Technical efficiency of Mirahawatte organic tea smallholders: a stochastic frontier approach

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Introduction

Organic agriculture is now becoming very famous among Sri Lankan farmers as it is able to catch more foreign exchange to the country. World public is more concerning on sustainable agro-product consumption to secure the economic, environmental and social benefits. Tea is one of the most prominent organic export crops in Sri Lanka. The relevant actions need to take to develop the organic tea production in the country. Before moving to that, most effective solution to upgrade the production is increasing the technical efficiency; ability to produce maximum output using existence inputs and technology. Measuring the technical efficiency will prove the actual sustainability of tea industry in economics terms.

Sri Lanka tea industry consists with estate sector and tea smallholdings. Contribution from the tea smallholders to the national tea production was 72% in 2013 (Ministry of Plantation Industries, 2013).As tea smallholders play a major role in Sri Lankan economy, analyzing technical efficiency is imperative. Main objectives targeted to measure the value of technical efficiency of tea smallholders in Mirahawatte and to find out the determinants of technical efficiency of organic tea smallholders in Mirahawatte.

Methodology

Technical efficiency of Mirahawatte organic tea smallholders were measuredin this study with 71 organic tea small holders registered under Marginalized Organic Producer's Association. Stochastic frontier model was used to estimate the technical efficiency. Primary and secondary panel data were collected during the period of 2011/2012 to 2013/2014. Technical efficiency was estimated by a stochastic frontier function using a Cobb-Douglas model, incorporating technical inefficiency effect model. In Cobb-Douglas model effect of eight inputs against output was measured. In technical inefficiency function, sixteen variables were identified as efficiency components oftechnical inefficiency. Data ware analyzed using STATA version 11 and frontier 4.1c computer programme.

$= (\quad + \quad - \quad);$ (Battese andCoelli, 1995)

Cobb-Douglas model specification is,

$( ) = {}_0 + {}_1 ({}_1) + {}_2 ({}_2) + {}_3 ({}_3) + {}_4 ({}_4) + {}_5 ({}_5) + {}_6 ({}_6) + {}_7 ({}_7) + {}_8 ({}_8) + \quad -$

Specification of technical efficiency function is,

$= {}_0 + {}_1({}_1) + {}_2({}_2) + {}_3({}_3) + {}_4({}_4) + {}_5({}_5) + {}_6({}_6) + {}_7({}_7) + {}_8({}_8) + {}_9({}_9) + {}_{10}({}_{10}) + {}_{11}({}_{11}) + {}_{12}({}_{12}) + {}_{13}({}_{13}) + {}_{14}({}_{14}) + {}_{15}({}_{15}) + {}_{16}({}_{16}) +$

Table 1: Description of variables of Cobb-Douglas model

Notation	Variable	Description
Y	Output	Kilograms
	Parameter for intercept of regression line	
	Land extent	Acre
	Family labour	Mandays
	Hired labour	Rupees
	Compost utilization	Kilograms
	Liquid fertilizer utilization	Litres
	Plant protection utilization	Grams
	Dolomite utilization	Kilograms
	Poultry manure utilization	Kilograms
	Random error	
	Efficiency component of technical inefficiency	

Table 2 : Description of the variables of the technical inefficiency model

Notation	Variable	Description
	Age of farmer	Years
	Gender	Dummy (1=male,0=female)
	Occupation dummy 1	Dummy (1=none, 0=otherwise)
	Occupation dummy 2	Dummy (1=informal, 0=otherwise)
	Occupation dummy 3	Dummy (1=formal, 0=otherwise)
	Experience in tea cultivation	Years
	Experience in organic farming	Years
	Education	Scored (1=below O/L, 2=O/L, 3=A/L,4=Degree)
	Other income	Rupees per month
	Age of plantation	Years
	Pruning frequency	Years
	Pruning practice	Dummy (1=yes, 0=no)
	Training	Times
	Post	Dummy (1=yes, 0=no)
	Crop dummy 1	Dummy (1=VP, 0=otherwise)
	Crop dummy 2	Dummy (1=seedling, 0=otherwise)
	Unobservable random variable	

Results and Discussion

According to the maximum likelihood estimates for the prameters of stochastic frontier, land extent became significant at 1% significant level and family labour and hired labour became significant at 10% significant level. All the variables had a positive relationship with the output. Gamma (γ) value is 0.626. Accordingly, 62.6% of random variation on organic tea production is explained by inefficiency.

Maximum likelihood estimates of parameters for the inefficiency model are mentioned in Table 4. Age, gender, occupation dummy 1, occupation dummy 3, experience in tea cultivation, experience in organic farming, education and crop dummy 2 become significant. According to those results, technical efficiency would be increased by increasing younger, male, experienced and VP tea cultivated smallholders. Unemployed and the smallholders engaged in formal occupations obtained more efficiency.The mean technical efficiency was found to be 71.39%. Technical efficiency ranged between 10.12% and 94.45%.

Table 3: OLS and Maximum Likelihood Estimates for the parameters of stochastic frontier

Variable	Parameter	Coefficient		SE		t ratio	
		OLS	MLE	OLS	MLE	OLS	MLE
Constant	β_0	5.758***	7.219***	0.309	0.432	18.587	16.68
Land extent	β_1	0.862***	1.168***	0.111	0.102	7.712	11.348
Family labour	β_2	0.093**	0.069*	0.041	0.038	2.281	1.809
Hired labour	β_3	0.077***	0.04*	0.019	0.02	3.87	1.917
Compost	β_4	0.024	0.006	0.019	0.018	1.209	0.367
Liquid fertilizer	β_5	0.065**	-0.008	0.03	0.035	2.12	-0.246
Plant protection	β_6	0.048	0.045	0.041	0.042	1.093	1.111
Dolomite	β_7	-0.022	-0.0001	0.029	0.03	-0.765	-0.004
Poultry manure	β_8	-0.0009	0.0008	0.022	0.021	-0.043	0.042
σ^2	0.387						
γ	0.626						
Log likelihood		-0.00011	-0.007				
LR test		0.663					

: Significance at 10%, **: Significance at 5%, *: Significance at 1%*

Table 4: Determinants of inefficiency of Cobb-Douglas model for organic tea small holders

Variable	Parameter	Coefficient	Standard error	t ratio
Age	δ_1	0.07***	0.015	4.451
Gender	δ_2	-1.652***	0.49	-3.31
Occupation dummy 1	δ_3	-1.328**	0.65	2.042
Occupation dummy 2	δ_4	-0.57	0.578	-0.986
Occupation dummy 3	δ_5	-1.705*	0.978	-1.743
Experience in tea	δ_6	-0.042**	0.02	-2.099
Experience in organic	δ_7	-0.39***	0.118	-3.304
Education	δ_8	1.202***	0.257	4.667
Other income	δ_9	-0.00001	0.00001	-0.955
Age of plantation	δ_{10}	-0.005	0.03	0.179
Pruning frequency	δ_{11}	-0.007	0.063	-0.12
Pruning practice	δ_{12}	0.081	0.351	0.231
Training	δ_{13}	-0.176	0.162	-1.086
Post	δ_{14}	-0.594	0.546	-1.088
Crop dummy 1	δ_{15}	-0.365	0.522	-0.7
Crop dummy 2	δ_{16}	1.746**	0.7382.365	

: Significance at 10%, **:Significance at 5%, *:Significance at 1%*

Conclusion

There is still 28.61% of remaining potential to develop the output levels without increasing input levels and technology. Several policy recommendations can be given. Empowering policies to attract especially young people and females, organizing special extension programmes for elder smallholders, arranging regular meetings among farmer groups to share knowledge from experienced farmers and government involvement to increase replanting subsidy are the identified recommendations.

References

Battesse, G. E and Coelli, T. J. (1995). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function For Panel Data. Empirical Economics, 325-332.

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