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CONTENTS

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INTRODUCTION

REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESIS (ES)

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

LIMITATIONS

SCOPE FOR FURTHER RESEARCH

REFERENCES

APPENDIX/ANNEXURE

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PRODUCTIVITY OF AGRICULTURAL EXTENSION PACKAGE (CASE OF WOLAITA ZONE)

TADELE TAFESE HABTIE
HEAD
DEPARTMENT OF ECONOMICS
WOLAITA SODO UNIVERSITY
WOLAITA SODO TOWN

ABSTRACT

This study assessed the impact of extension package participation of the farm households on the productivity of crop production in Wolaita zone. It made use of survey data of 149 full package farmers and 151 partial package farmers. In order to measure the total factor productivity differentials, this study use the transitive version of Tornqvist index. To identify factors affecting farm level total factor productivity we used ordinary least square. Thus, results from the findings showed that partial package farmers are about 69% less in total factor productivity compared to full package farmers showing engaging in extension package fully has advantage in crop production. Results of the ordinary least square regression of total factor productivity showed that only non-farm income and distance to market have significant positive effect on total factor productivity differential. Finally, it was recommended that agricultural support services should direct their efforts to make farmers fully adopt agricultural extension packages.

KEYWORDS

Wolaita Zone, TFP, full package farmers, partial package farmers, tornqvist index.

INTRODUCTION

It is known that Agriculture remained to be the mainstay of Ethiopian economy accounting about 41.6% of the total economy in 2010 (GTP, 2010). This implies that the development of the Ethiopian economy heavily depends upon the speed with which agricultural growth is achieved. In an effort to achieve agricultural growth, the Government of Ethiopia (GoE) has adopted different institutional support services that need to catalyze this growth. Wolaita Agricultural Development Unit (WADU) was one of such institutions providing support services in Wolaita zone starting from 1970.

Following the 1991 market liberalization, Agricultural Development Led Industrialization (ADLI), introduce Participatory Agricultural Demonstration Extension of Technology (PADETS) designed to take major role in increasing productivity and production of small holding farmers. This program involves establishment of farmer training centers (FTC) for farmers to receive information, training, demonstration and advice. PADETS also involves provision of inputs, credit and information on agricultural technology (Alemu et al, 2009). This paper attempts to examine the impact of agricultural extension packages on the crop productivity of farmers in the rural areas of Wolaita zone by using cross-sectional data.

REVIEW OF LITERATURE

At a basic level, productivity examines the relationship between input and output in a given production process (Coelli et al. 1996). Productivity is then expressed in an output versus input formula for measuring production activities. It does not merely define the volume of output, but output obtained in relation to the resources employed. Hence, the analytical framework that handles productivity is theory of production, which postulates a well-defined relationship between output and factor inputs.

Productivity can be conceptualized into two main components, partial factor productivity (PFP) and total factor productivity (TFP). PFP (average product) is defined as the rate of output to a specific input whereas TFP is a ratio of total outputs (measured in an index form) to total inputs (also measurement as an index). If the ratio of total outputs to total inputs is increasing, then the ratio can be interpreted as more outputs can be obtained for a given input level. Hence, total TFP captures the growth or changes in outputs not accounted for the growth or changes in factor inputs.

The advantage of the concept of TFP relies on its ability to explain productivity for the whole inputs used in the production process. That is, TFP approach is found to be suitable for cases where the complexity and diversity of production system is large (like case of smallholder farming in Ethiopia). Moreover, the superiority of the method of TFP over the PFP emerges from the fact that PFP is misleading if there is high substitutability between inputs (Gavian and Ehui, 1996 as cited in Gezahegn et. al., 2006). However, PFP measures are sometimes useful when the objectives of producers, or the constraints facing them, are either unknown or unconventional.

The growth of TFP overtime (across cross-section) can result from several factors. First, changes in efficiency: as change in skills in using the existing techniques of production changes productivity; second, when there is variation in scale or level of production overtime: as the output per unit of input varies with the scale of production; and third, technological change which pushes the production frontier upward. Technological change itself can result from quality improvement in input or quality improvements in the production process (like using improved farming practices of production such as ploughs, fertilizers, pesticides, improved seeds).

The most commonly used measures of growth in TFP are growth accounting, data envelopment analysis (DEA) and index number approaches. In growth accounting approach, we specify a production function that is both stable across time (cross section) and levels of aggregation. The selected aggregate production function is then used as the basis for decomposing economic growth into components attributed to growth in the various input factors. In this method, the growth accounting residual is an index number measure of TFP growth.

The Data Envelopment Analysis (DEA) is a special mathematical linear programming model. DEA approach to TFP growth measurement decomposes changes in TFP into a component that results from a move towards the efficiency frontier (technical efficiency change) and a second component resulting from a shift in the frontier (technological change).

The index number approach uses theory of index numbers. This method is similar to growth accounting approach but does not require specifying a production function. It needs a detailed information on outputs, inputs and prices indeed. It essentially measures TFP as a ration of the index of output to input, whereby a value larger than 1 is considered as resulting from growth in TFP. Laspeyres, Paasche, Fisher and Törnqvist indices are among the commonly used indices in the wide literature of index numbers. The major difficulty with the index number approach is to derive aggregate output and input measures that represents the numerous outputs and inputs involved in most production processes.

The Fisher and Törnqvist indices satisfy all axiomatic tests except for circularity (transitivity). These two indices are generally preferred for productivity measurement due, in part, to satisfying index number properties. In practice, the indices yield extremely similar values, especially if computed for periods (cross sections) that are not very far apart.

Moreover, Caves, Christensen, and Diewert (CCD) has converted non-transitive Törnqvist indices in to transitive Törnqvist. This property is especially important for cross-sectional data in which one makes pair-wise comparisons for all firms in s and t categories. Suppose we start with Törnqvist indices, Q^T_{st} for all pairs, s and t. Then, the transitive Törnqvist indices, Q^T_{st} is given by:

$$Q_{st}^{CCD} = \prod_{i=1}^{M} \left[Q_{sr}^{T} \times Q_{rt}^{T} \right]^{1/M} \quad \text{.... Eq. (1)}$$

The log change in this transitive Törnqvist indices is:

$$\ln Q_{st}^{CCD} = \frac{1}{M}\sum_{r=1}^{M}\left[\ln Q_{sr}^{T} - \ln Q_{rt}^{T}\right]$$

$$= \frac{1}{2}\sum_{i=1}^{N}\left(\omega_{it} + \overline{\omega}_i\right)\left(\ln q_{it} - \ln \overline{q}_i\right) - \frac{1}{2}\sum_{i=1}^{N}\left(\omega_{is} + \overline{\omega}_i\right)\left(\ln q_{is} - \ln \overline{q}_i\right) \quad \text{.... Eq. (2)}$$

$$\overline{\omega}_i = \frac{1}{M}\sum_{j=1}^{M}\omega_{ij}$$

Where is arithmetic mean of output (input) shares for each commodity i (each input i)

$$\overline{\ln q_i} = \frac{1}{M}\sum_{j=1}^{M}\ln q_{ij}$$

is arithmetic mean of each log output i (each log input i) over M

M = number of enterprises (like households, countries, companies etc.) or time periods.

Caves, Christensen, and Diewert show that under certain circumstances, the Törnqvist index (which is the discrete counterpart of the Divisia index) is equivalent to the geometric mean of two Malmquist output productivity indexes. Moreover, they show that the Törnqvist index is "exact" for technology that is trans-log (i.e., one can compute a nonparametric productivity index that is "exactly" consistent with the trans-log form). Furthermore, since the trans-log is flexible, the Törnqvist index is "superlative" in the terminology coined by W. Erwin Diewert (Diewert, 1976).

IMPORTANCE OF THE STUDY

This research lend evidence to:

- Identify the contribution of agricultural extension packages to crop productivity
- Help decision makers how to formulate policy based on the research findings
- Recommend how to implement agricultural extension packages

STATEMENT OF THE PROBLEM

The introduction of Participatory Agricultural Demonstration Extension of Technology (PADETS) since early 1990s has been taken as a major tool to transform agriculture in the Agricultural Development Led Industrialization (ADLI) program of the government of Ethiopia. PADETS which represents a significant public investment amounting for almost 2% of agricultural GDP per annum is found to have surprisingly several views regarding its impact (David J. Spielman, 2008). Some of the surveys suggest that despite this huge investment, production and efficiency has increased little. The extension system also does little to encourage and exploit the inherent resourcefulness of those who work closely with farmers (Gezeheghn et al., 2006). Moreover, extension workers saw their role mostly as distributors of fertilizer and credit rather than technical advisors (Abate Bekele et al, 2006). However, other studies found such services contribute significantly to the agricultural productivity in Ethiopia (Alemu et al, 2009).

Despite of these studies on the impact of extension programs at national level, little is done to assess the impact of these extension program at zonal or/and Woreda level. Moreover, though agricultural extension program has long history in Wolaita (WADU, 1970), nothing is done to assess its recent development. Hence, this study will look in to the impact of the agricultural extension package on the crop productivity of farmers in Wolaita zone.

OBJECTIVES

The general objective of the study is to assess the impact of the agricultural extension package on the productivity of farmers in Wolaita zone. Specifically, the study aims at:

1. To look in to productivity differentials between fully and partially participating extension farmers
2. To identify determinants of productivity differentials between fully and partially participating extension farmers

HYPOTHESIS

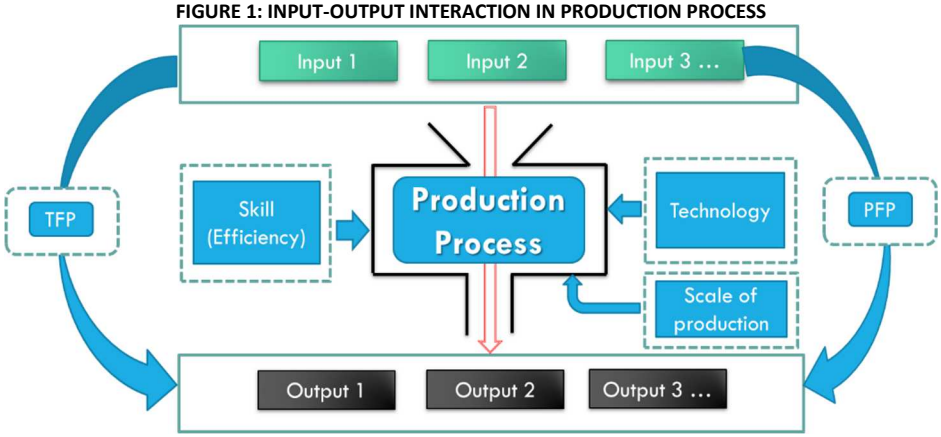
There is no significant contribution of agricultural extension packages to the crop productivity of farmers in rural Wolaita zone.

RESEARCH METHODOLOGY

LOGICAL FRAMEWORK

In this study we assume the multi-input and multi-output in production process. Moreover, it is assumed that the production process is affected by skill of operators, technology available and scale of production like market expansion. Advancement in technology induces quality improvement in production process where as improvements in skill of operators brings change in efficiency of production process.

FIGURE 1: INPUT-OUTPUT INTERACTION IN PRODUCTION PROCESS



Likewise change in scale of production like expansion of market impacts the production process. When we deal with the productivity measures in such framework, Total factor productivity (TFP) explain productivity for the whole inputs used in the production process while Partial factor productivity (PFP) explains rate of

output to a specific input. Thus the productivity (TFP in our case) will be affected by skill, technology and scale of production in which agricultural extension packages are intended to bring.

MEASUREMENT OF TOTAL FACTOR PRODUCTIVITY DIFFERENTIALS

In this study the change in transitive Törnqvist indices (Caves, Christensen, and Diewert (1982a)) is used to calculate change in TFP between for full-package (t) and partial-package farmers (s):

$$\ln TFP_{st} = [\frac{1}{2}\sum_{i=1}^{N}(\omega_{it} + \overline{\omega_i})(\ln Y_{it} - \ln \overline{Y_i}) - \frac{1}{2}\sum_{i=1}^{N}(\omega_{is} + \overline{\omega_i})(\ln Y_{is} - \ln \overline{Y}_i)]$$
$$- [\frac{1}{2}\sum_{i=1}^{N}(\upsilon_{it} + \overline{\upsilon}_i)(\ln X_{it} - \ln \overline{X}_i) - \frac{1}{2}\sum_{i=1}^{N}(\upsilon_{is} + \overline{\upsilon}_i)(\ln X_{is} - \ln \overline{X}_i)] \quad \text{.... Eq. (3)}$$

$\overline{\omega_i} = \frac{1}{M}\sum_{j=1}^{M}\omega_{ij}$ is arithmetic mean of output shares for each commodity (crop type) i

$\overline{\upsilon}_i = \frac{1}{M}\sum_{j=1}^{M}\upsilon_{ij}$ is arithmetic mean of input shares for each input i

$\overline{\ln Y_i} = \frac{1}{M}\sum_{j=1}^{M}\ln Y_{ij}$ is arithmetic mean of each log output i over M

$\overline{\ln X_i} = \frac{1}{M}\sum_{j=1}^{M}\ln X_{ij}$ is arithmetic mean of each log input i over M and M = number of households

The multiple regressions model is employed to identify the determinants of TFP as follows:

$$TFP_i = \alpha_i + \sum_{s=1}^{17}\alpha_s\psi_{si} + \eta_i \quad \text{.... Eq. (4)}$$

Where: *S:* s^{th} determinant; i: the i^{th} household (HH); ψ_{Si}: Land size (Timad), Labor power (Labor days), Draft power (Timad oxen days), Value of seed (Birr), Value of fertilizer, HH age, HH sex, HH farming experience, HH education, Dependency ratio, Distance from farmer training center (FTC), HH nonfarm income, Number of plots owned, Distance to local market (hours), η_{ik} Random error term for efficiency effect model; α_s Parameters to be estimated.

DATA AND SAMPLING

Both primary and secondary data were employed to attain the objectives set. Primary data was collected from sample households through structured question-naire and secondary data from concerned line offices such as agricultural offices and central statistical agency.

In this study two stage sampling procedure is adopted. First, we divide Wolaita zone in to eight clusters in way that encompasses agro-climatic conditions and farming system of the zone. Then, a sample of eight Kebeles are selected first from each cluster using simple random sampling. According to the sampling frame from these eight Kebeles 51% are found to be partial package farmers. Once these kebeles are identified, we select a sample of 147 full package farmers and 153 partial package farmers from selected kebeles proportionally using simple random sampling.

RESULTS AND DISCUSSIONS

Our estimate for Total Factor Productivity (TFP) based on the Tornqvist TFP Index outlined in Eq. (3) (Table – 1) reveals on average TFP falls from full package farmers to partial package farmers by 69 percent. The trend is that in majority of the matching cases there is a rise in productivity from partial package farmers to full package farmers. We can also see from Table -1 that in about 60 percent of the cases, TFP increases when we move from partial to full package farmers with the majority (57 percent) of these cases with an average of 113 percent increment in TFP (-2< TFP ≤ 0.95). While no significant difference is observed in TFP between partial package and full package farmers for 5 percent of the cases. Moreover, in about 34 percent of the cases TFP increases when we move from full package to partial package farmers with the majority (71 percent) of these cases with an average of 141 percent increment in TFP (1.05<TFP ≤ 5).

TABLE 1: SUMMARY OF ESTIMATED TOTAL FACTOR PRODUCTIVITY

TFP Category	Mean	SD	Frequency	Cumulative Frequency
TFP ≤ -6	-7.59	0.64	2	2
-6 < TFP ≤ -4	-4.72	0.55	11	13
-4 < TFP ≤ -2	-2.84	0.68	13	26
-2< TFP ≤ 0.95	-0.13	0.76	34	60
About one*	1.00	0.03	5	65
1.05<TFP ≤ 5	2.41	1.07	24	89
5<TFP ≤ 10	6.49	1.40	8	97
TFP>10	12.22	2.39	2	99
Mean : 0.31 SD: 3.66 Min: -8.04 Max: 13.91				

*(0.95 <TFP ≤ 1.05)

Looking in to the determinants of TFP (Table - 2), only household nonfarm income and household distance to the local market are found to significantly affect TFP. Nonfarm income has expected positive sign assuming nonfarm income supports participation in agricultural extension packages while the unexpected positive sign of distance to the local market may be due to the fact that as farmers are near to market (mostly recreation center of rural areas), they devote more leisure time.

TABLE 2: DETERMINANTS OF TOTAL FACTOR PRODUCTIVITY (TFP)

Variable	Coefficient	t - value
Constant	-2.29	-1.09
Land size (Timad)	0.1883	1.18
Total labor power (labor days)	0.0006	0.07
Total draft power (oxen days)	0.0295	0.89
Total value of seed (Birr)	-0.0004	-0.74
Total value of fertilizer (Birr)	-0.0007	-1.14
Household age	0.0023	0.04
Household sex (1=male)	0.0706	0.06
Household farming experience	-0.0656	-1.02
Household Education(1=illiterate)	-1.0120	-1.03
Dependency ratio	0.5224	1.88
Distance from farmer training center (FTC)	0.0034	0.53
Household nonfarm income (Birr)	0.0002	2.08*
Number of plots owned	0.0229	0.04
Distance to local market (hours)	0.0159	2.36*
N = 99 R^2 = 0.2714 Prob > F = 0.0125		

* Significant at α=0.05

FINDINGS

The result that our estimate of the Total Factor Productivity for full package farmers has raised by about 69 percent compared to partial package farmers may imply participating in agricultural extension packages fully contribute more to crop productivity of farmers. Moreover, the positive significant effect of household nonfarm income on Total Factor Productivity differentials may imply that engaging in alternative nonfarm income can make farmers to fully participate in agricultural extension packages and raise their Total Factor Productivity in turn. Household distance to the local market is also found to significantly affect Total Factor Productivity differentials. This may also imply raise in Total Factor Productivity can be achieved through creating access to package inputs and to markets to sale production.

RECOMMENDATIONS

- Agricultural extensions package implementers should strengthen their efforts to broaden full participation of farmers in agricultural extension packages.
- Agricultural extensions along with local government in the study area should design strategies for farmers to raise their nonfarm income in the off farm seasons and work to raise access of farmers to local markets.

CONCLUSIONS

- Adopting technologies of agricultural extension package fully have brought about substantial difference in productivity between partial and full package farmers.
- Total Factor Productivity differential are only significantly affected by non-farm income and household distance to the local market.

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