Food security effects of multinational brands crop protection products: Evidence from cotton-wheat zone Punjab, Pakistan

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Summary

Throughout the past years, agricultural technological inputs have been actively evolving with a moderate rate of technology adoption. The adoption of agricultural technological inputs has been encouraged by, among others, escalating demand in the food sector in both developed and developing countries. While the adoption of agricultural technological inputs has been becoming important in developing countries, rigorous assessment of the quality and origin of available technologies and their outcomes in developing countries is lacking.

Firstly, there are is an abundance and prevalence of generic, nationally produced agricultural products in contrast to multinational brands agricultural products in the agricultural mainland of Pakistan. The widespread adoption of generic agricultural products has serious consequences on sustainable agricultural development. Among the available agricultural technological products, particularly, crop protection products (for example insecticides, fungicides, herbicides, and chemicals for seed treatment) have an obvious impact on the biophysical environment. Secondly, the multinational brands crop protection products outclass generic crop protection products due to their rigorous process of product development and product quality assurance. However, the multinational brands crop protection products are often much more expensive. Thus, the adoption of multinational brands crop protection products *versus* generic crop protection products among smallholder farming households may have important consequences on sustainable agricultural development for developing countries. While some implications of such adoption decisions have been intensively research, some other highly relevant research aspects were not covered.

First, with regard to factors affecting adoption of crop protection products, empirical evidence shows that smallholder farming households in Pakistan, in general, adopt crop protection products. It is known that socioeconomic variables determine adoption of recommended crop protection products practices and the quantity of crop protection products applied. While farm and farmer capital influence initial adoption of crop protection products, the determinants of the adoption of more expensive crop protection products promising a higher quality remains unaddressed. Second, there is a growing body of literature on the outcomes of adoption decisions regarding agricultural technologies. The empirical evidence shows that technology adoption may contribute positively to productivity, poverty alleviation, and food security in developing countries. However, the following points have not been addressed:

(i) food security effects of multinational brands crop protection products in the agricultural mainland of developing countries;

(ii) farm harvest effects of multiple crop protection product categories instead of only one category (pesticides, fungicides, herbicides, insecticides, and chemical seed treatment);

(iii) self-selection biased and potential heterogeneity of multinational brands crop protection products and adopters countenance.

Hence, this dissertation aims to fill respective gaps in the existing literature in two core areas. Firstly, we aim to analyse the association of farm and farmer capital variables with the adoption of improved crop protection products. Compared to generic, nationally produced products, we expect multinational brands crop protection products to promise (and deliver) an improved overall product quality. Secondly, we want to test if the adoption of multinational brands crop protection products improves food security. Both areas use data from a cross-sectional survey conducted in 2017. The survey includes data from 275 smallholder farming households from the cotton-wheat zone in the Punjab province, Pakistan. The Punjab is the agricultural heartland of Pakistan.

First, we employ ordered probit models to estimate the role of farm and farmer capital towards the adoption of multinational brands crop protection products in the Punjab, Pakistan. The results show that agricultural extension services, among others, farm and farmer capital variables are fundamental to technology adoption. The adoption of multinational brands crop protection products is strongly positively correlated to household food security. The cross-sectional survey exclusively contains non-experimental observations. Therefore, this evidence of correlation between the adoption of multinational brands crop protection products and farmers food security may be tainted due to possible self-selection bias and potentially existing, unobserved sources of heterogeneity. This situation represents a substantial methodological challenge.

Second, we address this methodological challenge of relying in non-experimental observations by using an endogenous switching probit model to account for potential heterogeneity in estimating adoption effects on food security. Full information maximum likelihood estimates indicate that adoption of multinational brands crop protection products is guided by comparative advantage: farmers adopt multinational brands crop protection products if they benefit from adoption compared to non-adoption. Furthermore, we find statistically significant evidence of heterogeneity effects. These effects are significantly higher for those farmers who adopted relative to those who

did not adopt. On top of that, the result of selection modelling, yet again, decisively supports the hypothesis that the accessibility of agricultural extension information *via* radio is the easiest way to disseminate proven agricultural technologies and to foster the adoption of multinational brands crop protection products.

A few salient take away and policy implications can be drawn from this dissertation. From a fundamental science point of view, these results provide, for the first time, evidence that adoption of multinational brands crop protection products is principally guided by the same farm and farmer capital variables as initial adoption. This result confirms that the intensification of agricultural extension service visits and the promotion of agricultural extension information *via* radio broadcasts stand out as most promising policy options. Additionally, we determine the fundamental role of multinational brands crop protection products for enhancing food security of smallholder farming households. Particularly, we observed that the adoption of multinational brands crop protection products may *reduce* food security of non-adopters if they adopt. So, promoting the adoption of multinational brands crop protection products without carefully considering likely net benefits for individual farming households would be misguided.