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Technological change in Uganda's agriculture between 2005-2010

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Abstract

The study estimates the rate of technological change in Uganda's agriculture between 2005-2010 across the 4 major regions of the country. Using a nationally representative household panel data set, we use a time trend variable in the stochastic production frontier to account for hicks-neutral technological change, then the frontier is re-modeled using binary time trend dummy variables to capture the temporal pattern of technological change. Overall we find that technological progress was small and insignificant of 0.031% but further decomposition at regional level revealed more interesting findings. The western region had technological progress at 0.6%, and the central region had technological regress of 0.57%, both significant at the 5% level. The northern region had technological progress at 0.008% and the eastern region had technological regress of 0.11% both insignificant at 5% level. The findings suggest that more public and private investments in region-specific technology development would be required to accelerate technological progress especially in the northern and eastern regions of the country. Alternatively with the existing level of investment, effort should be made to address the institutional issues that constrain efficient dissemination of the technologies developed from the NARS.

Key words: Hicks-neutral technological change, Stochastic production frontier, technological progress/regress

Résumé

L'étude estime que le taux de changement technologique dans l'agriculture de l'Ouganda entre 2005-2010 a travers les 4 principales régions du pays. En utilisant l'ensemble des données du panel de ménages représentatif à l'échelle nationale, nous utilisons une variable de tendance temporelle dans la frontière de production aléatoire pour tenir compte des péquenauds neutres, de changement technologique, ensuite la frontière est remodelée à l'aide des variables indicatrices binaires sur les tendances temporelles pour capturer la structure temporelle de l'évolution technologique. Dans l'ensemble, nous constatons que le progrès technologique était petit et insignifiant de 0,031%, mais en outre la décomposition au niveau régional a révélé des résultats plus intéressants. La région de l'Ouest a eu des progrès technologiques à 0,6%, et la région centrale du pays a eu une régression technologique de 0,57%, à la fois significatif au niveau de 5%. La région du Nord a eu des progrès technologiques à 0,008% et la région de l'Est a eu une régression technologique de 0,11% à

la fois insignifiant au niveau de 5%. Les résultats suggèrent que, plus d'investissements publics et privés dans la région, les développements spécifiques des technologies seraient nécessaires pour accélérer les progrès technologiques en particulier dans les régions du nord et de l'est du pays. Sinon au niveau des investissements existants, l'effort devrait être fait pour résoudre les problèmes institutionnels qui limitent la diffusion efficace des technologies développées à partir des SNRA.

Mots clés: changement technologique, frontière de production stochastique, le progrès technologique / régresser

Introduction

Improving agricultural productivity remains a challenge for the government of Uganda despite numerous policy reforms undertaken in the sector in the recent past and donor development assistance that has been invested in increasing productivity at the household level. Despite these efforts, poverty in the rural agricultural dependent households has risen which poses a challenge on how to continue to address this problem. Technological change is one of the avenues that are believed will contribute to increases in agricultural productivity in developing countries in general and Uganda in particular.

Agriculture technology development in Uganda is the responsibility of the National Agricultural Research System (NARS) under the National Agricultural Research Organisation (NARO). The technologies are obtained from the NARS as well as any other private research partners through research. NARO through its regional subsidiaries, the zonal agricultural research and development institutes (ZARDIs) develops research priorities for the different regions, develops the technologies, undertakes on-station demonstrations, and on-farm trials. This study tracks the effect of these innovations on agricultural output across the four regions of Uganda; Central, Eastern, Northern and Western, as a measure of technological change in the country's agriculture.

Literature summary

Technological change is defined as the change in the best practice production frontier (Nishimizu and Page, 1982) or as a shift in the production function with all input quantities held constant (Karagiannis *et al*., 1999). The shift may be outward (technical progress) or inward toward the origin (technical regress). Technological progress, as defined by Nishimizu and Page, 1982, is the consequence of innovation or adoption of new technology by best practice firms.

The performance of agriculture can be evaluated by identifying the shifts of the production frontier or technological change as sources of output growth (Giannakas *et al.*, 2001; Si and Wang, 2011). Rapid shifts of the frontier may not be expected in the sector, if activities are mature industries, or the lack of technical progress may be indicative of failures in investment planning and implementation to allow for acquisition of new technology, while still in others, the movement of the frontier may reflect the success of explicit policies to facilitate the

acquisition of foreign technology (Nishimizu and Page, 1982). It is therefore important to identify the nature of these shifts for appropriate policy intervention.

Study description

The study analyses technological change across the four regions of Uganda between 2005 and 2010 using the UNPS data. The model used in the study assumes the presence of Hicks-neutral technical change where a single time trend (or year) variable is included in the stochastic production frontier model to capture the effect of technological change on agricultural output following the proposition by Battese and Coelli, 1995. The coefficient of the year variable thus included is taken as the measure of Hicksian neutral technological change. The rate of technological change between 2005 and 2010 is estimated for the country data as well as for the regions, and the factors thought to be associated with it are discussed.

The measure of technological change thus obtained is one measure for the entire period of study, for the country data and for each of the four regions. However in order to capture the temporal pattern of technological change, binary time trend dummies are introduced to the model, assuming a fixed intercept in each region but which can vary across the regions, and taking the first time period as the reference period (Gujarati, 2004). Time period 1 is used as the reference period for each region. The value of median output of time period one is determined, and differences from this output for the subsequent time periods are also determined to enable the tracking of these changes in output with time, for each region and for the country data.

Research application

The study finds that there was technical regress of 0.031% in agricultural production in the country sample, which was not statistically significant. There were however regional differences. The western region had technical progress of 0.6% significant at 5% level, followed by the northern region at 0.008% but was not significant. The central region had technical regress of 0.57% significant at 5% followed by the eastern region, technical regress of 0.11% which was not significant.

Table 1. Maximum likelihood estimates for the parameters of technical change across the four regions.

Region	Parameter	Coefficient	t-ratio
Central	β_1	-0.57**	-1.97
Eastern	β_1	-0.11	-0.46
Northern	β_1	0.008	0.095
Western	β_1	0.60**	2.2
Uganda	β_1	-0.031	-0.63

The factors thought to contribute to these differences vary with the region. In the western region, the dense population and adoption of the technologies disseminated in the NARS might have been responsible for the technical progress, while in the northern region, government effort to resettle the population and support agricultural activities through the NUSAF program might have supported technical progress. In the central region, the proportion of the labour force engaged outside of agriculture (60%) is high and the labour migration from agriculture to other more lucrative opportunities seems to pause a challenge for technical progress in the region in addition to nutrient depletion from the soils. The eastern region notably experienced frequent floods during the period possibly causing the fluctuations in technical change and subsequent technical regress.

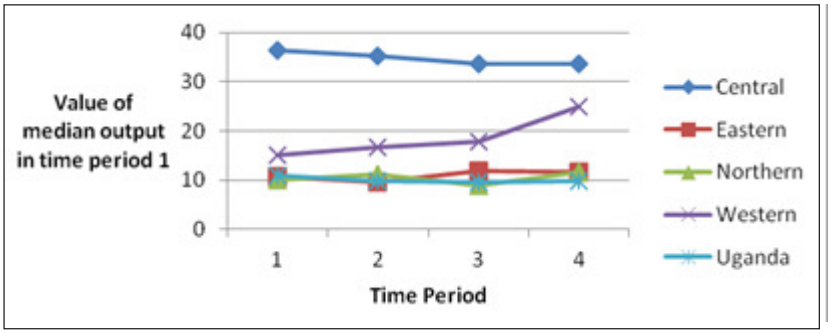

Figure 1. The effect of technical change on median output of time period 1 per region.

There was mild technological regress and subsequent contribution to output growth in the country's agriculture during the study period. Technological change can be enhanced through accelerated investment in research for technology development, and addressing the institutional issues that constrain efficient technology dissemination. The study supports technology development that is based on the specific regional differences in the country to take into consideration the variations that do exist across regions.

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