

## Adoption of Zero Tillage in Rice Based Cropping System in Manipur State

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### ABSTRACT

The objective of the study was to estimate the viability of zero tillage (ZT) technology in rapeseed over conventional tillage and also to examine the factors affecting the adoption of ZT in rice-rapeseed system. Economic analysis of the data presented in this paper showed that zero tillage method for rapeseed cultivation was the most economical and attractive option for farming community. Farmers' adoption of zero-tillage technology was studied by using logit model. The logit analysis results of this study showed that farmers' decision to adopt zero tillage technology were positively and significantly related to age of the respondent farmer (AGE), government assistance (ASSIST), farm tenancy (TENANT) and sandy loam type of soil (SOILSL). The study highlighted that younger farmers were mostly educated and had the tendency to take risk and adopt the ZT technology. However, farmers having irrigated lands were not interested in adoption of ZT technology due to diversification towards high value vegetables but the farmers who had more experience in farming and cultivating large farm sizes were more likely to adopt zero tillage technology.

**Key words:** Adoption; Zero tillage; Logit analysis;

Cereals, mostly rice is the most important crop grown in both the hill and valley regions of Manipur state where it occupies about 70 per cent of the total cropped area and contributes over 95 per cent of the total food grains production. The agriculture in the state is mono-cropped keeping the lands mostly fallow during the rabi season except in few pockets where the irrigation facilities are available. The average irrigated area of the state is 30.75 per cent and the availability of irrigated area during rabi season is negligibly low that ultimately lead to low cropping intensity of 108 per cent. Non-availability of irrigation facilities is a major constraint in adoption of rabi crops in the state. The successful demonstration of zero tillage (ZT) technology in rapeseed variety M-27 after rice crop by the ICAR Research Complex for NEH Region, Manipur Centre through training and Front Line Demonstrations (FLDs) in different districts of the state lead to the transformation of the mono-cropped rice cropping system to doubled cropped rice-rapeseed cropping system. At present the practice is being followed on nearly 30, 000 ha as compared to a mere 500 ha a decade ago. Traditionally, just 10 years ago,

the tillage practice for rapeseed showed that there were over 3 ploughings with the tractor/power tiller. The Zero-tillage technology is becoming a savior to the farmers of the state. The farmers are mostly risk averters due the vagaries of weather and other climatic conditions. For a technology to be adopted and effective really, it is a pre-requisite that it has been evaluated with respect to its economic feasibility and viability which is a major determinant of its adoption. The study aims in studying comparative economics of zero tillage vis-à-vis conventional tillage system and the factors that are mostly affecting the adoption of ZT technology in rice-rapeseed system in Manipur state.

### METHODOLOGY

The study was conducted in Thoubal district of Manipur. A list of adopter and non adopter famers was prepared from Kakching, Khongjom, Hiyanglam and Wabagai villages. Finally, a total of 120 farm ERS having a distribution of 60 adopters and 60 non-adopters of ZT rapeseed cultivation were selected using proportionate random sampling technique. The data was collected

during rabi 2008-09 by personal interview method using pre-tested questionnaire.

Farmers' adoption of zero tillage technology was studied by using logit model. The logit model in this study postulates that  $P_i$ , the probability that farmer  $i$  adopts ZT technology is a function of an index variable  $Z_i$  summarizing a set of his individual attributes:

$$P_i = F(Z_i) = F(\beta' X_i) = \frac{1}{1+e^{-Z_i}} = \frac{1}{1+e^{-(b' X_i)}} \dots\dots(1)$$

where  $b$  is a  $(k \times 1)$  vector of co-efficient,  $X_i$  is a  $(k \times 1)$  vector of the farmer  $i$ 's attributes, and  $e$  is the base of natural logarithm. The index variable  $Z_i$  is a dichotomous variable i.e., it takes the value of one if a farmer adopts ZT technology ( $Z_i = 1$ ) and takes the value zero otherwise ( $Z_i = 0$ ).  $Z_i$  has been shown to be the logarithm of the odds ratio (Kennedy, 1985).

$$Z_i = \log [P_i / (1 - P_i)] = b' X_i \dots\dots\dots(2)$$

Since  $P_i$  in (2) will be equal to 1 if a choice is made and 0 otherwise, the correct estimation in equation (2) requires the use of Maximum Likelihood Estimation (MLE) procedure. The empirical model specification was:

$$Z_i = \beta_0 + \beta_1 \text{AGE} + \beta_2 \text{ASSIST} + \beta_3 \text{EXPERF} + \beta_4 \text{TENANT} + \beta_5 \text{FSIZE} + \beta_6 \text{GRAZ} + \beta_7 \text{SOILSL} + \beta_8 \text{IRRIGA} + e$$

It shows that the index variable  $Z_i$  indicating whether the farmer adopts ZT technology or not is expressed as a linear function of the above listed variables.

where:

- AGE = age of the household head in years;  
 ASSIST = normalized sum of dummy variables where each dummy measures the receipt of one of four types of assistance (technical information, chemical fertilizers, plant protection chemicals and seeds) from government/NGO;  
 EXPF = Experience of farmer in years;  
 TENANT = an indicator variable for whether tenant or not (=1, if yes; = 0, if no);  
 FSIZE = size of farm holding in hectares;  
 GRAZ = A dummy variable for proneness of the field to grazing (=1, if yes; =0, if no);  
 SOILSL = A dummy variable for the sandy loam

type of field (=1, if yes; =0, if no) and

IRRIGA = A dummy variable indicating availability of irrigation facility (=1, if yes; =0, if no)

The error term, which represents unobservable socio-economic factors and characters of surveyed households are assumed to be independently distributed. The approximate age of the household head (AGE) was based on elicited information from respondents. Dummy variables were for assistance from Government (ASSIST); level of farm tenancy (TENANT); proneness of the field to grazing (GRAZ); sandy loam type of field (SOILSL) and availability of irrigation facility (IRRIGA). Household assistance from Government/NGO is measured as the normalized sum of dummy variables where each dummy measure the receipt of one of four types of assistance (technical information, chemical fertilizers, plant protection chemicals and seeds) from government/NGO.

## RESULTS AND DISCUSSION

*Input cost and returns of rapeseed under Zero-tillage and Conventional tillage conditions:* The traditional indigenous rapeseed variety local *Yella* and high yielding M-27 were taken under zero tillage cultivation in which HYV covered about 60 per cent of the area. The high yielding M-27 could reach an average yield of 7.2 qt/ha with a maximum of 16 qt/ha whereas, local *Yella* could reach maximum up to 11 qt/ha with average yield of 5 qt/ha. Local *Yella*, however, if grown under fertile irrigated soils, can earn extra income from the tender shoots which are being used as palatable local vegetable. High yielding M-27 variety had 44 per cent yield advantage over existing local *Yella* under zero tillage condition.

Table 1 presents comparative economics of local and high yielding varieties under zero tillage and tillage conditions. Although having similar cost of production, M-27 realized 78% higher net return than local *Yella*. The benefit cost ratio of 2.83 was also much higher than the local *Yella* (2.10). As shown by lower net return and benefit cost ratio of 1.44, indicated non-profitability of rapeseed under tillage conditions. The study concludes that zero tillage under rapeseed with high yielding variety is a highly remunerative crop in the state. The adoption of zero tillage technology thus, would

improve farmer's profit and eventually contribute towards reducing poverty and keeping environment clean.

Table 1. Input cost and returns of rapeseed under Zero-tillage and Conventional tillage in Thoubal district, Manipur. (Rs./ha)

Particular	ZT		CT
	Local variety (Yella)	HYV (M-27)	HYV (M-27)
Seed	450	500	500
Manures and fertilizers	2358	2398	2611
Labour (human)	2544	2878	5760*
Plant protection chemicals	428	438	426
Interest on working capital (@ 10% for 3 months)	145	155	232
Total Cost	5925	6369	9525
Average yield (tones/ha)	4.99	7.2	5.5
Gross returns	12475	18000	13750
Net returns	6550	11631	4225
Output-input ratio	2.10	2.83	1.44

\*Include both human and tractor hours.

ZT = Zero tillage

CT = Conventional Tillage

*Adoption of zero tillage technology:* If the adoption of zero tillage technology is seen as an important aspect of a movement towards a more sustainable agriculture, then an understanding of the factors that lead farmers to adopt is a key component of policy design. Descriptive statistics of the variables used in the study are given in Table 2. The data in Table 2 indicated that on average, each farmer had 1.08 ha of agricultural land (FSIZE) with an average age (AGE) of 45.82 yr and had 12.35 yr of farming experience (EXPE). The results of the logit analysis for zero tillage technology adoption are presented in Table 3. The dependent variable is the probability of adopting zero tillage technology. The specified logit model fits the data very well as indicated by the likelihood ratio test ( $\lambda$ ), which is significant at 1 per cent level. The high level of McFadden  $\rho^2$ , obtained attests to the good predictive ability of the model. With

few exceptions, the estimation yielded the expected signs for the significant variables of the independent variables.

Table 2. Descriptive statistics for variables in the logit model.

Variable	Unit or type	Mean	SD
AGE	Years	45.82	18.302
ASSIST	Sum dummy	2.98	2.632
EXPF	Years	12.35	5.98
TENANT	Dummy	0.58	0.492
FSIZE	Hectares	1.08	1.120
GRAZ	Dummy	0.36	0.483
.SOILSL	Dummy	0.67	0.386
IRRIGA	Dummy	0.26	0.238

Table 3. Parameter estimates for logit model.

Variable	Co-efficient	"t" ratio
Intercept	-3.586 **	2.053
AGE	0.038*	1.860
ASSIST	8.328***	3.732
EXPF	0.146	0.917
TENANT	0.263**	2.102
FSIZE	0.011	1.180
GRAZ	-0.658 *	1.832
SOILSL	+0.987***	2.742
IRRIGA	- 0.705**	2.051
-2 log (l)b	65.364***	-
McFadden $\rho^2$	0.574	-
Sample size	120	-

Note:

- \*\*\*, \*\* and \* indicate significance at 1, 5 and 10 per cent probability levels, respectively
- The likelihood ratio tests are significant at 1 per cent probability level.

The results showed that farmers' decision to adopt zero tillage technology were positively and significantly related to age of the respondent farmer (AGE), Govt. assistance (ASSIST) in the form of technological information, chemical fertilizers, plant protection chemicals and seed, farm tenancy (TENANT) and sandy loam type of soil (SOILSL). It indicates that younger farmers are mostly educated and has the tendency to take risk and adopt the ZT technology. As in many rural development programmes, the government assistance appears to have a substantial impact on the adoption of zero tillage technology, the finding consistent with surveys by *Pattanayak and Mercer (1998)*. Surprisingly, tenants were adopting more of ZT

technology in order to enable to recoup the low income earn from the first crop of rice. Farmers with fields having sandy loam type of soil were adopting more of zero tillage technology. Generally, sandy loam types of soils in the state are located nearby the rivers, lakes, streams and low lying areas and thus, having high moisture content and retention capacity.

Similarly (Table 3), negative significant influence for adoption of zero tillage technology includes proneness of the field to grazing (GRAZ) and availability of irrigation facilities (IRRIGA). It implies that fields susceptible to grazing are likely not to adopt ZT technology. Interestingly the coefficient for size of irrigated land holding was significant but negative. The reason being irrigated lands in the locale although less in proportion was mostly diversified towards high value vegetables. Similar finding was reported by *Padaria et al (2009)*. The year of experience in farming (EXPF) and farm size (FS) although insignificant variables have positive relationship. This was not very surprising since most of the households in the survey were having good experience in farming and average farm size of 1.08 ha thus, didn't have any significant impact. It indicates that

farmers who have more experience in farming and cultivating large farm sizes were more likely to adopt zero tillage technology.

## CONCLUSION

Zero tillage technology is very conducive in increasing the rapeseed production and net income, its popularity would increase day by day among the farming community in Manipur state. The adoption analysis of this study shows that government assistance have high significant impact on adoption. Therefore, to encourage Zero-tillage technology among the the poor tenants, the government should provide incentives to them. The assistance package must be integrated to include other needs such as access to credit to purchase farm inputs. Extension activities should be strengthened among households through technical support and front line demonstrations (FLDs). Young farmers should be encouraged to form Self Help Groups (SHGs) and Farmer's club to make awareness and develop skills in zero tillage technology. Village institutions such as Panchayats and local Clubs should take up initiatives to frame laws/rules to control grazing during rabi season.

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