

# Diagnostic Analysis of Technology Adoption and Factors Influencing Adoption Level of Tribal Farmers of Madhya Pradesh

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## ABSTRACT

The agricultural technologies developed in the country have generated more income and employment to the cultivators. However, tribal dominated regions of Madhya Pradesh falling under such conditions of agricultural backwardness have not yet been able to benefit from the fruits of technological innovation fully or even partly. Keeping this in view a study on technology adoption and its determinants has been conducted in Santna districts of M.P. Using multistage stratified random sampling techniques total 120 tribal farmers were selected from 10 villages of two block such as majhgawan and shohawal RD block of Satana district of Madhya Pradesh. The examination of technology adoption revealed that the area under study was characterized by preponderance of low level of technology adoption and smaller sized farms, the position of which in respect of adoption of new technology was quite disheartening. The increase in the level of adoption was accompanied by increase in the size of holding, use of family workers and maintenance of bullock pairs/ machinery. The increase in investment on fixed capital, particularly farm implements and machinery was associated with increase in the technology adoption. Wheat and Soyabean were the predominant crops of the area under study with the highest percentage of area under HYVs compared to other crops. The intensity of cropping, use of bullock labour and hired human labour were found to increase with the increase in the level of adoption. The scores of social determinant particularly literacy index exhibited positive influence on the level of technology adoption. Similarly, the scores of psychological determinants, viz., attitude towards HYVs, risk orientation and credit orientation were observed to increase with the increase in Further, it was observed that increase in the level of adoption was associated with increase in the level of income from the crops grown on sample farms.

**Keywords:** technology adoption, adoption index, determinants, tribal, Satana

Although the technological breakthrough as such in Indian agriculture is no longer a new phenomenon, yet it has got a significant relevance particularly for the regions which are still lying in the embryonic stage of agricultural development. Tribal dominated regions falling under such conditions of agricultural backwardness have not yet been able to benefit from the fruits of technological innovation fully or even partly. Consequently, large number of researchers and economic analysis are concerned about knowing the potentialities created by new technology in the under developed regions and their implications for

agricultural development policies and programmes in meeting the socioeconomic goals of these regions. A new agricultural technology is believed to have generated more income to the cultivators. But how this increase in income is distributed among various categories of farms at various levels of technology adoption is a matter of socio-economic significance. Several available studies on technology adoption have separately addressed either affecting the adoption or its impact on farm economy across the farms and regions. The studies by Rawal (1981), Henery (1983) and Yadava and Gangwar (1987) revealed

that economic prosperity, social mobilisation and favourable psychological orientation are instrumented in the adoption of new technology. Frankel (1971) has brought out that the large farmers have benefited more than the small ones from the technology. A comprehensive study incorporating both the aspects as well as interactions between level of adoption and economic gains in tribal agriculture is necessary to get an integrated view. The new agricultural technology is believed to have generated more income to the cultivators. But how this increased income is distributed among various size groups of farms at various levels of technology adoption, is a matter of socio-economic significance. The knowledge to this effect would help the planners, policy makers and administrators to bring about necessary changes in agricultural development policies and programmes in meeting the socio-economic goals of the region. Taking into account the significance of the aforementioned facts, a study on technology adoption and its determinants in Santna region of M.P. was conducted.

## METHODOLOGY

### Sampling design

For conducting this study, a three-stage stratified random sampling design was used. District Satna is located in the Vindhya hill region and comes under Rewa division of Madhya Pradesh state. This study focuses attention on technology adoption its determinants and impact of technologies on tribals agriculture. Further, two blocks namely, Majhgawan and Sohawal of Satna district were selected purposively on the criterion of relatively higher number of tribals families as compared to other blocks of Satna district. The majhgawan and Sohawal blocks are specially called tribal blocks in Satna district. Thereafter, a list of villages lying in the selected blocks were prepared in respect of tribal population as well as and crop cultivation and agro-economic conditions. Then from the enlisted villages clusters of 5 villages having homogeneous soil crop complexity and ago-economic stratum were selected. Thus 10 villages of the two selected blocks were grouped into 35 clusters. Lastly a sample of 5 per cent clusters from each selected blocks was taken randomly. Thus two clusters were taken in the sample for detailed study. There were 10 villages in the two selected cluster of two blocks. Finally from all ten villages, out of total 600 tribal

farmers, 120 farmers were selected randomly for the personal interview and data collection. The study pertaining to the period June 2000 to July 2001.

### Analytical tools

**Level of technology adoption:** In order to work out the level of adoption of new technology and adoption index of individual farmer, following mathematical tool was employed.

$$TAI_i = \sum_{j=1, i=1}^{m, n} \left( W_{aj} \frac{AH_{ji}}{CA_{ji}} + W_{bj} \frac{FA_{ji}}{FR_j} + W_{cj} \frac{IA_{ji}}{IR_j} + W_{dj} \frac{PA_{ji}}{PR_j} \right) \times \frac{CA_{ji}}{\Sigma CA_{ji}} 100$$

Where,

$i = 1, 2, 3, \dots, n$ , and  $n$  = total number of farmers

$j = 1, 2, 3, \dots, m$  and  $n$  = total number of crops (Paddy, Wheat, Gram, Arhar and Soyabean)

$TAI_i$  = Technology adoption index of  $i$ th farmer  
 $AH_{ji}$  = Area under HYVs/improved of  $j$ th crop of  $i$ th farmer.

$CA_{ji}$  = Cropped area (HYVs/improved + local varieties) of  $j$ th crop of  $i$ th farmer.

$FA$  = Amount of chemical fertilizers (N+P+K) applied per unit of area in the cultivation of HYVs/improved for  $j$ th crop by  $i$ th farmer.

$FR_j$  = Amount of chemical fertilizers (N+P+K) recommended for application per unit of area in the cultivation of HYVs/improved for  $j$ th crop.

$IA_{ji}$  = Number of irrigation applied to  $j$ th crop by  $i$ th farmer. This variable was assigned zero value for the rainfed crops.

$IR_j$  = Number of irrigation recommended for  $j$ th crop.

$PA_{ji}$  = Amount spent in rupees on using plant protection measures  $j$ th crop by  $i$ th farmer.

$PR_j$  = Amount of money spent on recommended plant for protection chemicals in  $j$ th crop.

$\Sigma CA_{ji}$  = Gross cropped area under all HYVs/improved crops of  $i$ th farmer.

$$W_{aj} + W_{bj} + W_{cj} + W_{dj} = 1$$

$W_{aj}$  = Share of cost of HYVs/improved seed of the  $j$ th crop of  $i$ th farmer's cost of cultivation.

$W_{bj}$  = Share of cost of chemical fertilizers of the

$j$ th HYVs/improved crop of  $i$ <sup>th</sup> farmers cost of cultivation.

$W_{c_j}$  = Share of cost of irrigation of the  $j$ <sup>th</sup> HYVs/improved crop of  $i$ <sup>th</sup> farmer's cost of cultivation.

$W_{d_j}$  = Share of cost of plant protection chemical of the  $j$ <sup>th</sup> HYVs/improved crop of  $i$ <sup>th</sup> farmer's cost of cultivation.

The adoption (TAI <sub>$i$</sub> ) varies from 0 to 100 percent depending upon the degree of adoption of new technology by farmers. On the basis of adoption index, all the 120 sample farmers were classified into three categories viz; low adopter (0 to 20 percent TAI <sub>$i$</sub> ) medium adopter (21 to 40 per cent TAI <sub>$i$</sub> ) and high adopter (above 40 percent TAI <sub>$i$</sub> ).

The present study is primarily based on categories of low, medium and high adopters which will always refer to the aforesaid classification. The above classification is based on the level of adoption on the farm as a whole, taking into account all the major crops (paddy, arhar, soyabean, wheat and gram) grown on the farm. However, there may be some intercrop variation in the level of adoption which will not be reflected when major crops grown on sample farms will be aggregated.

### Determinants of technology adoption

For identifying factors that affecting the level of technology adoption, stepwise linear regression analysis was performed taking level of technological adoption i.e. adoption index as a dependent variable and few independent variables which were expected to have effect on the adoption of new technologies. Functional form of cause and effect relationship is written as follows:

$$AI = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + U$$

Where,

AI = Adoption index

$X_1$  = Size of farmer's family (No)

$X_2$  = Family labour availability (No.)

$X_3$  = Size of holding (ha)

$X_4$  = Literacy index

$X_5$  = Age of the farmer (years)

$X_6$  = Off-farm labour ratio

$X_7$  = Attitude towards HYV

$X_8$  = Risk orientation

$X_9$  = Credit orientation

$X_{10}$  = Income from crops

$a$  is the intercept,

$b_1, b_2, b_3, b_4 \dots b_{10}$  = Regression coefficients of the respective factors

$U$  = Error term which represents the untraced factor, not included in the equation but having impact on adoption of technology.

## RESULTS AND DISCUSSION

### Level of technology adoption and its determinants

**Level of technology adoption:** The level of technology adoption refers to the extent of application of package of practices recommended for a particular crop. The level of technology adoption across sample farmers of different holding size and its determinants were analysed in detail and the results are presented in the following tables. It is apparent from Table 1 that marginal (<1 ha.) and small (upto 2 ha.) categories of farmers formed the major portion (75 per cent) of the sample size, while the other category (above 2 ha) of farmers accounted for a small proportion of only (25 per cent) of the sample size. This clearly indicates the skewed distribution of land in the study area.

**Table 1:** Size group wise levels of adoption on sample farms

Level of adoption	Marginal	Small	Large	All farms
Low (up to 20%)	22 (42.31)	8 (21.05)	5 (16.67)	35 (29.17)
Medium (21 to 40%)	23 (44.23)	20 (52.63)	9 (30.00)	52 (43.33)
High (above 40%)	7 (13.46)	10 (26.32)	16 (53.33)	33 (27.5)
<b>Total</b>	<b>52'</b> <b>(43.33)</b>	<b>38</b> <b>(31.67)</b>	<b>30</b> <b>(25)</b>	<b>120</b> <b>(100.00)</b>

Figures in parenthesis indicate percentage to the sample size.

When the extent of technology adoption among the different categories of farmers was examined. It was observed from Table 1 that a major portion (72.5 per cent) of farmers of the study area were

following low and medium level (upto 40%) of new technology. Of these, a substantial fraction (44.23 per cent) of farmers were still under very low (below 20 per cent) level of technology adoption. However, a small fraction (27.5 per cent) of farmers were coming under the category of high level (above 40 per cent) of adoption. The foregoing discussion revealed the fact that the adoption of technology had not made an appreciable headway resulting into preponderance of traditional methods of crop cultivation. When the size-group wise level of adoption was examined, the situation of smaller sized farms, which constituted a major fraction of sample farmers, appeared to be more disheartening.

### Technology adoption rate

Average adoption index for each categories (holding size) farmers as well for different categories of farmers based on adoption level is also worked out and presented in Table 2.

**Table 2:** Average adoption index in different categories of farmers

Category	Marginal	Small	Large	Overall
Low (upto 20%)	13.22	12.40	13.43	13.06
Medium (21 to 40%)	30.88	31.23	31.69	31.16
High (above 40%)	51.28	48.40	50.06	49.82
<b>Total</b>	<b>26.16</b>	<b>31.78</b>	<b>38.44</b>	<b>31.01</b>

*Figures in parenthesis indicate average adoption index in different categories farmers.*

Overall adoption index in marginal category of farmers was 26.16 where as it was 38.44 incase of large farmers. This result shows higher rate of technology adoption by large farmers as compared to the smaller one. The reason may be poor resource base and lack of technical know-how in smaller farmers. Adoption

index across the categories of level of technology adoption shows that it was at middle level (13 and 30 per cent) in case of low and medium adopter, where as it was just so per cent in case of high adopter. This result further reflects that even the high adopter farmers were not using fully recommended package of practices for the crops under the study.

**Determinants of technology adoption:** Before making an attempt to crystallize the significant factors affecting technology adoption, it is considered relevant to have a general idea about factors selected on a priority basis. That can affect the technology adoption the brief description of these factors is given here. The following aspects were covered in this section. The results of regression analysis of these factors are described under last part of this section.

### Economic determinants

**Farm size:** The size of farm is considered to be one of the most important economic determinants of adoption of new technology. Apart from income generating resource, the importance of size of farm can be visualized in other sense as it is a symbol of greater social status and economic security. Therefore, one may expect that farmers having better command on land resource will have higher level of technology adoption. The magnitudes of level of adoption and size of farm holdings are examined in Table 3.

It is observed from the table that the distribution of farms and cultivated land moved almost proportionately, resulting thereby large acreage of the study area coming under low level of (below 40 per cent) technology adoption. Only a small fraction of (42 per cent) land witnessed high level (above 40 per cent) of adoption. It is interesting to note that the increase in the level of adoption was positively correlated with the farm size. This clearly confirmed the fact that the size of farm had direct bearing on

**Table 3:** Adoption wise net cultivated area and average farm size

Level of Adoption	No. of farms	Percentage of farms to total sample	Total net cultivated area (ha)	Percentage of net cultivated area to total sample area	Average farm size (ha)
Low	35	29.17	24.49	19.61	0.7
Medium	52	43.33	48.18	38.58	0.93
High	33	27.5	57.2;	41.82	1.58
All farms	120	100.00	124.9	100.00	1.07

the level of adoption. In nutshell, one may say that the size of farm appeared to be a major determinant of adoption of technology. Since, the area under study was predominated by smaller sized farms, the large proportion of area witnessing low level of technology adoption is obvious.

**Capital investment:** The capital investment pattern of farmers is another important determinant of adoption of new technology. The farm building, implements and farm machinery and livestock were the major forms of capital investment, which helps in assessing the farmers' prosperity and their attitude towards these investments and adoption of new technology. The Table 4 gives a picture of per hectare value of fixed assets at different levels of technology adoption, classified under farm building, livestock and farm machinery and implements. Inclusion of land would have made the comparison less sensitive with respect to other assets because it forms a very high proportion of total investment on a farm. For the same reason, residential houses have also been excluded from the fixed investment. The average level of total investment per hectare showed an increasing trend with the level of adoption varying from ₹ 5355.63 on low adopter group to ₹ 8319.56 on high adopter group with an average of ₹ 6103.14 on overall sample farms.

On an average, livestock ranked first in terms of its share in the total investment accounting for about 43 per cent investment on the farms, followed by farm building and implements and machinery. On comparing the variation of total fixed capital investment at different levels of technology adoption, it was observed that with the increase in the levels of technology adoption due to investments on farm building, implements and machinery were also increased. This is symbolic of progressiveness and awareness of farmers towards the importance of

farm machinery and implements in adoption of new technology. More so, the higher investment on farm building by higher level of adopters is indicative of their economic prosperity. However, the investment on livestock evoked a mixed trend with the levels of adoption, indicating there by inconsequential role of livestock in adoption of new technology.

**Cropping pattern:** Cropping pattern within a homogeneous agro-climatic area is considered to be influenced by soil type, size of holding, source of irrigation, level of investment and availability of resources. However, in changing scenario of agriculture, the new agricultural technology plays a vital role. It was found that wheat (local and HYV) is the most important crop constituting on an average 25.27 per cent of the total cropped area in the sample villages, followed by paddy (24.91 per cent), Gram (20.8 per cent), soyabean 6.55 per cent and Arhar (5.78 per cent). Whereas other crops like Jowar, bajra, til in kharif and peas, barley etc. in rabi were occupied to about 16.69 per cent of total gross cropped area. Thus the foodgrains dominated the cropping pattern on all the groups of farm in the study area. With across the major crops grown in the study area, it is observed that HYVs of wheat occupied the highest proportion of gross cropped area and rest of the crops i.e. wheat, arhar, gram and paddy had small proportions of gross cropped area under HYVs which were 4.53, 4.51, 3.15 and 18.48 per cent, respectively. This indicates that though the adoption of HYVs in case of wheat crop was low, it was still lower and disheartening in case of soyabean, gram, paddy and arhar. It was further noted that with the increase in the level of adoption, there was an increase in the percentage of area under HYVs to total gross cropped area almost in all crops.

**Social determinants:** Three social factors, which are expected to affect the technology adoption have been taken into account. They are age of the entrepreneur,

**Table 4:** Fixed capital investment excluding land on sample farms

Level of adoption	Farm building		Implements and machinery		Livestock		Total investment
	Investment	Percentage to total fixed	Investment	Percentage to total fixed investment	Investment	Percentage to total fixed investment	
Low	1015.07	18.95	756.38	14.13	3584.18	66.92	5355.63
Medium	2121.27	40.79	1300.60	25.02	1777.83	34.19	5199.7
High	3185.45	38.29	216.25	26.64	2917.86	35.07	8319.56
All farms	2091.28	34.27	1393.67	22.84	2618.19	42.89	6103.14

size of family and literacy index. It can be seen from Table 5 that adoption rate was negatively related with the age of entrepreneur, where as positive relation between adoption rate and education of the farmer was found. However, the average size of family presented a mixed trend with the level of adoption. It was found that largest in family size for high adopter group on account of larger size of holding owned by joint family system. Similarly, the high index of literacy on higher adopter group is symptomatic of their economic prosperity. The higher literacy index may help the farmers to understand the pros and cons of technology in a much better way.

**Table 5:** Size of family, educational status and average age of different adopter groups on sample farms

Level of adoption	Age of entrepreneur	Size of family	Literacy index
Low	54.14	7.71	0.31
Medium	46.23	7.19	0.58
High	38.52	8.30	0.64
All farms	46.42	7.65	0.52

**Psychological determinants:** The psychological factors such as attitude towards HYV, risk and credit orientation are other important determinants, which influence the adoption of agricultural technology on farms. The measurement of their magnitude in relation to the level of adoption of technology was examined in detail and the results are presented in Table 6.

**Table 6:** Size of family, educational status and average age of different adopter groups on sample farms

Level of adoption	Attitude towards HYVs	Risk orientation	Credit orientation
Low	2.46	2.06	2.8
Medium	3.60	2.64	3.56
High	4.21	3.85	4.42
All farms	3.44	2.8	3.58

Under psychological determinants, three factors expected to influence the adoption of agricultural technology such as attitude towards HYV, risk orientation and credit orientation of the cultivators were considered for investigation. It is evident from the table that the scores of all the three psychological factors showed an increasing trend with the level of adoption. This meant that with more favourable

attitude of a cultivator towards HYV and more risk bearing capacity, there were higher levels of adoption. Similarly, as the farmers mental orientation towards taking credit from the financial institutions changed in its favour, they went in for higher level of technology adoption. In other words, the attitude towards HYV and risk and credit orientation has direct bearing on technology adoption.

**Adoption function:** Adoption function equation expresses the level of adoption of new technology as a function of the various factors affecting the technology adoption. The technology adoption index of individual farmer has been taken as the proxy for the level of adoption. As discussed earlier, altogether ten factors coming under the purview of economic, social and psychological determinants were selected on a prior basis, which were expected to affect the level of technology adoption. Taking these factors as the independent variables and the technology adoption index of each farmers as the dependent variable, a linear step wise regression analysis was performed, the result of which is given in Table 7.

**Table 7:** Regression coefficients, standard errors and coefficient of multiple determination of factors affecting technology adoption on sample farms

Factor	Constant	Regression coefficient	Coefficient of multiple determination
Credit orientation		5.277* (0.944)	0.890
Attitude towards HYV	-14.743	7.345* (1.075)	
Risk orientation		3.758* (1.048)	
Age		-0.199* (0.055)	

\* Significant at 1 per cent; \*\* Significant at 5 percent; Figures in parentheses indicate standard errors.

It can be noticed from the table that out of these ten factors, only four of them such as credit orientation of the cultivator, attitude towards HYV, risk orientation and age of the entrepreneur contributed significantly to the adoption of technology explaining jointly 89 per cent of variation in the level of adoption. Among these four significantly influencing factors the age of entrepreneur is showing negative coefficient (-0.199) indicating there by limitations of this factor to influence the resultant. The attitude towards HYV was found to the most consequential factors

influencing the technology adoption contributing upto 7.35 per cent with an unit addition in the index of this factor. In the order of merit credit and risk orientation were placed on second and third having a contribution to the resultant by 5.28 and 3.76 per cent respectively with their unitary additional unit. A perusal of the table further reveals that all the significant factors except entrepreneurs' age (an unalterable factor) were positively associated with the level of adoption and thus as expected, turned out to be commensurate with earlier findings based on simple tabular analysis presented in the preceding tables. This meant that improvement in these major factors would lead to higher level of technology adoption. Similar findings were also reported by many other researchers (Rawal, 1981 and Sharma *et al.* 1987).

### SUMMARY AND CONCLUSION

The examination of technology adoption revealed that the area under study was characterized by preponderance of low level of technology adoption and smaller sized farms, the position of which in respect of adoption of new technology was quite disheartening. The increase in the level of adoption was accompanied by increase in the size of holding, use of family workers and maintenance of bullock pairs/machinery. The increase in investment on fixed capital, particularly farm implements and machinery was associated with increase in the technology adoption. Wheat and Soyabean were the

predominant crops of the area under study with the highest percentage of area under HYVs compared to other crops. The intensity of cropping, use of bullock labour and hired human labour were found to increase with the increase in the level of adoption. The scores of social determinant particularly literacy index exhibited positive influence on the level of technology adoption. Similarly, the scores of psychological determinants, viz., attitude towards HYVs, risk orientation and credit orientation were observed to increase with the increase in adoption level. Further, it was observed that increase in the level of adoption was associated with increase in the level of income from the crops grown on sample farms.

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