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Welfare impact of pesticides management practices among smallholder cocoa farmers in Ghana

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ABSTRACT

The simultaneous adoption of pesticides management practices has the potential of boosting productivity and improving the welfare of smallholder cocoa farmers in Ghana. This study identified the factors influencing farmers' choice of the combination options of pesticides management practices using cross-sectional data randomly collected from 838 cocoa farm households. The results from the multinomial logit model revealed that farmers' decision to adopt insecticides only, fungicides only or a combination of the two is influenced by different socio-economic, farm-specific and institutional factors as well as farmers' perception about incidence of pests and diseases on their farms. Using both multinomial endogenous switching regression (MESR) framework and the inverse-probability-weighted regression adjustment (IPWRA) estimator, the adoption of pesticides management practices improves households' welfare. However, the highest payoff was achieved when insecticides and fungicides were adopted simultaneously. The results of the study implies that farm-level cocoa-specific programmes such as Cocoa Disease and Pest Control Programme (CODAPEC) promoting the use of pesticides to improve productivity in Ghana's cocoa industry should be strengthened to enhance the simultaneous adoption of both insecticides and fungicides.

1. Introduction

In Sub-Saharan Africa (SSA), agriculture has remained the main route for stimulating economic growth, overcoming food insecurity and reducing poverty. Despite the significant contribution of agriculture to the overall SSA economic growth, it has not done enough to ensure a better welfare for African people [1]. For example, the poverty rate in SSA is not only the highest in the world; it is about 100% above the global average while the economic activities of 75% of poor African living in rural areas are linked to agriculture and its related activities [2]. In Ghana, the role of agriculture in national development cannot be overemphasized. The contribution of agricultural sector to Ghana's GDP is 20.2%, and about 25.8% of the Ghanaian households are engaged in agricultural activities [3,4]. The largest and the most significant portion of the sector is the crop sub-sector contributing 15.7% out of the 20.2% share of the agricultural economy to the GDP in 2015 [3]. Within the crop sector, the cocoa sub-sector is of particular interest to the people and the government of Ghana due to its dominance in agricultural export.

The Ghanaian cocoa industry forms a significant proportion of the social and economic mainstay of the country. Cocoa is an important contributor to GDP, a significant foreign exchange earner, creating employment opportunities for thousands of Ghanaians. For example, in 2013, the sector did not only contribute GH¢ 1.963 billion representing about 2.23% of Ghana's GDP, but it also created jobs for approximately 794,129 farm households [5]. Regarding the contribution to the world cocoa market, Ghana maintains its pedigree as the second largest producer in both Africa and the World supplying about 27% and 20% of cocoa, respectively [6]. The country also enjoys a premium price in the global marketplace for building a high reputation for the supply of top quality cocoa beans. Nevertheless, cocoa production in SSA in general and Ghana, in particular, is predominantly on small-scale with many challenges. Among these challenges are inadequate access to finance and extension services, poor infrastructural development, high incidence of pests and diseases, low fertility of the soil and low adoption of improved technology practices. However, adoption of cocoa pesticides (insecticides and fungicides) by cocoa farmers are recognized as a significant challenge in the industry [7]. Low adoption rates have the potential to hamper farm

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productivity and subsequently shrink welfare gains from farm households. Previous studies [6,7] have indicated that high incidence of pests and diseases could reduce farm output in the range of 60-90%.

High incidence of pests and diseases can affect farmers' ability to increase production and consequently impact on their welfare through income reduction. The most damaging cocoa pod disease in Ghana is 'black pod' caused by a fungus called *Phythophtora megakarya* and has the potential to reduce output by 40-90% [7,8]. Cocoa capsids or mirids (*Distanthiella theobromae or salbegella singularis*) are insect pests considered to be of severe constraint to cocoa production in West Africa, particularly in Ghana. Outbreaks of these pests can cause up to 75% decline in cocoa output [8]. To minimize the adverse effects of pests and diseases and to enhance productivity growth on a sustainable basis, the government of Ghana through Ghana Cocoa Board (COCOBOD) initiates a project dubbed Cocoa Disease and Pest Control Programme (CODAPEC) also referred to as the "mass spraying exercise." The official mission of the project is to increase cocoa productivity growth through pesticides application (insecticides and fungicides). The primary requirements for this pesticides application package as recommended by Ghana Cocoa Research Institute (CRIG) are spraying against capsid (application of insecticides) 3-4 times per cocoa season, and spraying against black pod diseases (application of fungicides) 6-9 times per cocoa season [9]. The CODAPEC programme was originally planned to spray each Ghanaian cocoa farm twice per cocoa season with insecticides and fungicides between August and December per cocoa season by well-trained community-based spraying gang with no financial costs to the farmers [10,11]. Thus, CODAPEC programme is inadequate, and farmers are supposed to complement the free spraying to complete the full adoption package [9,12,13]. Abankwah et al. [12] noted that the CODAPEC programme had not reached its full potential because it has failed to follow the recommended frequency of pesticides application. As a result, cocoa farmers are found using both Cocoa Research Institute of Ghana (CRIG) approved and unapproved pesticides on their farms [14]. Recent studies have shown that the use of agrochemicals such as pesticides had been low, and the welfare of Ghanaian cocoa farmers whose hard work generates so much revenue for the economy has not improved that much [7,15,16]. Besides, some studies [14,17] have indicated that farmers' productivity gains have been hampered by the limited use of agrochemicals. However, what these and many other studies failed to discuss is the impact of these pesticides management practices on the welfare of the cocoa farm households. The study aims to examine the causal effect of pesticides management practices adoption on household welfare using farm-level data across the four major cocoa-producing regions in Ghana.

A clear documentation of the welfare effects of pesticides management practices is a necessary first step in addressing the constraints of diffusion of agricultural production technologies [18]. Evidently, poverty is pervasive among smallholder Ghanaian cocoa farmers. Hence, adoption of pesticides management practices is expected not only to contribute to output increase but improves farm household welfare. Moreover, there are limited studies on the adoption impact of pesticides on farmers' welfare in the cocoa sector in Africa. Many studies [19–24] had focused on improved seed varieties of crops such as rice, maize, wheat, and groundnuts. Therefore, the study intends to fill these gaps and contribute to the existing knowledge in adoption studies by estimating the welfare impact of pesticides management practices. Besides, different welfare indicators such as cocoa farm yields (kg/ha), gross cocoa farm income per hectare, consumption expenditure per capita and productive farm assets were used as compared with previous studies [23,25,26] that focused only on consumption expenditure per capita.

2. Methodology

2.1. Conceptual framework and estimation technique

Within the framework of an axiom of rationality, farmers will only adopt a farm technology if it adds more to farm profit than farm operational cost, given resource constraints [26]. As stated earlier, under the CODAPEC programme, spraying of individual cocoa farms with pesticides are inadequate (not up to the recommended rate), and farmers are expected to complement the COCOBOD free pesticides application to complete the full adoption package. Hence, the conceptual definition of adoption in this study is the complementary spraying of cocoa farms by farmers. Thus, farmers who complement COCOBOD free pesticides application are considered as adopters, while those who do not are non-adopters. In this case, farmers may simultaneously adopt both fungicides and insecticides management practices which will lead to four possible combination options. The four combination options for pesticides management practices available to the farm households are: (i) non-adoption of pesticides (F_0I_0), (ii) adoption of fungicides only (F_1I_0), (iii) adoption of insecticides only (F_0I_1) and (iv) adoption of both fungicides and insecticides (F_1I_1). These combination options are presented in Table 1.

However, the actual choice is a function of expected profit from the selected combination option, given the existing constraints. In this study, the impact of farmers' adoption of the alternative combinations of the application of pesticides on farmers' welfare is modelled using cocoa farm yield, gross cocoa farm income per hectare, consumption expenditure per capita, and productive farm assets as outcome variables.

In an experimental analysis, the assessment of pesticides application impact on the outcome variable could be done by comparing farm households adopting different sets of the package. However, this technique is not appropriate for farm-level observation data because of the problem of self-selection. This is because cocoa farmers make their own decisions (self-select) whether to adopt or not to adopt a particular combination option

Table 1
Farmers' choice on cocoa pesticides combination/package.[a]

Choice	Pesticides combination	Fungicides		Insecticides		Sample observation	%
		F_1	F_0	I_1	I_0		
1	F_0I_0		✓		✓	159	19
2	F_1I_0	✓			✓	92	11
3	F_0I_1		✓	✓		151	18
4	F_1I_1	✓		✓		436	52
Total						838	100

Note: Each element in the combination is a binary variable for the pesticides combinations. F_1 and F_0 denote adoption and non-adoption of fungicides while I_1 and I_0 denote adoption and non-adoption of insecticides, respectively.
[a] The study used combination and package interchangeably.