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# TENANCY AND ADOPTION OF NEW FARM TECHNOLOGY: A STUDY IN WEST BENGAL, INDIA

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## ABSTRACT

The study examines the level of adoption of new farm technology and the factors responsible for that, under four major tenurial arrangements. The study is based on the data collected from a sample of 160 farm households from six villages in Burdwan district of West Bengal pertaining to the agricultural year 1993-94. The main question addressed in this paper is to examine how agrarian structure in the broadest sense shape technological development in the farm sector. The results highlight the significant differences in adoption across the tenurial arrangements and support the view that tenancy has a direct impact on adoption of modem farm technology. Size of holding, resource base of the farmer, regularity in rent payment to the landlord, irrigation and other infrastructural variables were also found to have important influence on adoption of new farm technology.

## I. INTRODUCTION

New farm technology, the concept of which revolves around the increasing returns per unit of area and per unit of time, is the prime mover for any agricultural transformation. But for its adoption some minimum level of institutional and/or organizational conditions are necessary (Hugar, Umesh and Suryaprakash, 1992). Appropriateness of tenurial status may provide necessary incentives to the farmers to invest on items of new farm technologies', In this context the dominance of crop-sharing cultivation undoubtedly have had to include a radical assault on adoption of new farm technology in a state like West Bengal where the reform measures were undertaken with due seriousness mainly after the successful implementation of `Operation Barga'[z], the mass recording of share-croppers, in 1978. Consequently, a radical change in the agrarian scenario is observed in the state (Pal, 1995). The underlying objective of the programme was to give the sharecroppers heritable right and security of permanent occupation in land and thereby intending to encourage the tenants to make investment on land improvements and modern farm inputs.

Further, the implementation of `Operation Barga' has resulted in various tenurial arrangements based on different provisions for the share of the tenants in the inputs and the

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outputs[3]. This in turn assumed to have varying impact on the adoption of new farm technology by the tenants. However, no significant attempt has been made in the available literature to analyse the comparative performance of different tenurial arrangements developed after the successful implementation of `Operation Barga' with respect to adoption of new farm technology. Most of the studies, in this direction, have dealt with the aspects of allocative efficiency and that too only for ownership cultivation vis-a-vis sharecropping cultivation, in general (Rudra, 1981; Chattopadhyay, Ghatak and Majumdar, 1984 and Lieten, 1992). Recently, some claims have been made that land tenureship has significant influences on the adoption of improved farm technology (Bhuiyan, 1987; Webster, 1990 and Pal, 1995). Those studies tend to treat all the sharecropping arrangements as a single category and the compared sharecropping cultivation with ownership cultivation but failed to explain the reason for better performance of ownership cultivation over sharecropping, though Pal (1995) mentioned some possible reasons like resource endowments, managerial skill, risk taking attitude etc. However, in view of the importance of the issue, there is not much discussion either at empirical or at theoretical levels. It is in this background, the present study was conducted with the specific objectives: (1) to study the extent of adoption of new farm technology under different arrangements and (2) to identify the factors affecting the adoption of new technology.

## 2. METHODOLOGY

### Selection of study area

The present study is confined to Burdwan district of West Bengal. Considering the objectives of the study, Burdwan district was chosen purposively due to maximum concentration of recorded sharecroppers in the district. The land owning people have been quite influential in the district, and interestingly, the peasant movements under the banner of several political parties have also characterized the district since pre-independence era (Chattopadhyay, Ghatak and Majumdar, 1984). Moreover, this district is the largest producer of foodgrains in the state and thus the performance of agriculture in this district has a substantial impact on the overall agricultural performance of the state.

### Sampling and Data

The sampling was carried out in three stages. In the first stage, a list of all the blocks along with the number of recorded sharecroppers of various types was prepared and 'Kanksha' block was selected purposively owing to maximum concentration of different types of sharecroppers in this block. In the second stage of sampling, a list of all the villages in Kanksha block was prepared and out of 92 villages in the block a cluster of six villages viz., Ajoypally, Fuljury, Jambon, Jatgoria, Kajladihi and Shibpur were selected. Then a list of all the farmers under different tenurial classes of the six selected villages was prepared along with their holding size. Not much variation was observed in terms of average size of holding across

the villages but there was substantial variation across the tenurial arrangements. A summary of the information collected at this stage is given in Appendix I, II and III. Finally, in the last stage of sampling a total of 160 farmers, 40 from each of the four major categories of tenurial arrangements, were selected randomly[4] in probability proportionate to different size groups viz., marginal (<1 ha.), small (1-2 ha.), medium (2.01-4 ha) and large (>4 ha.). In order to achieve the second objective of this study a sub sample of 98 farmers were selected from the above 160 farmers, following appropriate sampling technique, ensuring proportionate representation from different tenurial category and size groups (Appendix II).

The four common tenurial arrangements for cultivation of land, prevailing in this study area i.e., Burdwan district of West Bengal were considered for analysis were: (1) pure ownership cultivation i.e., where land owners cultivate land themselves (Category-A), (2) pure sharecropping cultivation with 50:50 output sharing between tenants and land owners where sharecroppers contribute only human labour (Category-B), (3) pure sharecropping cultivation with 60:40 output sharing tenants and land owners where sharecroppers provide bullock labour or manure and fertilizer beside human labour (Category-C), and (4) pure sharecropping cultivation with 75:25 output sharing between tenants and land owners and the sharecroppers provide all the inputs except land (Category-D).

Since the study is based on primary data, the required data were collected from sample farmers through personal interview method pertaining to the agricultural year 1993-94. The necessary secondary information required for sampling at different stages was collected from various government offices.

**Analytical tools**

In order to fulfill the first objective of the study i.e., to study the extent of adoption of new farm technology under different tenurial arrangements, the extent of use of modern farm inputs was analysed and the technology adoption indices for individual farmers were developed based on which the farmers were classified into different technology adoption classes. The technology adoption index of individual farmer was developed as follows by modifying the formula given by Chandra and Singh (1992):

$$AI_i = 0.25 \times \left\{ \sum_{j}^{m} \left( \frac{AH_{ji}}{CA_{ji}} + \frac{FA_{ji}}{FR_j} + \frac{IA_{ji}}{IR_j} + \frac{PA_{ji}}{PR_j} \right) \times \frac{CA_{ji}}{\sum CA_{ji}} \right\}$$

where, $i$ = 1,2,3,.....n; n = total no. of farmers,

$j$ = 1,2,3,.....m; m = total no. of crops,

$AI_i$ = technology adoption index of $i^{th}$ farmer (%),

$AH_{ji}$ = area under HYV of $j^{th}$ crop of $i^{th}$ farmer (ha.),

$CA_{ji}$ = gross cropped area (HYV + Local) of $j^{th}$ crop of $i^{th}$ farmer (ha.),

$FA_{ji}$ = amount of chemical fertilizer applied per unit of area in the cultivation of HYV of $j^{th}$ crop by $i^{th}$ farmer (Rs.),

$FR_j$ = amount of chemical fertilizer recommended per unit of area in the cultivation of HYV of $j^{th}$ crop,

$IA_{ji}$ = no. of irrigation applied to $j^{th}$ crop by $i^{th}$ farmer,

$IR_j$ = no. of irrigation recommended for $j^{th}$ crop,

$PA_{ji}$ = amount of plant protection chemicals applied to $j^{th}$ crop by $i^{th}$ farmer (Rs.),

$PR_j$ = amount of plant protection chemicals applied to $j^{th}$ crop.

The technology adoption indices ($AI_i$ 's) thus calculated varies from zero to 100 percent. Based on technology adoption indices, the farmers were classified into five classes: (1) very poor adopter ( 0 – 20 AI ), (2) poor adopter ( 21 – 40 AI ), (3) moderate adopter ( 41 –60 AI ) , (4) high adopter ( 61 – 80 AI ) and (5) very high adopter (81 – 100 AI ). Finally, mean level of technology adoption indices for all the four categories of farmers were calculated.

A linear regression equation[5] (which turned out best fit) of the following type was estimated to identify the factors affecting the adoption of new farm technology.

$$AI = b_o + b_1X_1 + b_2X_2 + \ldots\ldots\ldots\ldots + b_{10}X_{10},$$

Where, AI = technology adoption index of the farmer,

$X_1$ = no. of working members in the farm family,

$X_2$ = size of operational holding (ha.),

$X_3$ = fixed investment on farm (Rs./ha.),

$X_4$ = percent contribution of non-farm income to total family income,

$X_5$ = distance of the village from block head quarter (Kms.),

$X_6$ = irrigation facilities ;

$X_6$ = 1, totally rained

= 2, more than 50% area is under rainfed

= 3, less than 50% area is under rainfed

= 4, totally irrigated.

$X_7$ = education level of the decision maker ;

$X_7$ = 1, illiterate

= 2, upto primary education

= 3, upto higher secondary education

= 4, college and above.

$X_8$ = age of the farmer ;

$X_8$ = 1, above 60 or below 20 year

= 2, 40–60 year

= 3, 20-40 year.

$X_9$ = operational independence of the farmer ;

$X_9$ = 1, no. of very little independence (Category-B)

= 2, low independence (Category-C)

= 3, moderate independence (Category-D)

= 4, complete independence (Category-A)

$X_{10}$ = regular rent payment by the sharecropper ?

$X_{10}$ = 1, yes

= 2, no

$b_1$ = intercept and $b_1, b_2, \ldots\ldots B_{10}$ are regression coefficients of the respetive factors.

## 3. RESULTS AND DISCUSSION

### Extent of adoption of new technology

HYV seeds, fertilizer, irrigation, pesticides and tractor power are regarded as the important components of new farm technology. Hence, the extent of use of these modern farm inputs was assessed on the four categories of farms representing major tenurial arrangements prevailing in the study area. The expenditure in case of farms representing major was taken as proxy to the level of their use. It is apparent from Table 1 that the expenditure on these modern inputs varies considerably among the four categories of tenurial arrangements and was highest in Category-A (owner cultivation) and lowest in Category-B (50:50 output sharing). However, the next in order after Category-A stands the Category-D (75:25 output sharing) in the use of modern farm inputs. Thus direct relationship between the level of use of modern farm inputs and the tenant's degree of operational independence is exhibited. As detailed in section on methodology, the technology adoption indices were constructed for different categories of tenurial arrangements considering actual use vis-a-vis recommended levels of HYV seeds, fertilizer, irrigation and pesticides. Farm mechanization, though an important component of new farm technology could not be taken into account, as there is no recommended level thereof. Technology adoption index was found highest being 79.59 in Category-A (Table 1).

Next in order were Category-D (74.52), Category-C (63.83) and Category-B (45.07). Consequently, the magnitude of technology adoption index is also directly related to the operational independence of tenants as was observed for the use of modern farm inputs.

**Table 1. Level of modern farm inputs use under different tenurial arrangements.**

| Items | Categories of tenurial arrangements | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 1. Area under HYV (% of GCA) | 79.79 | 34.89 | 58.00 | 58.36 |
| 2. Expenditure on fertilizer (Rs./ha.) | 1428 | 435 | 884 | 1033 |
| 3. Expenditure on irrigation (Rs./ha.) | 700 | 260 | 460 | 500 |
| 4. Expenditure on pesticides (Rs./ha.) | 454 | 130 | 287 | 323 |
| 5.Expenditure on tractor & machinery (Rs./ha) | 479 | 131 | 237 | 327 |
| Technology adoption index | 79.59 | 45.07 | 63.83 | 74.52 |

Note: GCA = Gross Cropped Area

The percent distribution of farms according to the level of technology adoption is given in Table 2. The table reveals that majority of the sample farms belonged to very high and high technology adoption class. However, a high degree of variation is observed across the tenurial arrangements. While, 87.5 percent of the farms in Category-A were in very high and high technology adoption class, a substantial fraction of the farms (40 percent) in Category-B were still found in the very poor technology adoption class. Not a single farm in this Category was ranked as very high adopter of new technology. The results with respect to Category-D farms are quit similar to Category-A i.e., 87.5 percent of the farms belonged to very high and high technology adoption class. While in Category-C, 60 percent of the farms belong to very high and high technology adoption class and 32.5 percent to very poor and poor classes. It is thus revealed that though the adoption of improved farm technology has made an appreciable headway in the study area in general, the farms in Category-B & C of tenurial arrangements have lagged behind. Such variation across the tenurial arrangements can be attributed to several factors, which are discussed in the following section.

**Table 2. Percent distribution of farms according to level of technology adoption.**

| Items | Categories of tenurial arrangements | | | |
|---|---|---|---|---|
| | A | B | C | D |
| 1. Very Poor | 2.5 | 40.0 | 20.0 | 0.0 |
| 2. Poor | 5.0 | 5.0 | 12.5 | 5.0 |
| 3. High | 35.0 | 22.5 | 45.0 | 47.5 |
| 4. Very High | 52.5 | 0.0 | 15.0 | 40.0 |
| Total | 100 | 100 | 100 | 100 |

**Factors affecting technology adoption**

The results of the regression analysis carried out to examine the factors influencing adoption of improved farm technology are presented in Table 3. The various hypothesised factors considered in the analysis have been found to explain as high as 91.32 percent of the variation in the level of adoption of new farm technology on sample farms. However, only six factors viz., size of operational holding, non-farm income, irrigation facilities, distance of the village from block head quarter, operational independence of the farmer and regularity in rent payment were found to have significant influence on the adoption of new technology. All of these factors except distance of the village from block head quarter showed positive impact on the level of technology adoption which is quite logical because nearness to the block head quarter facilitates more frequent and easy access to the facilities and information pertaining to recent advances in farm technology. It also served as a proxy for marketing infrastructure and accessibility for modern farm inputs. The size of operational holding (to a limit of course) Provides sufficient income and thereby funds for investment on modern farm inputs and also environment for farm mechanization. The irrigation has complementary relationship with the two most important components of the farm technology viz., HYV seeds and chemical fertilizers. The positive association between share of non-farm income and technology adoption index is also logical and obvious too, as modern agricultural technology is capital intensive and thereby poorly resource endowed farmers are unable to save enough from the farm income alone to spend on modern farm inputs.

**Table 3: Regression results of factors affecting technology adoption.**

| Determinants/Factors | Parameter Estimated | (b/s) | Standard error |
|---|---|---|---|
| Intercept | : a | (-) 4.9812 | - |
| No. of family labour (head) | : X1 | (-) 0.1323 | 0.2330 |
| Size of operational holding (ha.) | : X2 | 2.7045* | 1.1315 |
| Fixed investment on farms (Rs./ha.) | : X3 | (-) 0.0001 | 0.0002 |
| Contribution of non-farm income (%) | : X4 | 0.4301** | 0.1068 |
| Distance of village from block head quarter (km) | : X5 | (-) 0.4530 | 0.1790 |
| Irrigation facility (D.V.) | : X6 | 15.9321** | 1.4788 |
| Education level of farmer (D.V.) | : X7 | 1.2012 | 1.4907 |
| Age of the farmer (D.V.) | : X8 | 2.4012 | 1.6623 |
| Operational independence of the farmer (D.V.) | : X9 | 3.0576 | 0.9720 |
| Regularity in rent payment (D.V.) | : X10 | 2.0723* | 0.7950 |
| Coefficient of multiple determination | : $R^2$ | $0.9132^{**}$ | |

Note : D.V.= Dummy Variable; ** = Significant at 1 percent; * = Significant at 5 percent

Similarly, operational independence of the farmers showed positive association with the technology adoption index, which confirmed the fact that tenancy has an important influence on adoption of modern farm technology. In reality, all the farmers under the tenurial categoryA enjoy highest possible freedom in decision making due to very nature of ownership cultivation. Tenants under category-D, also enjoy near complete freedom in decision making since they provide all the inputs except land and take most of the operational decision independently. However, under tenurial category-B and C, the tenants hardly enjoy any freedom regarding use of modern farm inputs. As material inputs are supplied by the landowners and labour input by the tenants, there is a tendency on the part of the landowners to decide on a level of technology which use smore labour input in substitution of material inputs in the production process to minimize the input costs borne by them. Regular rent payment by the tenants was also found to have significant bearing on adoption of modern farm technology. This encourages the landowners to invest more on improved farm inputs.

## 4. CONCLUSIONS

The main question addressed in this paper is to examine how agrarian structure in the broadest sense shape technological development in the farm sector. The results support the view that tenancy has a direct impact on adoption of modern farm technology. In general, the performance of the sharecroppers with limited operational independence (category-B and C) never came upto the level achieved by the farmers with self-cultivation. Therefore, attempts should be made to encourage ownership cultivation (or at least sharecropping arrangement with 75:25 output sharing) so that the farmers can take independent decision regarding their choice of crops and input basket. This can be done by granting ownership right of land to the tenants. Size of farm is found to have significant bearing on the adoption of improved farm technology. However, as per the stipulation of the law[6], sharecropping cultivation in many cases leads to further subdivision of holdings, which has far-reaching consequences for technology adoption in the long run. Policies, therefore be framed to check further subdivision of holdings which are already very small. At the same time adequate provision should be made in the tenancy laws to ensure regular payments of rent by the tenants which hitherto received little attention in real sense. Besides legal provision, the panchayats can be entrusted for monitoring and supervising the functioning of the legal provisions regarding sharecropping and should be empowered to settle various disputes. The study also reveals that because of poor resource base the tenants are unable to invest on modern farm inputs. Thus emphasis should be on creating employment opportunities in non-farm sector and proving institutional credit. The finding also call for greater emphasis on the development of rural infrastructure mainly irrigation and input supply system.

**Foot Notes**

[1] The concept of new farm technology as used in this study refers to the use of new inputs-HYV of seeds, fertilizer, pesticides, irrigation water and improved farm machinery.

[2] 'Operation Barga' – a crash scheme for mass recording of bargadars (share-croppers), launched by the Left Front Govt. of West Bengal in 1978, in collaboration with the groups of beneficiaries and with the active support of the peasant organizations in order to provide the share-croppers security of permanent occupation and due share in the output.

[3] During the post-operation Barga period seven different types of tenurial arrangements based on different cost and output share were identified by Pal (1995).

[4] Random sampling (without replacement) was done using 'Fisher and Yates random number tables'. For regression analysis a sub sample of 96 farmers were selected, following random sampling, with proprtionate weightage for four categories and size groups as occurring in the population.

[5] After testing for multicollinearity also.

[6] As per stipulation of all the lawful heirs of the bargadar (share-croppers) get the equal right to cultivate the land subject to some terms and conditions.

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## APPENDIX I

Farm size across villages and tenurial arrangements (in hectares)

| Tenurial Category* | Villages** | | | | | | Aggregate |
|---|---|---|---|---|---|---|---|
| | V1 | V2 | V3 | V4 | V5 | V6 | |
| A | 1.83 | 1.77 | 2.05 | 1.98 | 1.75 | 1.90 | 1.89 |
| B | 1.20 | 1.40 | 1.22 | 1.49 | 1.36 | 1.42 | 1.37 |
| C | 1.37 | 1.47 | 1.29 | 1.40 | 1.39 | 1.35 | 1.38 |
| D | 2.05 | 1.93 | 2.11 | 1.89 | 2.29 | 2.15 | 2.08 |
| E | 1.67 | 1.52 | 1.60 | 1.64 | 1.85 | 1.66 | 1.65 |
| F | 1.38 | 1.39 | 1.50 | 1.55 | 1.57 | 1.64 | 1.53 |
| Aggregate | 1.65 | 1.63 | 1.67 | 1.73 | 1.68 | 1.74 | 1.69 |

## APPENDIX II

Size groupwise incidence of four major categories of tenurial arrangements in the selected villages

| Tenurial Category* | Size groups** | | | | Total |
|---|---|---|---|---|---|
| | Marginal | Small | Medium | Large | |
| A | 93 | 126 | 71 | 33 | 323 |
| | (11) | (16) | (09) | (04) | (40) |
| B | 63 | 99 | 31 | 0 | 193 |
| | (08) | (12) | (04) | (00) | (24) |
| C | 59 | 52 | 21 | 6 | 138 |
| | (07) | (06) | (03) | (01) | (17) |
| D | 32 | 40 | 29 | 17 | 118 |
| | (04) | (05) | (04) | (02) | (15) |
| Total (A, B, C, and D) | 247 | 317 | 152 | 56 | 772 |
| | (30) | (39) | (20) | (07) | (96) |

Note: Figures in parentheses are number of sample selected for regression analysis

## APPENDIX III

Incidence of different categories of tenurial arrangements across the selected villages

(Number of farm households)

| Tenurial Aggregate Category* | Villages** | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | V1 | V2 | V3 | V4 | V5 | V6 | |
| A | 39 | 42 | 37 | 79 | 45 | 71 | 323 |
| | (35.00) | (35.59) | (35.58) | (37.98) | (36.89) | (48.63) | (38.68) |
| B | 23 | 32 | 31 | 58 | 28 | 21 | 193 |
| | (16.43) | (27.12) | (29.81) | (27.88) | (22.95) | (14.69) | (23.11) |
| C | 30 | 22 | 15 | 32 | 21 | 18 | 138 |
| | (21.43) | (18.64) | (14.42) | (15.38) | (17.21) | (12.59) | (16.53) |
| D | 27 | 16 | 15 | 26 | 20 | 14 | 118 |
| | (19.29) | (13.56) | (14.42) | (12.50) | (16.39) | (09.79) | (14.13) |
| E | 7 | 3 | 4 | 8 | 2 | 12 | 36 |
| | (05.00) | (02.54) | (03.85) | (03.85) | (01.64) | (08.39) | (04.31) |
| F | 4 | 3 | 2 | 5 | 6 | 7 | 27 |
| | (02.86) | (02.54) | (01.92) | (02.40) | (04.92) | (04.76) | (03.23) |
| Aggregate | 140 | 118 | 104 | 208 | 122 | 143 | 835 |
| | (100.00) | (100.00) | (100.00) | (100.00) | (100.00) | (100.00) | (100.00) |

Note: Figures in parentheses are percent to column total

* = A (Ownership cultivation); B (Sharecropping with 50:50 output sharing); C (Sharecropping with 60:40); D (Sharecropping with 75:25 output sharing); E (Other sharecropping arrangements); F (Other tenurial arrangements besides ownership cultivation and share-cropping arrangements)

** = V1 (Ajoypalli); V2 (Fuljuri); V3 (Jambon); V4 (Jatgoria); V5 (Kajladihi); V6 (Shibpur)