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THE INFLUENCE OF TECHNICAL INEFFICIENCY LEVEL THAT INVOLVE FARMER'S BEHAVIOUR ON RISK TOWARDS PROFIT IN RICE PRODUCTION OF INDONESIA

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ABSTRACT

This paper analyses the influence of the level of technical inefficiency that occur in farmers on profits earned. Where the level of technical inefficiency consider that factor of managerial capabilities of farmers, one of which is a farmer's behaviour in dealing with the risks of farming. The aims of this research are to analyse the influence of the level of technical inefficiency on profits and perform simulations to determine the strategic policies that can be done by the government for an increase in profits of rice farmers. The methods used are the method of Translog Stochastic Profit Frontier and share of expenditure for inputs against profit. Primary data by panel collected during the rainy season and the dry season in 2014/2015 with the number of observations for 610 farmers. The research area covers 7 subdistricts in Malang Regency, East Java Province, Indonesia. The results showed that there is influence negatively the level of technical inefficiency and significant with a profit of 2.61. The best policy is the provision of a hand tractor to farmer group and efforts to reduce the level of technical inefficiency through increasing attitudes and behaviour of farmers in dealing with the risks of farming with the changes increase in profit of 29.12%.

KEY WORDS

Risk behaviour, panel data, translog stochastic profit function, farming policy.

The stability of food supply is essential, if there is a deficit of stocks of foodstuffs would suck up the foreign exchange sizeable. Currently, the Indonesian government continuously intensified programs to achieve rice self-sufficiency next 3 years. Growth in the number of Indonesia's population continues to increase by 1.49% during 2000 to 2010 (Statistics Indonesia, 2011) so the rice consumption continues to increase. Consumption in Indonesia is still high in foodstuffs of rice compared to other countries (despite the downward trend in rice consumption from 2009 to 2013 amounted to 1.62%). In 2009, rice consumption as many 91.3 kg / capita / year, then declined to 85.5 kg / capita / year in 2013 (Statistics Indonesia, 2013), however Indonesia's rice consumption is still above the average consumption of rice of the Asian population, for example Korea of 40 kg / capita / year, Japan of 50 kg / capita / year, Malaysia of 80 kg / capita / year and Thailand of 70 kg / capita / year (Sulihanti, S., 2013). According to Respati, E., (2013) the total requirement of consumer society and industry based processed rice about 97.6 kg / capita / year in 2013 and in 2014 amounted to 97.4 kg / capita / year.

National rice production in 2013 of 71.279 million tons with the harvest area is 13,835,252 hectares (Statistics Indonesia, 2014). While the rice harvest area from 2000 to 2014 in Indonesia did not show a significant increase only 1%. Productivity of rice in Indonesia average of 50.6 quintal / hectare with an average rate of 1.44% from 2000 to 2014, while the Ministry of Agriculture has a target in 2014, productivity of rice in Indonesia could reach 60-70 quintal / hectare. East Java Province is the second largest producer of rice in Indonesia, but a fixed value in 2013 as many as 12.05 million tons of rice dry milling, decreased by 149 260 tonnes or about -1.22% compared to the year 2012, this was due to a decrease in productivity of 2.29 quintal / hectare or about -4.20%, although the harvested area increased by 3.1%. Several regencies / cities experiencing a shortage of rice due to more demand for rice than the resulting production, one of which is Malang Regency. The condition is equal to Malang Regency, although the highest productivity above the average of national and provincial namely by 62.3 quintal / hectare, but the lack of production and

fluctuations in the rate of productivity growth occurs. In 2010 in Malang Regency with a population of 2,413,779, the rice the needs of 306,549 tonnes and total production of 263,162 tonnes (Statistics Indonesia of East Java Province, 2013) or from different sources the number of rice production of 284,833 (Agriculture Agency of Malang Regency, 2011) resulting in a shortage of 43 387 tonnes or 21 716 tonnes. In the following years, the production of rice in Malang Regency continued to decline.

Fluctuations in the growth of productivity above, one of them caused by the behaviour of farmers in decision making when using input. Decisions concerning the application of the technology is based on the possibility of farming the risk that will be faced affect the allocation of inputs. Farmer's behaviour in dealing with the risk often encountered is behaviours that are reluctant face the risk or prefer to avoid the risk or risk averter (Agustina Shinta¹, 2006). The use of production factors that are inconsistent with suggestion program hence causing the maximum production cannot be achieved by the farmers. Rice farmers in Malang regency achieve technical efficiency of 76.5% (Agustina Shinta², 2006) so there is still a chance to increase the maximum production of 23.5%, or called there is still technical efficiency.

Kumbakhar (2002) states that the production of a commodity affected by whether or not efficient of farmers in the allocation of production inputs and technical inefficiency problems related to the managerial capability of farmers. Bokhuseva and Hockman (2004) also states that one of the factors causing the decline in production is the technical inefficiency. Farmers confronted with the series of choices about how to allocate its resources to produce alternative products that may be produced with the aim of maximize the profit. Production risk is the uncertainty aspect of production which is very important in the formulation of government policy and decision-making by farmers (Just and Pope (1978), Griffiths and Anderson (1982) and Guan H.Wan, et al., (1992)). According Battese, et al., (1994) that insert the risk of production in the stochastic frontier production function is the essence matter that associated with the prediction of technical efficiency, because the measurement of technical efficiency measures the degree of usefulness of the technology adopted in the production process.

Consideration of variables risk behaviour of farmers against a profit (performed by Foster and Rauser (1991)) and considerations incorporate technical inefficiency (performed by Abrar, (2001); Arnade and Trueblood (2002); Kumbhakar and Tsionas (2008); and Garshasbi, et al., (2010)) against a profit. Translog profit function models in this research will insert technical inefficiency of variables explicitly, while the farmer's behaviour in the face of risk has been implicitly included in the calculation of inefficiency because it is a managerial capability of farmers.

Associated with the above problems, the allocation of input use is essential in an effort to increase the production potential without neglecting the farmer's behaviour in the face of risk in the measurement of technical inefficiency, so that it can provide valid information about how government policies are applied. Thus this research aims to analyse the influence of the level of technical inefficiency on profits and perform simulations to determine the strategic policies that can be done by the government so that an increase in profits of rice farmers.

MATERIALS AND METHODS

Study Area. Location of research conducted by purposive in Malang Regency, East Java, Indonesia, considering that East Java is the centre of the highest rice after West Java while Malang Regency is a high productivity in East Java, but a trend fluctuation of the rate of productivity of rice were sharply during 2000-2013. The average productivity of rice for 13 years in Malang Regency reached 6,125 tons / ha, while the average productivity of East Java at 5:48 tons / ha and the national average of 4.73 tons / ha. Subdistrict was chosen for the example is that a subdistrict that-productivity above the average productivity of rice across Malang Regency because they have the opportunity to become self-sufficient area to fulfil the region, but the fluctuation of production and the rate of productivity growth sharply.

Time Determination Methods. The research was conducted in two stages, the first stage is the study of literature and secondary data collection obtained from various agencies carried out in January - March 2014 and the second stage is to collect primary data held during the harvest season in October 2014 to collect data recall previous seasons: the rainy season from October to March 2013 and the data for the dry season in April-September, 2014.

Data Analysis Methods. Methods to measure the behaviour of farmers in the face of risk can be seen in the article Agustina Shinta¹, et al. (2016) and the method of measuring the level of technical efficiency can be read in the article Agustina Shinta², et al. (2016). In this paper, the model formulation of profit rice farming using Translog Stochastic Profit Frontier the share of expenditure for the inputs and share for outputs against profit. Estimates will be done by three restrictions as follows: Young's Theorem on the assumption of homogeneity means that $\sum_{j=1}^n \beta_{ij} = 0$; all parameters i and j are estimated in the equation equal to zero and linearity meaning that $\sum_{j=1}^n \beta_0 = 1$; summation intercept in all equations equal to one.

Specifications model formulated in this research are over-identified conditions because the number of variables in the model amounted to 261 ($k = 261$), the number of endogenous and exogenous variables in a specific equations in the model amounted to 11 ($M = 11$) and the number of equation of in the model or the number of endogenous variables in the model amounted to 13 ($G = 13$). Thus $(K-M) > (G-1)$ is over-identified, therefore the estimation of parameters using the SUR (seemingly unrelated regression estimation) that will be analysed using SAS software. SUR method provides high efficiency in simultaneous estimation, as many as 1 equation of profit function, 11 equations of share of expenditure for inputs and one equation of share of output against profit allegedly simultaneously with the restrictions of linearity, symmetry and homogeneity.

To examine the accuracy of the model and the influence of exogenous variables and predetermine variables against endogenous variables, it is necessary F-test and t-test. Measurement used to measure the closeness between the predicted value on the model and the actual value among other measures RMSPE (Root Mean Squares Error Percent) U-theil coefficient and its decomposition. Once the model is said to be precise, then can be done a simulation of the model policy. The variables used in model formulation are summarized in Appendix 1 and the profit model formulations are summarized in Appendix 2.

RESULTS AND DISCUSSION

Sample Characteristics. The level of technical efficiency of farming has been analysed using a method TRANSLOG Stochastic Productivity Frontier by considering the behaviour of farmers in dealing with the risks of farming on a previous paper by the author. The summary can be seen in Table 1.

Table 1 – Distribution of Efficiency Level of Farmers Based on Risk of Behaviour (%)

Categories	Rainy Season			Dry Season		
	Risk averter	Risk neutral	Risk taker	Risk averter	Risk neutral	Risk taker
0.31 - 0.51	10.13	-	-	11.39	-	-
0.52 - 0.72	26.58	-	20.97	30.38	-	1.61
0.73 - 0.95	63.29	100	79.03	58.23	100	98.39

The behaviour of farmers unwilling to face the risk of achieving an efficiency of 73-95% as many as 63.29 in the rainy season and 58.23% in the dry season. For farmers who fall into the category of risk neutral and risk takers outnumber that can achieve higher levels of efficiency. In the Table 2 to 8 are the example of characteristics of the sample in the use of inputs based on risk behaviour, presented in Appendix 3.

Analysis Results of Technical Inefficiency Level Towards Profit. The level of technical efficiency has been obtained from measurements in the previous paper, then to find the level of technical inefficiency is 1 - the achievement of technical efficiency. Data the level of these

technical inefficiencies will be included in the analysis of farming profit. Translog profit function that takes into account the level of technical inefficiency is estimated using SUR (seemingly unrelated regression) which requires a two-stage estimation, namely the first stage, residual OLS is used to estimate the cross-equation error covariances, The second stage is estimated through regression parameter using the generalized least squares estimation of covariance. If the cross-equation error covariances is zero, the estimated OLS and SUR become equivalent. If the cross-equation error covariances is not zero, the estimated SUR has a standard error smaller than the OLS estimates (Sitepu, 2002).

Process analysis is then performed not by pooling data because of the limitations of ownership of software, so using cross section data with the support of a dummy 2 planting season. Translog profit function is analysed simultaneously with the share of expenditure for the inputs and production against profit with the restrictions / limitations of linearity, homogeneity and symmetrical. Analysis of the labors of men and women together into labor variable, because the wages of male labor and the wages of women workers who are not much different causing regression analysis violates the assumption of multicollinearity.

Table 9 – Profit Function with Consideration of Technical In-Efficiency Levels

No	Variables	Estimated Parameters	No	Variables	Estimated Parameters	No	Variables	Estimated Parameters
1	Intercep	2.275****	29	lnPBoPTKo	0.013****	57	lnPPSoZ2o	0.0067****
2	LnPBo	0.369****	30	lnPBoPOBKo	0.0028*	58	lnPSPoPOo	-0.033*
3	LnPUo	-0.38****	31	lnPBoPOBLo	0.007****	59	lnPSPoPTKo	0.258****
4	lnPZAo	-0.675****	32	lnPBoZ1o	1.28E-06	60	lnPSPoPOBKo	0.00168****
5	lnPPSo	-1.06****	33	lnPBoZ2o	0.00226****	61	lnPSPoPOBLo	0.00052****
6	lnPSPo	-0.39****	34	lnPUoPZAo	0.1762****	62	lnPSPoZ1o	0.0167****
7	LnPOo	-1.91****	35	lnPUoPPSo	0.1318****	63	lnPSPoZ2o	0.0025****
8	lnPTKo	3.639****	36	lnPUoPSPo	0.1399****	64	lnPOoPTKo	0.2765****
9	lnPOBKo	0.642****	37	lnPUoPOo	0.0166****	65	lnPOoPOBKo	0.1689****
10	lnPOBL	-0.097****	38	lnPUoPTKo	0.0442****	66	lnPOoPOBLo	-0.0397****
11	lnZ1o	0.7277****	39	lnPUoPOBKo	-0.0054****	67	lnPOoZ1o	0.023****
12	lnZ2o	-0.254****	40	lnPUoPOBLo	0.005****	68	lnPOoZ2o	0.057****
13	lnPBo2	-0.29****	41	lnPUoZ1o	0.005****	69	lnPTKoPOBKo	-0.023****
14	lnPUo2	-0.561****	42	lnPUoZ2o	-0.0014****	70	lnPTKoPOBLo	0.006
15	lnPZAo2	-0.415****	43	lnPZAoPPSo	0.1255****	71	lnPTKoZ1o	0.0066****
16	lnPPSo2	-0.522****	44	lnPZAoPSPo	-0.148****	72	lnPTKoZ2o	0.0074****
17	lnPSPo2	-0.4479****	45	lnPZAoPOo	-0.018	73	lnPOBKoPOBLo	0.00229
18	lnPOo2	-0.272****	46	lnPZAoPTKo	0.181****	74	lnPOBKoZ1o	0.008****
19	lnPTKo2	-0.992****	47	lnPZAoPOBKo	-0.0115	75	lnPOBKoZ2o	0.0159****
20	lnPOBKo2	-0.147****	48	lnPZAoPOBLo	-0.00788	76	lnPOBLoZ1o	0.0054****
21	lnPOBLo2	0.00149	49	lnPZAoZ1o	0.0322****	77	lnPOBLoZ2o	0.0143****
22	lnZ1o2	-0.1225****	50	lnPZAoZ2o	0.0074****	78	lnz1oz2o	0.0022****
23	lnZ2o2	-0.114****	51	lnPPSoPSPo	0.1169****	79	Dtehn	0.07****
24	lnPBoPUo	0.049****	52	lnPPSoPOo	-0.1597****	80	leff	-2.61****
25	lnPBoPZAo	0.078****	53	lnPPSoPTKo	0.2226****	82	dmt	-0.002
26	lnPBoPPSo	0.063****	54	lnPPSoPOBKo	-0.0126*			
27	lnPBoPSPo	0.09****	55	lnPPSoPOBLo	0.005****			
28	lnPBoPOo	-0.019****	56	lnPPSoZ1o	0.0226****			

Notes : F-value 35.78 (<0.0001); $R^2 = 0.82$; dw = 1.658

****, **, *, confidence level 99%, 97.5 % and 90 %.

Profit Translog Model analysed simultaneously with 13 equation of share of input costs against profit. So that the model used 13 endogenous variables, 261 parameters and 13 structural equations, the results of model analysis shows the variation of R^2 varies between 17% and 99.1%. R^2 indicates that the amount of the contribution of the explanatory variables and exogenous in the equation against variation in the endogenous variables. Statistical tests using the F-test shows that the explanatory variables on all structural equations influence simultaneously convincingly confidence level of over 99%. R^2 obtained is high at 0.82, meaning that the variables in the model indicates that the amount of the contribution of the explanatory variables and exogenous in the equation against variation in the endogenous variables, while the F-value of 35.78 and the Durbin Watson at 1,658. The results of analysis

with 81 parameters indicate as many as 10 parameters that do not affect the endogenous variables where the parameter is suggestive of exogenous variables dummy growing season and another constitute allegation of predetermined variables of equations of translog profit model that considers levels of technical inefficiency. The exogenous variables included in the equation are the dummy technology, the level of technical inefficiency and dummy growing season. Dummy technology shows the differences in the optimal profits obtained by farmers as a result of the application of technology. Technical inefficiency variables shown to affect negatively on optimal profits, the higher the level of inefficiency by 1%, it will decrease the optimal profit of farmers amounted to 2,618%, presented in Table 9.

Analysis of the profit function, would be more appropriate when using calculations share of input expenditure against profits. Results of analysis for the share of expenditure for inputs against profit presented in Appendix 4.

The Results of Simulation Determines the Policy to Increase Profit of Rice Farmers. Before carrying out the simulation, the model of translog profit function, share of expenditure for inputs and share of output against profit required validation procedures beforehand in order that the predicted value produced does not deviate from the actual value. Results of analysis of the value of the U-Theil generates between 0.01 - 0.4; UM values between 0.0 - 0.82; US values between 0.01 to 0.41, while the values of UC between 0.18 - 0.93. Value of U-Theil and UM almost zero and the value of UC close to one; only on SYpr equation that generates the value of the U-Theil (0.03), UM value (0.82), and the value of UC is a bit far from the one that is 0.18. From this analysis, then the model function in rice farming profit above can be used for simulation. Simulation scenarios are divided into two single simulation and double simulation, presented in the following table:

Table 10 – Impact of Single and Double Policy Simulations That Change in Profits

No	Scenarios	Basic Estimations	Prediction Estimation	Changes in Profits	Ranking
Single					
1	Sim 1 (HPP 15%)	17,194,427	20,234,424	15.02	8
2	Sim 2 (Subsidy of Px 25%)	17,194,427	17,543,532	1.99	13
3	Sim 3 (HT)	17,194,427	17,582,170	2.21	12
4a.	Sim 4a (Ineff Pend)	17,194,427	20,103,327	14.47	7
b.	Sim 4b (Ineff PR)	17,194,427	20,534,067	16.26	6
Double					
5	Sim 1 dan 2 (HPP and Subsidy)	14,951,065	16,109,116	7.19	10
6	Sim 1 dan 3 (HPP and HT)	14,951,065	16,149,439	7.42	9
7a	Sim 1 dan 4a (HPP and IneffPend)	14,951,065	18,463,306	19.02	5
b.	Sim 1 dan 4b (HPP and IneffPR)	14,951,065	18,727,610	20.17	4
8	Sim 2 dan 3 (Subsidy and HT)	14,951,065	19,052,252	21.53	3
9a.	Sim 2 dan 4a (Subsidy and IneffPend)	17,194,427	17,428,126	1.34	14
b.	Sim 2 dan 4b (Subsidy and IneffPR)	17,194,427	17,801,546	3.41	11
10a.	Sim 3 dan 4a (HT and IneffPend)	17,194,427	23,752,441	27.61	2
b.	Sim 3 dan 4b (HT and ineffPR)	17,194,427	24,258,943	29.12	1

Single policy simulation results shown that increasing farmers' profits can be acquired highest by efforts to reduce technical inefficiency through improved managerial capabilities of farmers namely to increase farmers' attitudes and behaviour in the face of the risks of farming. While the double policy simulation results highest increase in profit is the policy of hand tractor support to farmers' groups and efforts to reduce technical inefficiency through improved managerial capacity of farmers namely to increase farmers' attitudes and behaviour in the face of the risks of farming.

CONCLUSIONS

Based on the research that has been done, the conclusion can be formulated as follows: the level of technical inefficiency that occurs in rice farming in Malang Regency will significantly affect the achievement of a profit of -2.61. This means that the higher the level of

technical inefficiency single digit then the decrease a profit of 2.61 and simulation scenarios either single or double may give impact to increased profits on rice farmers between 1.99% - 29.12%. The best single policy simulation is an effort to decrease the level of technical inefficiency through the improvement managerial capacity of farmers, which is the attitude and behaviour of farmers in dealing with risks of farming with the changes increase profit of 16.26%. While the double policy simulation is best of hand tractor support to farmer group in order to reduce the cost of renting a tractor and efforts to reduce the level of technical inefficiency through increasing farmers' attitudes and behaviour in the face of the risk of farming with changes increase profit of 29.12%.

POLICY IMPLICATIONS

The implications for the government policy is how to increase the courage to take decisions in the allocation of input that is with training, informal education (Integrated Pest Management Field School, Integrated Crop Management Field School), counseling, and mentoring of technology, so that the information to induction of technology to be precise by farmers, policy in facilitating access to credit through local financial institutions, policy easy access / pricing information system through the department of agriculture and immediately apply to the whole area of insurance, for farmers to take the risk to produce because they feel safe and protected crop from plant pests and natural events.

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APPENDIX 1

Variables	Descriptions
Prfo	Actual profit divided by the price of dry milled rice stated in IDR
Pbo	The price of seeds normalized by the output price
Puo	The price of urea fertilizer normalized by output price
PZAo	The price of ZA fertilizer normalized by output price
PPSo	The price of NPK Phonska fertilizer normalized by output price
PSPo	The price of SP36 fertilizer normalized by output price
Poo	The price of organic fertilizer normalized by output price
PTKo	Labor wages of men and women normalized by the output price
POBKo	Solid pesticide price normalized by the output price
POBLo	Liquid pesticide price normalized by the output price
Z1o	Rent cost / land rent normalized by the output price
Z2o	Rent cost of tractor normalized by the output price
Dtehn	Dummy from the application of technology
leff	Technical inefficiency
Dmt	Dummy growing season
HPP	Government Purchase Price
Px	Input price
leff Pend	The impact of education on inefficiency
leff PR	The impact of the risk behavior on inefficiency
HT	Hand tractor
Sbbpr	Share of expenditure for the purchase of seed towards profits
Sbupr	Share of expenditure for the purchase of urea fertilizer towards profits
Sbzapr	Share of expenditure for the purchase of ZA fertilizer towards profits
Sbpspr	Share of expenditure for the purchase of NPK Phonska fertilizer towards profits
Sbsppr	Share of expenditure for the purchase of SP36 fertilizer towards profits
Sbopr	Share of expenditure for the purchase of organic fertilizer towards profits
Sbtkpr	Share of expenditure for labor towards profits
Sbobjpr	Share of expenditure for the purchase of solid pesticide towards profits
Sbobjpr	Share of expenditure for the purchase of liquid pesticide towards profits
Sbz1pr	Share of expenditure for land rent/tax towards profits
Sbz2pr	Share of expenditure for tractor rent towards profits
Sypr	Share for output towards profits
Py	Output price

APPENDIX 2

Table 2 – Use of Seed (Kg / ha) Based on the Behavior of Risk

Seasons	Risk Averter	Risk Neutral	Risk Taker	Suggestions
Rainy	12.00	11.73	13.79	15
Dry	12.00	12.54	13.61	15

Table 3 – The Use of Fertilizers (kg/ha) on Rainy season

Fertilizers	Risk Averter	Risk Neutral	Risk Taker	Suggestions
Rainy Season				
Urea	297.63	362.22	302.04	300
ZA	107.10	258.33	162.72	200
Phonska	161.20	242.00	243.86	200
SP36	121.65	10.12	24.54	150
Organic	247.28	192.04	322.51	500

Table 4 – The Use of Labors (Man-day)

Seasons	Tenaga Kerja	Risk Averter	Risk Neutral	Risk Taker
Rainy	Male	70	79	83
	Female	64	73	75
Dry	Male	70	77	81
	Female	64	61	68

Table 5 – The Use of Solid Pesticides (kg)

Seasons	Risk Averter	Risk Neutral	Risk Taker
Rainy	9.77	11.65	6.17
Dry	9.74	11.58	6.47

Table 6 – The Use of Liquid Pesticides (liters)

Seasons	Risk Averter	Risk Neutral	Risk Taker
Rainy	2.81	1.68	1.13
Dry	2.82	4.24	2.62

Table 7 – Profits Based on Farmers Risk Behavior on Rainy Season (IDR)

Variables	Risk Averter	Risk Neutral	Risk Taker
Total Cost	6,616,782	8,574,596	8,978,027
Revenue	26,344,580	35,711,111	30,801,229
Profit	19,727,798	27,136,515	21,823,202

Table 8 – Profits Based on Farmers Risk Behavior on Dry Season (IDR)

Variables	Risk Averter	Risk Neutral	Risk Taker
Total Cost	6,779,544	8,249,077	9,230,907
Revenue	26,949,306	34,222,222	36,662,980
Profit	20,169,763	25,973,145	27,432,073

APPENDIX 3

- (1) $\ln prfo = A_0 + A_1 \ln PBo + A_2 \ln PUo + A_3 \ln PZAo + A_4 \ln PPSo + A_5 \ln PSPo + A_6 \ln POo + A_7 \ln PTKo + A_8 \ln POBko + A_9 \ln POBLo + A_{10} \ln Z1o + A_{11} \ln Z2o + A_{12} \ln PBo2 + A_{13} \ln PUo2 + A_{14} \ln PZAo2 + A_{15} \ln PPSo2 + A_{16} \ln PSPo2 + A_{17} \ln POo2 + A_{18} \ln PTKo2 + A_{19} \ln POBko2 + A_{20} \ln POBLo2 + A_{21} \ln Z1o2 + A_{22} \ln Z2o2 + A_{23} \ln PBoPUo + A_{24} \ln PBoPZAo + A_{25} \ln PBoPPSo + A_{26} \ln PBoPSPo + A_{27} \ln PBoPOo + A_{28} \ln PBoPTKo + A_{29} \ln PBoPOBko + A_{30} \ln PBoPOBLo + A_{31} \ln PBoZ1o + A_{32} \ln PBoZ2o + A_{33} \ln PUoPZAo + A_{34} \ln PUoPPSo + A_{35} \ln PUoPSPo + A_{36} \ln PUoPOo + A_{37} \ln PUoPTKo + A_{38} \ln PUoPOBko + A_{39} \ln PUoPOBLo + A_{40} \ln PUoZ1o + A_{41} \ln PUoZ2o + A_{42} \ln PZAoPPSo + A_{43} \ln PZAoPSPo + A_{44} \ln PZAoPOo + A_{45} \ln PZAoPTKo + A_{46} \ln PZAoPOBko + A_{47} \ln PZAoPOBLo + A_{48} \ln PZAoZ1o + A_{49} \ln PZAoZ2o + A_{50} \ln PPSoPSPo + A_{51} \ln PPSoPOo + A_{52} \ln PPSoPTKo + A_{53} \ln PPSoPOBko + A_{54} \ln PPSoPOBLo + A_{55} \ln PPSoZ1o + A_{56} \ln PPSoZ2o + A_{57} \ln PSPoPOo + A_{58} \ln PSPoPTKo + A_{59} \ln PSPoPOBko + A_{60} \ln PSPoPOBLo + A_{61} \ln PSPoZ1o + A_{62} \ln PSPoZ2o + A_{63} \ln POoPTKo + A_{64} \ln POoPOBko + A_{65} \ln POoPOBLo + A_{66} \ln POoZ1o + A_{67} \ln POoZ2o + A_{68} \ln PTKoPOBko + A_{69} \ln PTKoPOBLo + A_{70} \ln PTKoZ1o + A_{71} \ln PTKoZ2o + A_{72} \ln POBkoPOBLo + A_{73} \ln POBkoZ1o + A_{74} \ln POBkoZ2o + A_{75} \ln POBLoZ1o + A_{76} \ln POBLoZ2o + A_{77} \ln LNz1oz2o + A_{78} \ln DTEHN + A_{79} \ln IEFF + A_{80} \ln dmt$
- (2) $Sbbpr = B_0 + B_1 \ln PBo + B_2 \ln PUo + B_3 \ln PZAo + B_4 \ln PPSo + B_5 \ln PSPo + B_6 \ln POo + B_7 \ln PTKo + B_8 \ln POBko + B_9 \ln POBLo + B_{10} \ln Z1o + B_{11} \ln Z2o + B_{12} \ln dtehn + B_{13} \ln Ineff + B_{14} \ln dmt$
- (3) $Sbupr = C_0 + C_1 \ln PBo + C_2 \ln PUo + C_3 \ln PZAo + C_4 \ln PPSo + C_5 \ln PSPo + C_6 \ln POo + C_7 \ln PTKo + C_8 \ln POBko + C_9 \ln POBLo + C_{10} \ln Z1o + C_{11} \ln Z2o + C_{12} \ln dtehn + C_{13} \ln Ineff + C_{14} \ln dmt$
- (4) $Sbzapr = D_0 + D_1 \ln PBo + D_2 \ln PUo + D_3 \ln PZAo + D_4 \ln PPSo + D_5 \ln PSPo + D_6 \ln POo + D_7 \ln PTKo + D_8 \ln POBko + D_9 \ln POBLo + D_{10} \ln Z1o + D_{11} \ln Z2o + D_{12} \ln dtehn + D_{13} \ln Ineff + D_{14} \ln dmt$
- (5) $Sbspr = E_0 + E_1 \ln PBo + E_2 \ln PUo + E_3 \ln PZAo + E_4 \ln PPSo + E_5 \ln PSPo + E_6 \ln POo + E_7 \ln PTKo + E_8 \ln POBko + E_9 \ln POBLo + E_{10} \ln Z1o + E_{11} \ln Z2o + E_{12} \ln DTEHN + E_{13} \ln dmt + E_{14} \ln dmt$
- (6) $Sbspr = F_0 + F_1 \ln PBo + F_2 \ln PUo + F_3 \ln PZAo + F_4 \ln PPSo + F_5 \ln PSPo + F_6 \ln POo + F_7 \ln PTKo + F_8 \ln POBko + F_9 \ln POBLo + F_{10} \ln Z1o + F_{11} \ln Z2o + F_{12} \ln DTEHN + F_{13} \ln Ineff + F_{14} \ln dmt$
- (7) $Sbopr = G_0 + G_1 \ln PBo + G_2 \ln PUo + G_3 \ln PZAo + G_4 \ln PPSo + G_5 \ln PSPo + G_6 \ln POo + G_7 \ln PTKo + G_8 \ln POBko + G_9 \ln POBLo + G_{10} \ln Z1o + G_{11} \ln Z2o + G_{12} \ln DTEHN + G_{13} \ln Ineff + G_{14} \ln dmt$
- (8) $Sbtpr = H_0 + H_1 \ln PBo + H_2 \ln PUo + H_3 \ln PZAo + H_4 \ln PPSo + H_5 \ln PSPo + H_6 \ln POo + H_7 \ln PTKo + H_8 \ln POBko + H_9 \ln POBLo + H_{10} \ln Z1o + H_{11} \ln Z2o + H_{12} \ln dtehn + H_{13} \ln Ineff + H_{14} \ln dmt$
- (9) $Sbobpr = I_0 + I_1 \ln PBo + I_2 \ln PUo + I_3 \ln PZAo + I_4 \ln PPSo + I_5 \ln PSPo + I_6 \ln POo + I_7 \ln PTKo + I_8 \ln POBko + I_9 \ln POBLo + I_{10} \ln Z1o + I_{11} \ln Z2o + I_{12} \ln DTEHN + I_{13} \ln Ineff + I_{14} \ln dmt$
- (10) $Sboblpr = J_0 + J_1 \ln PBo + J_2 \ln PUo + J_3 \ln PZAo + J_4 \ln PPSo + J_5 \ln PSPo + J_6 \ln POo + J_7 \ln PTKo + J_8 \ln POBko + J_9 \ln POBLo + J_{10} \ln Z1o + J_{11} \ln Z2o + J_{12} \ln dtehn + J_{13} \ln Ineff + J_{14} \ln dmt$
- (11) $Sbz1pr = K_0 + K_1 \ln PBo + K_2 \ln PUo + K_3 \ln PZAo + K_4 \ln PPSo + K_5 \ln PSPo + K_6 \ln POo + K_7 \ln PTKo + K_8 \ln POBko + K_9 \ln POBLo + K_{10} \ln Z1o + K_{11} \ln Z2o + K_{12} \ln dtehn + K_{13} \ln Ineff + K_{14} \ln dmt$
- (12) $Sbz2pr = L_0 + L_1 \ln PBo + L_2 \ln PUo + L_3 \ln PZAo + L_4 \ln PPSo + L_5 \ln PSPo + L_6 \ln POo + L_7 \ln PTKo + L_8 \ln POBko + L_9 \ln POBLo + L_{10} \ln Z1o + L_{11} \ln Z2o + L_{12} \ln DTEHN + L_{13} \ln IEFF + L_{14} \ln Dmt$
- (13) $Sypr = M_0 + M_1 \ln PBo + M_2 \ln PUo + M_3 \ln PZAo + M_4 \ln PPSo + M_5 \ln PSPo + M_6 \ln POo + M_7 \ln PTKo + M_8 \ln POBko + M_9 \ln POBLo + M_{10} \ln Z1o + M_{11} \ln Z2o + M_{12} \ln Py + M_{13} \ln DTEHN + M_{14} \ln IEFF + M_{15} \ln Dm$

APPENDIX 4

Table 11 – Share of Expenditure for Inputs towards Profit

Variables	Share of Input Expenditure towards Profit						Share of Input Expenditure towards Profit				
	Seed	Urea Fertilizer	ZA Fertilizer	NPK Ps Fertilizer	SP36 Fertilizer	Organic Fertilizer	Labor	Solid Pesticides	Liquid Pesticides	Rent/ Tax of land	Rent of tractor
Intercept	0.1144	0.273	-0.473	-0.641	-0.81	-1.09	1.078	0.2145	-0.06	0.087	0.0454
lnPBo	-0.29	0.049	0.078	0.063	0.09	-0.019	0.013	0.0028	0.007	1.28E-06	0.00226
lnPUo	0.049	-0.561	0.176	0.1318	0.1399	0.0166	0.0442	-0.0054	0.005	0.005	-0.0014
lnZAo	0.078	0.176	-0.415	0.1255	-0.148	-0.018	0.181	-0.0115	-0.00788	0.0322	0.0074
lnPPSo	0.063	0.1318	0.1255	-0.522	0.1169	-0.1597	0.2226	-0.0126	0.005	0.0226	0.0067
lnPSPo	0.09	0.1399	-0.148	0.1169	-0.4479	-0.033	0.258	0.00168	0.00052	0.0167	0.0025
lnPOo	-0.019	0.0166	-0.018	-0.1597	-0.033	-0.272	0.2765	0.1689	-0.0397	0.023	0.057
lnPTKo	0.013	0.0442	0.181	0.2226	0.258	0.2765	-0.992	-0.023	0.006	0.0066	0.0074
lnPOBKo	0.0028	-0.0054	-0.0115	-0.0126	0.00168	0.1689	-0.023	-0.147	0.00229	0.008	0.0159
lnPOBLo	0.007	0.005	-0.00788	0.005	0.00052	-0.0397	0.006	0.00229	0.00149	0.0054	0.0143
lnZ1o	0.000001276	0.005	0.0322	0.0226	0.0167	0.023	0.0066	0.008	0.0054	-0.1225	0.0022
lnZ2o	0.00226	-0.0014	0.0074	0.0067	0.0025	0.057	0.0074	0.0159	0.0143	0.0022	-0.114
Dummy Application of Technology (Dtehn)	0.0032	-0.0024	-0.037	-0.00675	-0.00845	0.0872	-0.00094	-0.055	-0.035	0.0015	0.00697
leff	-0.04	0.181	0.361	0.2563	0.2411	0.965	-0.465	0.02697	-0.00655	-0.1	-0.094
Dummy rainy and dry seasons (Dm)	-0.0027	-0.01144	0.0128	0.0008	0.179	0.039	0.0369	0.0175	-0.3014	-0.00067	-0.0014

****, ***, **, * ; Convindence level at 99%, 97.5%, 95 % and 90%