The Contribution of Conservation Agriculture to Production Efficiency and Household Welfare in Zambia

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Sustainable agriculture is deemed to have environmental, social and economic opportunities for growers, laborers, consumers and policymakers in the entire food system. It is however documented that, the common conventional farming practices in developing countries, which involve frequent ploughing of farm lands, slash- and-burn and monoculture gradually degrade the physical and chemical qualities of tropical soils, including those in sub-Saharan Africa. To restore soil health, mitigate the detrimental impacts of climate change and facilitate the attainment of food and nutrition security, especially in SSA, it is imperative to either harness existing knowledge or adopt new technologies. Several pieces of evidence indicate that agricultural production systems like conservation agriculture technology has the potential to rehabilitate degraded soils and improve productivity in a sustainable manner. To motivate the adoption and diffusion of conservation agriculture technology and to sustain the use of the technology in SSA requires a comprehensive study on the prospects of conservation agriculture to the realization of beneficial economic, environmental and social attributes of sustainable agriculture. The history of conservation agriculture technology in sub-Saharan Africa is linked to maize-based systems mainly focusing on the prosperity index of sustainability. By contrast, this study contributes to the literature by being the first of its kind to holistically examine conservation agriculture of maize farmers in Zambia with reference to prosperity, people, and planet indices of sustainability. The study first examines allocative and scale efficiency and the determinants of inefficiency among maize farmers in Zambia using a zero-inefficiency stochastic frontier model to account for both inefficiency and full efficiency to ensure unbiased efficiency estimates. Second, this study employs a discrete time duration model to explore the role of peer effects through farmers' social and institutional networks as well as farmers' risk attitude in the adoption and diffusion of conservation agriculture technology. In particular, a principal components analysis is employed to compute latent variables that are important in analyzing the impact of information transmission from stock of adopters that the farmer associates with, access to extension services and access to farmers associations. To the extent that farmers consider the impact of risk in the technology diffusion process, profit moments including, mean, variance, skewness and kurtosis are used to determine upward and downward risks. Also, a selectivity-corrected stochastic meta-frontier approach that accounts for potential selection bias and technology heterogeneity is used to explore the impact of conservation agriculture on environmental efficiency of maize farmers, with respect to nitrogen fertilizers recovery. Finally, the determinants of adoption and impact of conservation agriculture technology adoption on farm output, throughput accounting ratio and poverty situation of households in Zambia are estimated. The empirical results show that, unlike the stochastic frontier model, the zero-inefficiency stochastic frontier model successfully allows for both fully efficient and inefficient firms to be accounted for in the estimation procedure. The estimates also reveal the presence of scale economies, with the zero-inefficiency stochastic frontier model better predicting scale efficiency compared to the stochastic frontier model. Furthermore, farmers practicing conservation agriculture are environmentally more efficient than conventional farmers. Also the adoption of conservation agriculture technology increases maize output and farm throughput accounting ratio and reduces household poverty. The results also reveal that farmers' years of schooling, risk preferences, social networks, access to credit, extension services and machinery as well as soil quality positively influence adoption and diffusion of conservation agriculture

technology. The findings also show that inefficiency is explained by the level of education, access to extension services, distance to markets, access to credit, gender and land ownership.