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Farmers' Perceptions and Willingness to Pay for Metarhizium-based Biopesticide to Control Cotton Bollworms in Benin (West Africa)

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Abstract

The study assesses farmers' perceptions and willingness to pay for a biopesticide developed from *Metarhizium anisopliae* a fungi. A sample of 400 conventional and organic cotton producers was randomly selected in cotton producing zones in Benin and interviewed for their perceptions on the efficacy of the biopesticide and the likely prices they are willing to pay for the product to control a major pest like *Helicoverpa armigera* or cotton bollworm causing substantial crop losses. An econometric model (Logit) is used to identify factors highly likely to affect farmer's willingness to purchase the product. The results show that *Helicoverpa armigera* or cotton bollworm is perceived by farmers as the most severe pest with losses reaching up to 100%. Farmers attribute the current pest intensity to a number of factors including ineffectiveness of chemical pesticides, delay in access to input mainly fertilizers and the development of refuge host plants for cotton pests. The results also show that most cotton producers and their households members are exposed to chemical insecticides without adequate protection devices during the pest control sprays. Both organic and conventional cotton producers have expressed a significant interest in the use of *Metarhizium* to control *Helicoverpa* on cotton. Both types of farmers willing to pay more for any pest control product that would improve cotton product quality for higher cotton price. Three variables influencing farmers' willing to pay for biopesticides from Metarhizium were efficacy, agro-ecological zone and broad spectrum.

Key words : Biopesticides, Cotton bollworms, farmers survey, Benin

Introduction

Cotton (*Gossypium herbaceum*) contributes approximately 24% to the Gross National Product (GNP) and 64% to the country export revenues (Kouton *et al*.; 2006). *Helicoverpa armigera,* or cotton bollworm, a serious source of significant financial losses. Until now, the only available pest control option was many sprays of chemical insecticides. The overuse and misuse of chemical pesticides pose serious threats to non-target organisms, human health and the environment. In cotton producing zones in Northern Benin, acute poisoning deaths reaches up to 92 at the end of 2000 (Pesticides News, 2000). The hazards caused by the misuse of chemical insecticides have driven scientists, policy makers including donors and development institutions toward promoting the production of biological based cotton protection in the sub-region. A fungal entomopathogen *Metarhizium anisopliae* (biopesticide) as an effective biological control device against most damaging cotton pests was been developed by IITA and its partners. It represents only about 2.5% of the overall pesticide market now but carries great potential to control several other cowpea pests including *M. sjostedti* and *A. craccivora* (Ekesi, 1999) and on the microbial control of stem-borers, banana weevil and termites (Dent *et al*., 1999). The objective of this study is to assess the potential demand characteristics for *Metarhizium anisopliae* based biopesticide to control *Helicoverpa Armigera* on cotton in Benin. More specifically, the study assesses farmers' knowledge of alternative control methods on cotton, and identifies constraints and opportunities of the use of *Metarhizium*-based biopesticides compared to current chemical pesticides. The study determines the key factors affecting farmers decision making for use of biopesticide and willingness to pay for biopesticide.

Materials and Methods

Study area

This study was carried-out in cotton producing zones of central and Northern Benin. These zones have been selected according to the significant contribution of cotton in farming systems. Organic cotton is also produced in addition to conventional cotton in these zones. The Central part of the country is characterized by annual rainfall level between 1000 and 1400 mm.

Maize, cowpea, soybean and cassava are the staple food crops and land pressure is driving the farming systems to more identification with increasing levels of input per unit and cropped.. The Northern zone has one rainy season with an average 1200 mm per year. Cotton remains the most important cash crop and covers more than 14000 ha. Food crops include yam, maize, cassava, cowpea and groundnut.

Methodology

Data were collected from a sample of 400 cotton producers from 14 villages across different cropping systems (200 conventional cotton producers and 200 organic cotton producers). Logistic regression a common method for the estimation of willingness to pay (WTP) (Govindasamy *et al*., 2001) was chosen to analyze the farmer's decision for paying for Metarhizium based biopesticide.

The empirical model measuring the probability that a farmer is willing to pay a premium for biopesticide from Metarhizium-based biopesticide is expressed as:.

$$P_i = F(WTP_i) = \frac{1}{1+e^{-WTP_i}} = \frac{1}{1+e^{-(X_i\beta+\varepsilon_i)}}$$

i = 1, ..., n

Where P_i is a probability function, Xi is a vector of observed characteristics of demand.. They include socio-demographic, attitudinal and behavioural variables, β is a vector with the corresponding estimated variables' coefficients. *WTP* is the willingness to pay. The error vector εi consists of unobservable random variables.

Results

Farmers' pest control methods

Chemical pesticides remain the most common methods used by farmers to control pests and diseases in cotton. Endosulfan is the most used chemical pesticide against *Helicoverpa* in cotton followed by Lambdacal (Lambda-cyhalothrin) and Conquest (Atrazine).. In controlling pests and diseases in cotton, most farmers combine various chemicals in cocktails for ''enhancing'' the effectiveness of chemicals. This could be also an indication of pest resistance developed over years by the overuse of cheap and available chemical pesticides. The advantages of using chemical pesticides as reported by cotton growers include their fast action, broad-spectrum properties, and availability. Most of the producers and farm workers are exposed to chemical hazards during spraying because of lack of appropriate protection devices. Contamination can also occur through drinking water. Among the competitive alternatives to synthetic pesticides, botanical extracts are used to control pests on cotton. Neem is the common plant used for its extracts. Availability of neem, low cash cost and relative safety for health and environment have been cited by 52, 100 and 93% of cotton producers respectively, as the major advantages for using neem extract (table 2).

Table 1. Names and description of variables of the Econometric model

Variables names	Description
Efficacy	1 =Willing to pay US$1 or more for this biopesticide. 0= less than $1
Agro-ecological zone	1 = farmers from the north province of Benin;0=farmers in centre
Age	Farmer's age
Education	Farmer's educational status
Gender	Gender of the farmer
Contact	Indicates how often extension officer visits the farmer
Pest intensity	Farmers' perceptions on the current trend of pest intensity on cotton.
Mode of action	Indicates how this biopesticide acts
Spectrum	Indicates the spectrum or coverage of the biopesticide (= 1 broad spectrum; 0= otherwise)

Table 2: Cotton growers' perceptions on the advantages and disadvantages of botanical pesticides

		Percent (%) N=200
Advantages	Available	53
	Cash cost	99
	No health and environmental risk	93
Disadvantages	Slow action	73
	High labor demand	92
	Painful pounding of neem leaves	26

Table 3: Price that farmers are willing to pay for a Metarhizium-based biopesticide ($/l)

	Organic Cotton		Conventional	
	Mean	Std. Deviation	Mean	Std. Deviation
Current price of chemical pesticides	5.03	3.39	7.80	0.38
Metarhizium-Based Biopesticide (MBB) increases yield by 10%	5.91	3.50	7.84	3.02
MBB increases yield by 25%	6.89	4.31	8.89	4.05
MBB decreases yield by 10%	2.81	3.09	5.31	1.22
MBB decreases yield by 25%	2.21	2.16	4.58	1.70
MBB decreases yield by 10% and increases cotton price by 10%	2.93	3.14	7.41	2.83
MBB decreases yield by 10% and increases cotton price by 25%	3.41	3.66	8.97	4.13
MBB decreases yield by 25% and increases cotton price by 10%	2.67	2.46	5.15	2.69
MBB decreases yield by 25% and increases cotton price by 25%	3.09	3.11	6.95	4.07

Note: Exchange rate US$1= 500 FCFA; MBB= Metarhizium-based biopesticide

The disadvantage reported by farmers includes slow action, higher labor demand and painful pounding.

Farmers' willingness to pay for a biopesticide from Metarhizium

Farmers' willingness to pay for a biopesticide made with Metarhizium to control the main pest "Helicoverpa" on cotton was assessed with various scenarios. The simulation includes two levels of yield increments (10% and 25%), and similar levels in reduction in cost of pest control and increasing cotton price. Both organic and conventional cotton producers expressed interest of the use of Metarhizium to control Helicoverpa on cotton. The price premium they are willing to pay for this new product varies according to organic cotton or conventional cotton. The mean percent of premium for each scenario is presented. As mentioned in the table above, higher yield and cotton prices would be incentives for farmers to pay for any input including Metarhizium-based biopesticide (MBB). The results show that farmers would pay more for an increase in yield than they would for higher cotton price. This is due to uncertainty in price levels of cotton fibber usually set by the government. Prices are responsive to agricultural policies. Cotton producers are not willing to pay price premium for this biopesticide if the yield decreases

Determinants of farmers' willingness to pay for new biopesticide

A logistic model was used to identity the factors likely to affect farmers willingness to purchase a biopesticide from *Metarhizium* as an alternative to chemical pesticide to control Helicoverpa on cotton and therefore are likely to affect its promotion and commercialization. The results of this model are presented in table 4**.**

Three factors contribute significantly to farmers' willingness to pay for a Metarhizium based

biopesticide: the level of efficacy of biopesticide, agro-ecological and broad spectrum (see table4). The others factors like a*ge, gender, education*, *contact* with extension, m*ode of action* of the biopesticide and farmers' perceptions on p*est intensity* were not significant in decision about paying for biopesticide.

Discussion

The assessment of farmers' knowledge and perceptions on cotton pests is carried out. The main common cotton pest reported by farmers in the Northern and central regions of Benin is Helicoverpa causing major losses. It is present in all zones in Benin and it is the most frequent and dangerous pest in cotton (Sinzogan *et al*., 2004). According to farmers perceptions, the level of Helicoverpa damage increases each year due to lowering efficacy of current chemical pesticides and the level of resistance which is increasing. Some alternatives were developed including the overuse of chemical pesticides and the combination of various chemicals in cocktails to address the resistance issue. The introduction of Metarhizium-based biopesticide is one of the alternatives to control Helicoverpa on cotton. The price premium that farmers are willing to pay remains low and ranks from 14% for conventional cotton producers to 37% for organic cotton producers. This result is comparable to that observed by De Groote *et al*. (1998) assessing farmers' perceptions and willingness to pay for biological control of locusts and grasshoppers in Mali and Niger. Farmers willingness to pay for locust control was small, but not negligible (De Groote, 1999). Results demonstrated that farmers' willingness to pay for biopesticide was influenced by some key factors which might be considered before the introduction and diffusion of this new product. The key factors that are most likely to affect farmers' willingness to pay for biopesticide from Metarhizium is *Broad spectrum*. The willingness to pay clearly depends on income and cash availability, and availability of credit might play a major role (De Groote, 1998). The results indicate that the strategies for the introduction of this biopesticide in the two regions of Benin (North and Centre) would have to be different because of the differential previous experience in pests control methods. In Northern region of Benin, where farmers have had less experience of the use of botanical method to control pests on cotton, farmers would expect a biopesticide to perform as effective chemicals. In central region, where the use of botanical method is widely sprayed and understood, the Metarhizium-based biopesticide could be introduced with a high adoption and diffusion rates.

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Table 4. Econometric (Logit regression) results for factors affecting farmers' willingness to pay for Metarhizium-based biopesticide

	B	S.E.	Wald	Df	Sig.	Exp(B)
Efficacy	2.501	.409	37.330	1	.000	12.190
Agro-ecological zone	-1.006	.415	5.872	1	.015	.366
Age	.076	.225	.114	1	.736	1.079
Education	.246	.174	2.005	1	.157	1.279
Gender	-.461	.394	1.370	1	.242	.630
Contact	-.267	.549	.237	1	.627	.766
Mode of action	.385	.419	.845	1	.358	1.469
Broad Spectrum	1.339	.425	9.944	1	.002	.262
Pest intensity	-.333	.422	.623	1	.430	.717

Chi-square = 139.954 df = 9 Sig. = .000 % of prediction: 80.0%b
-2 Log likelihood = 275.934