 | 1.66 | 1.48 |
| 3.0 | 1.73 | 1.52 |
| 3.5 | 1.79 | 1.55 |
| 4.0 | 1.87 | 1.59 |
| 4.5 | 1.95 | 1.62 |
| 5.0 | 2.03 | 1.65 |
| 5.5 | 2.11 | 1.68 |
| 6.0 | 2.19 | 1.71 |
| 6.5 | 2.23 | 1.74 |
| 7.0 | 2.25 | 1.78 |
| 7.5 | 2.28 | 1.82 |
| 8.0 | 2.30 | 1.86 |
| 8.5 | 2.33 | 1.91 |
| 9.0 | 2.36 | 1.94 |
| 9.5 | 2.38 | 1.95 |
| 10.0 | 2.40 | 1.96 |
| 10.5 | 2.42 | 1.97 |
| 11.0 | 2.44 | 1.98 |
| 12.0 | 2.60 | 1.96 |
| 13.0 | 2.76 | 1.95 |
| 15.0 | 2.85 | 2.00 |
| 20.0 | 2.95 | 2.15 |
| 25.0 | 2.95 | 2.25 |
| 30 - 50 | 2.90 | 2.72 |
| 50+ | 3.17 | 4.67 |

Source: Office of the Registrar General, Census of India 1961, New Delhi, India

Appendix Table 7: Break-up of Cash Expenditure per acre for Hybrid and Local Bajra (in rupees) in Visnagar and Kalol Talukas, Mehsana District, Gujarat, 1966

| Items of Cash Expenditure | Crop | Villages | | | |
|---|---|---|---|---|---|
| | | Kamana | Kansarakui | Soja | Mokhasan |
| Total | HYV | 153 | 126 | 227 | 196 |
| | Local (P) | 99 | 44 | 120 | 142 |
| | Local (NP) | 87 | 42 | 145 | 159 |
| Seed | HYV | 8 | 8 | 8 | 8 |
| | Local (P) | - | - | - | - |
| | Local (NP) | - | - | - | - |
| Manures (FYM) | HYV | - | - | 19 | 49 |
| | Local (P) | - | - | 16 | 17 |
| | Local (NP) | - | - | 50 | 27 |
| Fertilizers | HYV | 42 | 68 | 7 | 5 |
| | Local (P) | 1 | 1 | 1 | 4 |
| | Local (NP) | 2 | - | 1 | - |
| Irrigation | HYV | 45 | 6 | 66 | 25 |
| | Local (P) | 11 | 1 | 3 | 9 |
| | Local NP) | 1 | 3 | 3 | 15 |
| Labor (casual + permanent farm laborer) | HYV | 48 | 39 | 110 | 103 |
| | Local (P) | 58 | 36 | 89 | 107 |
| | Local (NP) | 54 | 36 | 73 | 108 |
| Others* | HYV | 10 | 5 | 17 | 6 |
| | Local (P) | 29 | 6 | 11 | 5 |
| | Local (NP) | 30 | 3 | 18 | 9 |

*Includes land revenue and rent paid.

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