NJAS - Wageningen Journal of Life Sciences 70–71 (2014) 113–121

Contents lists available at ScienceDirect

NJAS - Wageningen Journal of Life Sciences

journal homepage: www.elsevier.com/locate/njas

Analysing the farm level economic impact of GM corn in the Philippines

Miladis M. Afidchao[a,b,*], C.J.M. Musters[a], Ada Wossink[c], Orlando F. Balderama[d], Geert R. de Snoo[a]

[a] Institute of Environmental Sciences (CML), Leiden University, the Netherlands
[b] Department of Natural Sciences (DNS), College of Development Communication and Arts & Sciences, Isabela State University, Cabagan, Isabela, Philippines
[c] Economics, School of Social Sciences, University of Manchester, Manchester M13 9PL, United Kingdom
[d] University Research Office, Isabela State University, Echague, Isabela, Philippines

ARTICLE INFO

Article history:
Received 14 May 2013
Received in revised form 17 May 2014
Accepted 19 May 2014
Available online 19 June 2014

Keywords:
corn
genetically modified crops
farm economics
smallholder farms
decomposition analysis
Philippines

ABSTRACT

This paper analyses the farm economic viability of genetically modified (GM) corn in the Philippines. Data was collected from 114 farmers in Isabela province including non-GM, *Bacillus thuringiensis* (*Bt*), herbicide tolerant (HT) and *Bt*HT corn farmers. Results of univariate analysis showed that non-GM corn was not statistically different from *Bt*, *Bt*HT and HT corn in terms of production output, net income, production-cost ratio and return on investment. Multivariate econometric analysis for the agronomic input variables showed a higher return on investment for *Bt* corn as the only significant difference between seed types. Next, pest occurrence and severity variables were included in the regression to address endogeneity. The Blinder-Oaxaca decomposition method was used to further investigate differences between growers of *Bt*HT corn and non-GM corn into an endowment and a coefficient effect. The decomposition analysis showed that *Bt*HT corn has a negative impact on return on investment as revealed by the negative signs of the overall mean gap and the characteristics and coefficient components. In contrast, the overall mean gap for net income indicated that adopting *Bt*HT corn could potentially increase non-GM growers' income mainly from better control of corn borer pest even though mean levels of borer occurrence are lower for non-GM growers.

1. Introduction

The adoption of genetically modified (GM) corn, cotton and soybean improves yields and reduces pesticides usage (e.g., [1], [2], [3], [4], [5] and [6]). Recent meta-analyses by Finger *et al.* [7] and by Areal *et al.* [8] of GM corn, cotton and soybeans provides evidence that these crops lead, on average, to a higher economic performance than conventional crops. Other studies have confirmed these higher averages for specific countries and specific crops. For developing countries the 2007 farm income gains from *Bacillus thuringiensis* (*Bt*) and herbicide tolerant (HT) corn were estimated at $302 and $41 million, respectively [9].

Contrariwise, the results reported in studies such as those listed above remain a matter of great controversy as noted as early as 2000 by Zadoks and Waibel [12]. The performance of GM crops is variable, socio-economically differentiated, and contingent on a range of agronomic and institutional factors [11], [14], [15], [16]. There is particularly a need for further evidence on the benefits for resource-poor farmers. The most obvious pecuniary benefit for resource-poor farmers is increase in yield [7], [11] and [13]. But results from field trials or partial analysis of gross returns and/or cost for pest control do not necessarily imply that farmer's incomes and welfare are improved.

In this paper we focus on the Philippines, the first and so far only country in Asia to have approved the commercial cultivation of GM corn. After *Bt* corn was first commercialized in the Philippines in 2003, there was a dramatic increase in its adoption. By 2010, GM corn was grown on over a quarter million hectares by 270,000 Filipino farmers [19]. Since GM corn seeds cost are higher than that of the available commercial iso-hybrid corn in the market, high income and large-scale farmers were the first adopters of this technology. More recently small-scale and poor farmers have also adopted the technology.

In an earlier study we investigated Filipino small-scale farmers' reasons for adoption and their experiences growing GM corn [21]. Results from this survey work showed that these farmers were

* Corresponding author. Tel.: +639178159691.
E-mail address: miladis_afidchao@yahoo.com.ph (M.M. Afidchao).

http://dx.doi.org/10.1016/j.njas.2014.05.008
1573-5214/

motivated to switch to GM corn for economic reasons (perceived yield increase, better insect control, reduced costs of inputs) and also out of curiosity. The experience of using GM corn however led to statistically significant changes in the respondents' opinion. Sixty-eight percent of the *Bt* corn respondents did not agree that their economic status had improved after they had started using the technology or that *Bt* corn is worth investing in. A significant number of *Bt* respondents now perceived negative effects of *Bt* corn on farmers' economic status. Of the *Bt*HT adopters 21% and 29% said they had changed their standpoint to disagreement in regard to the statements that *Bt*Ht corn is worth investing in and could improve the lives of farmers, respectively.

These findings motivated us to a conduct a comparative assessment specifically for small-scale farmers in the Philippines. The changes in farmers' opinion after using GM corn justify a more in-depth economic assessment of the GM technology under the conditions and skill level of these farmers. In addition, previous studies on the economic impact of GM corn in the Philippines focused only on *Bt* corn [16], [17] and [44]. *Bt*HT and HT corn are now also widely grown in the Philippines. Hence in our paper we compare conventional, *Bt*, HT and *Bt*HT corn.

We focus at the farm level and at the variability across farms/farmers. We take explicitly into account that genetically modified (GM) corn seed is substantially higher in price and hard to afford by a resource poor farmer [22]. This price can be up to 84% higher than for non GM-corn depending on the type and number of transgenic traits included in the seed. Thus, to deal with the farm economic issues we seek to answer the research question: Is GM corn more economically viable and worth the investment than non-GM corn at the farm level? We investigate farm level differences by corn variety in expenditure for agricultural inputs (labour, seed, and fertiliser costs), gross and net return, production-cost ratio and return on investments. Following previous studies on profitability [17] and adoption [23] and [24] of GM corn we use econometric analysis to evaluate if and how agronomic variables (i.e. labour costs, agricultural inputs, corn types and farm area) affect production cost, total return, net income, production-cost ratio and return on investment.

This paper further contributes to the discussion by employing the Blinder-Oaxaca decomposition method [25] [26] to decompose the observed differences in economic performance between GM adopters and non-adopters into two components, namely a characteristics effect and a coefficients effect. This decomposition technique is widely used in economic applications to study mean outcome differences between groups [27], [28] and [29]. The counterfactual exercise answers the question, what would happen to the GM adopters if their distribution of characteristics was as for the non-GM adopters but if they maintained the returns to their characteristics? A comparison of the counterfactual and estimated performance distribution for the GM group and the non-GM group yields the part of the performance difference that is attributable to differences in covariates (farm and farmer endowments). The remainder of performance difference is then attributable to differences in returns to covariates. To the best of our knowledge, no other study has employed this decomposition technique to investigate the GM-economic impact nexus.

2. Material and methods

2.1. Area description: GM Corn and the family farm in the Philippines

The Philippines has a total of 9.6 million hectares (32%) agricultural land area of which 51% and 44% are arable and permanent croplands, respectively [18]. There are ~1.8 million corn farmers in the country and 60% of these cultivate yellow corn. Mostly, these farmers are categorized as small, semi-subsistence farmers with a farm area of less than 4 hectares [30]. All corn in the country is grown on rain fed non-irrigated land. The cornfields of these small farmers are mostly situated in marginal places. In contrast, most of the large-scale plantations of yellow corn are found in well-situated lowland or upland areas.

Small-scale farmers plant one corn variety, sometimes intercropped with tobacco, fruits (pineapple) and vegetables. Post-harvest activities include de-husking, shelling and grain drying which is done manually by both family and hired labour. Harvested corn is sun-dried immediately after harvest [30]. The small-scale farmers are dependent on trader-financiers for full-season input financing because they lack the necessary capital. Farmers repay their loans with a certain interest (~7-15%) either in cash or in corn product upon harvest. The trader-financier decides on the terms of condition of the payback agreement. For large-scale farmers that have large cornfields (cornfield size of more than 3 hectares) hired labour and mechanized farming are common practices.

Among the sixteen regions in the Philippines, the Cagayan Valley region ranks first in terms of corn production. Isabela province in the Cagayan Valley region was chosen as the case study area for the farm level economic assessment. In Isabela province average yield of *Bt* corn per ha was reported to exceed yield of conventional corn by up to 33% in the 2003-2005 seasons. In 2008-2009, *Bt* and *Bt*HT corn yields surpassed conventional corn by 4-5% and by 13-22%, respectively [20]. Recall that the 2003/2004 crop year is the first year that *Bt* corn became available to Philippine farmers. Hence, data from 2003-2005 crop years gives information about the "initial" impacts of *Bt* corn [16]. The surplus yield of *Bt*HT corn compared to *Bt* corn for 2008-2009 was due to its combined traits which resolved problems due to both Asian Corn borer and weed pest severity.

In Isabela province, farm demonstrations showcased the advantages of using GM corn including both its pecuniary and non-pecuniary benefits. One of the non-pecuniary benefits of GM corn, especially of *Bt*HT (insecticide plus herbicide tolerant) corn is that less labour inputs are required for weed management. With proper spraying of herbicide, the weed problem can be reduced or totally controlled. However many poor farmers may still resort to manual weeding in *Bt*HT corn employing the labour force of the (extended) family on a cooperative basis as they cannot afford to buy herbicides [21].

2.2. Survey

The survey was conducted from October to December 2010 to obtain data for the wet growing season. In order to select our respondents within the group of general farmers who were best able to give us the first-hand information we needed, we applied a purposive sampling technique. Purposive sampling was accomplished of 114 corn farmers in the province of which 42, 8, 44 and 20 were non-GM, *Bt*, *Bt*HT and HT corn adopters, respectively. Ninety-percent of the respondents were classified as small-scale farmers with farm sizes of not more than 3 ha. Only 10% of the respondents were large-scale farmers with farm sizes of 4 to 8 ha. Almost all farmers (98%) in the sample practiced mono-cropping and 25% was female. A self-structured questionnaire was used during the face-to-face interview of the respondents who were from 10 municipalities and 33 villages of the province.

The respondent did not differ significantly in age, household size, residency in their respective municipality, and level of education (Table 1). All farmers encountered weed problem but their level of concern varies. Further analyses revealed large differences between non-GM and *Bt* farmers in encountering weed and Asian corn borer (ACB) problems and likewise for the level of concern