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Impact Assessment of agricultural research and development to reduce virus problems in tomato production in Mali: Farmers perceptions

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Abstract

Pests and diseases caused by bacteria, nematodes, fungi and viruses cause significant losses to tomato in West Africa. This study, carried-out within the framework of the IPM-CRSP implemented jointly by IITA, IER and Virginia Tech. and State University, assesses farmers' perceptions on tomato pests and analyzes factors affecting pest management decision-making. Surveys were carried out in three tomato production areas where pests and diseases are major agricultural problems encountered by farmers. Data were collected a sample of from 343 farmers through a set of questionnaires on tomato production systems. Farmer's decision-making in pest management was modeled using an econometrics Logit probability model. Results show that the main disease reported by most farmers is tomato leaf curl viruses transmitted by whitefly (*Bemissia tabaci*). The spray of chemicals was not effective on whitefly-transmitted viruses, but the observance of host free period could significantly reduce the population of whiteflies. Key factors affecting farmers' pest management decision-making are gender; share of tomato income from household income and the level of farm income. Men are more involved in tomato production due to access to pesticide and effective demand for pesticides because of incomes (purchasing power). This paper concludes that tomato production can increase significantly if improved varieties tolerant to whitefly viruses are developed and disseminated, and farmers trained on the appropriate use of chemicals using a participatory approach to raise their level of awareness and information on effective pesticide use and pest-management decision-making.

Introduction

Tomato viruses, diseases, and other pests have become a severe constraint to tomato production in West Africa, including Mali (Soumaré and *al.*, 2004). Gemini viruses in particular have reduced the yield and the area under tomato production throughout the region in recent years. Viruses and other pest problems have resulted in increased use of chemical pesticides in attempt to reduce crop losses. Tomato is sensitive to pest pressure and is therefore subject to intensive application of chemical pesticides including toxic ones. Resistance to pests, low awareness about risks and availability of cheap but high toxic pesticides have increased their misuse and abuse. The misuse of pesticides has raised concerns about health hazards linked to intoxications resulting in morbidity, deaths and environmental pollution (Coulibaly and *al*., 2006). Various alternatives such as improved varieties tolerant to insects and diseases; biopesticides, botanical extracts have been tested and promoted to reduce the misuse and overuse of pesticides in West Africa. Viruses however are particularly difficult to manage through only chemical use. Efforts have been made jointly to solve virus and other pest problems in tomato by the Institute of Rural Economy (IER) of Mali, Virginia Tech., AVRDC, IITA and Cornell University. This effort has involved collaboration between IPM-CRSP managed by Virginia Tech. for the assessment of potential impacts of solving or reducing specific pest management problems on tomato in West Africa, and the Agricultural Biotechnology Support Program (ABSPII) managed by Cornell University for the development of a genetically modified tomato to provide resistance to a poty virus that may become problem in the future if the Gemini virus problem is solved. This paper presents the results of a baseline survey carried-out on tomato production in Mali, and analysis of the economic impacts of research to reduce virus problems. More specifically, it assesses farmers' perceptions and knowledge of tomato pests and analyzes factors affecting farmers' pest management decision-making

Data and Methods

Sampling and survey: Surveys were carried out within tomato farmers' communities in high tomato production areas in Mali in 2006. Data were collected from tomato producers, scientists and industry experts. A sample of 343 vegetable producers was selected across 6 districts in the Southern and Central region. Vegetable producers were stratified according to tomato basic cropping systems and source of water supply for watering.

Theoretical model: Farmer's decision-making in pest management is modeled using an econometric (Logit) model. This model is used to identify key factors most likely to affect pest management decision-making of tomato producers. We assume that pest management decision-making is a function of farm household

characteristics, management practices and local socioeconomics conditions. Mathematically, Logit probability is represented by:

$$\phi(Z_i) = e\frac{Z_i}{1+e^{Z_i}} = \frac{1}{1+e^{Z_i}} \qquad (1)$$

$-\infty < Z_i < \infty$ Where $Z_i = \beta X_i$; **ß** a vector of unknown coefficients; X_i a vector of factors of the i^{th} farmers. $\Phi(\beta X_i)$ the probability that the i^{th} factor will affect farmer's pest management decision-making. The probability that a given factor affects pest management decision-making is the area under the standard normal curve between $-\infty$ and ß X_i. The larger is the value of ß X_i, the more important is this factor affecting farmer's decision-making. The change in $\Phi(\beta X_i)$ relative to the change in X_i is given by:

$$\frac{\delta\phi(\beta X_i)}{\delta X_{ij}} = \left[\frac{\delta\phi}{\delta Z_i}\right]\left[\frac{\delta Z_i}{\delta X_{ij}}\right] = f(Z_i)\beta_j \qquad (2)$$

Where $f(Z_i)$ is the value of density function associated with each value of the underlying Z_i index. Farmers' pest management decision-making is influenced by a vector of factors X_i including farmers characteristics, management practices and local socioeconomic conditions.

Empirical specification: The empirical specification of the model identifies the likely factors affecting tomato pest management decision-making in Mali. The descriptive statistics on the variables include in the empirical model are given in table 1

Results and discussion

Farmers' Socio-demographic profile: Tomato producers are young with an average of 42 years and one third are women. Only 20% of tomato producers attended primary school, 11% completed secondary education, and another 17% were schooled in adult education. The percentage of illiterate farmers is 22% for females and 31% for males. The majority of farmers are members of local grassroots organizations where information and experience as well as problems linked to crop production are shared and discussed. They have significant experience in tomato farming with an average of 15 years across the sites. Household average size is 8 people. Tomato producers are closed to the major market and to the main road. The distance from tomato producers' field to the nearest market is on average 7 km and 3 km to the nearest major road.

Farmers' perceptions and knowledge on tomato pests The results indicate that farmers were familiar with tomato pests and diseases. The most common diseases and viruses reported are bacterial wilt, tomato leaf curl viruses, and foliar diseases which are reported by 26%, 25% and 24% of producers respectively. Leaf spots (bacterial leaf spot, grey leaf spot and early blight) are also mentioned by 13% of farmers. The main problems of tomato production reported during dry season are tomato leaf curl viruses (TLCV) and bacterial wilt (Gilbertson and *al*., 2006; Nagaraju and *al.*, 2002). Farmers assume that TLCV is caused by a high temperature, deficiency in water in the field. Only few of them were aware that TLCV was transmitted by a whitefly vector, *Bemisia tabaci*. In the rainy season, foliar diseases, early blight (*Alternaria solani*) grey leaf spot (*Stemphylium solani*) and bacterial leaf spot (*Xanthomonas campestri*) are the most common diseases reported by tomato producers. The most common tomato pests are worms, aphids, white flies and viruses reported by 27%, 22% and 18% of farmers respectively. Worms, aphids and white fly are believed to decrease yield and/or quality of tomato despite the use of chemicals, by 15%, 7% and 5% of farmers respectively. The increased resistance to chemical pesticides seems to be one of the most important factors causing the observed trend in pest severity on tomato. The effectiveness of chemical pesticides is not a factor, as more than three fourths of tomato producers mentioned that chemicals used on tomato are effective. Less than 10% of tomato producers combine the use of chemicals with other non chemical

methods such the destruction of host plants, the observance of host free period, the use of nets to cover seedlings in nursery or the use of plant extracts to control tomato pests.

Factors affecting pest management decision-making: Using econometrics Logit probability model, four factors have significantly affected tomato producers' pest management decision-making. These variables include farmer's gender ("*Gender"*), the proportion of tomato income in the total annual income (*"Tomato income"*) and the proportion of farm income in the total annual income (*"Farm income"*). *"Tomato income"* and *"Farm income"* were negatively associated with a producer's decision-making, indicating that the tomato producer whose tomato or farm income is a smaller proportion of total annual income pays attention to pest management decision-making. *"Gender"* coefficient was positively associated with decision-making explaining that men are more involved in pest management decision-making than women. The significant of the farm structure *"Land Ownership"* variable supposes that pest management decision-making is also based on the farm characteristics. This variable is positively associated with farmer's decision-making indicating that he is willing to practice IPM methods to control pests on tomato when he had a property right on the land. This result is not comparable to that found by McNamara and *al,* 1991, in assessing factors affecting peanut producer adoption of IPM in USA. These authors found that the adoption decisions are not based on structural characteristics of the farm because producers follow only a portion of the IPM recommendations.

Conclusion

Tomato production remains one of the most important cash crops in Mali where it is produced both in dry and rainy seasons. Insects, diseases caused by bacteria, nematodes, fungi, and viruses are the major production constraints and caused significant losses on tomato in term of yield and quality. Chemical pesticides are the common method used by farmers to control pests on tomato, but are not effective on whitefly-transmitted viruses. An alternative currently developed includes observance of a host free period for tomato production. The results show that the most likely factors affecting pest management decision-making in Mali include producer's characteristics and farm structure. Management practices and institutional factors focusing on producer's capacity building did not statistically influence producers' decision-making. Appropriate measures in order to prevent future environmental risks should be taken.

Farmers need to be trained on the appropriate use of chemicals using a participatory approach to raise their level of awareness on pesticide use and pest-management decision-making.

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Table 1. Names and description of factors in farmers' choices

Variables names	Description of the variables
Dependant variable	
Y	Have you, or any member of your family, ever participated in Farmer Field School (FFS) Training for IPM?: 1 for Yes and 0 for No
Explanatory variable	
Household characteristics	
Gender	1 for male; 0 for female
Age	Farmer's age
Education	Farmer's educational status (0 for No education, 1 for basic education (6 years), 2 for secondary education (7-13 years)
Farm experience	Number of year in tomato production
Family labor	Number of persons who work in the family
Tomato farm size	Area cropped for tomato (in ha)
Vegetable consumption	Proportion of vegetable consumed
Tomato income	Share of tomato in farmer annual income
Farm income	Share of farm income in total annual income
Management practices	
Place of sale	Place of sale of tomato 1 for market, 2 for field/village
Factors of pesticide choice's	The most important factors considered in the choice of pesticides (1 = relative advices, 2 = efficacy, 3 = Extension agent advice, 4 = Pesticide cost, 5 = pesticide dealer advice/local radio)
Socioeconomics factors	
Land ownership	Mode of land uses (1 = Inheritance, 2 = Ownership, 3 = Renting)
Irrigation	Type of water supply use for tomato cropping (1 = Irrigation system, 2 = Recycled cans, 3 = Rain fed)
Institutional factors	
Extension	Farmers who have been visited by an agricultural extension agent, 1 = farmer has been visited by an extension agent, 0 = otherwise
IPM participation	1 if farmer or any member of his family has participated in Farmer Field School (FFS) training for IPM; 0 otherwise

Table 2. Logit regression results for factor affecting pest management decision-making

Explanatory variables	B	S.E.	Wald	df	Sig.	Exp(B)
Producer characteristics						
Gender	.776	.259	8.990	1	.003	2.172
Age	-.001	.002	.368	1	.544	.999
Education	.183	.192	.906	1	.341	1.200
Farm experience	.001	.001	1.152	1	.283	1.001
Family labor	.004	.005	.761	1	.383	1.004
Tomato size	.000	.000	1.404	1	.236	1.000
Vegetable consumption	.004	.003	2.433	1	.119	1.004
Tomato Income	-.002	.001	4.114	1	.043	.998
Farm Income	-.009	.003	5.980	1	.014	.992
Management practices						
Place of Sale	.001	.001	1.371	1	.242	1.001
Factors Pesticides	-.047	.072	.425	1	.514	.954
Farm structure						
Land Ownership	.527	.197	7.127	1	.008	1.693
Irrigation	.001	.001	.740	1	.390	1.001
Institutional factors						
Extension	.000	.001	.028	1	.866	1.000
IPM Participation	.206	.272	.571	1	.450	1.228

Prediction rate = 0.63 X^2 = 77.53 Df = 15 Sig.= .00 -2 Log likelihood = 395.199