Symposium topics and subtopics:

3. Conception and assessment of innovating sustainable horticultural systems, including organic horticulture

Farm economics and management

Title: Farmer's perceptions of Eco-friendly nets adapted to vegetable production in Benin

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Abstract:

City food supplies are a rising concern for food security in an urbanizing context as productivity and yields are expected to increase to meet the growing needs of urban dwellers. Domestic food supplies will not only require increased food production but face a series of constraints related to quality. Some of such constraints are the restrictions on insecticide residues. Eco-friendly nets contribute to improve food production with both reducing insecticide residues and improving product quality. Eco-friendly nets proved to be a viable alternative to harmful and unsustainable insecticide application practices in tropical countries. However, this technology needs to be adapted to the social and economic context in which small-scale farmers evolve. To this end, we investigated a cross-section study of 115 farmers involved in vegetable production and evenly distributed between adopters and non adopters in the Mono and Couffo divisions of Benin. We identified the various factors that govern their preferences. We performed a summary and partial analysis using Likert's scale measurement, W-test of Kendall as well as a multiple regression model. Results show that insecticides were still adopted by 70% of the sample either exclusively or in conjunction with eco-friendly nets. Farmer's preferences expressed for insect control revealed that speed of action and spectrum activity were the first two factors influencing the adoption of a insect control technology. These results were in concordance with preferences expressed by farmers for eco-friendly nets as speed of action and spectrum activity were considered as positive factors. However, costs were considered as negative factors (labor costs, fixed costs and depreciation). The model stated that level of income, knowledge about net use, access to credit and level of education positively correlate with the level of satisfaction for eco-friendly net use in its initial stages of adoption.

INTRODUCTION

Preserving food security in a growing urbanization context through City food supplies are a rising concern in South Saharan. This is true for vegetables which production is assumed to be key for agricultural diversification and linking smallholder gardeners to market (Weinberger and Lumpkin, 2007; World Bank, 2008; Ekesi et al., 2009).

In Benin vegetable farming is dominantly intensive in the south (Brock, 2006, Adorgloh-Hessou, 2006). Its employs about 4 % of the active population (RNIB, 2008) and especially smallholders and vulnerable persons such as ladies, (Tokannou et Quenum, 2007), jobless youth and dismissed persons from public sector (Assogba Komlan, 2010). Vegetable farming is one of the twelve priority sectors identified to boost the agricultural sector in Benin. Doing so, the expected objective is to mitigate the pernicious effects of poverty (FAO, 2006, Tokannou and Quenum, 2007; Hounguè and Kindomihou, 2009) which incidence is in rising (33, 3 % to 35, 2 % between 2007 and 2009 according to INSAE (2010)). Their effects are malnutrition and chronic diseases among others. Therefore, Government's attention is focused on it through important resources allocation (PSRSA, 2010). So far the local supplies fail in meeting the needs of urban dwellers because the sub-sector is facing insect damages (among others) and transmitted diseases which cause an average 30-40% loss in vegetable harvesting (Toannou et Quenum, 2007). Consequently, production is still fails to meet national standards for yield quality and environmental health.

To control insects, vegetable farmers spray persistent insecticides such as Endrin, Heptachlor, Aldrin and Dieldrin since 1950. The easiest access of these products dedicated to cotton production from both formal and informal markets has lead to their widespread use in Benin (Tokannou and Quenum, 2007 and Ahouangninoun 2008). There is a rise in human exposure and poisoning due persistent insecticides use (Ntow, 2006). Atingoto (2009) revealed manifold human diseases of which neurological and allergic disturbances, cancer, mental deficiency etc. related to insecticides use. These negative effects are aggravated by environmental degradations of groundwater, soil and air pollution.

Eco-friendly nets could be helpful for farmers. Thibaut *et al*. (2006) reported that netting protection is better than unprotected control on lepidopteran larvae and both foliar sprays and control on *Plutella xylostella (L.),* nets treated with deltamethrin provided total protection of young plants against the aphid *Lipaphis erysimi (Kaltenbach).* Taylor *et al*. (2001), Berlinger *et al*. (2002) revealed that fine mesh screening enables a cost effective production of tomato and other vegetables even under significant pest pressure. Weintraub, (2009) found that the advantage of mesh screening permits movement of air and help reduce humidity, which enhances plant pathogen development. However, this technology needs to be adapted to the social and economic context in which farmers operate. Since 2010 a Participatory Technology Development is implemented with the farmers through a national NGO aiming the assessment of the farmers' perceptions of this new tool. In Theory, farmers' perceptions are a guiding concept of behavior (Gengaje, 1996). Perceptions are viewed as a determinant of their decisions to adopt a new agricultural technology in preference to an old one (Negatu and Parick, 1999) and of the interactions farmers have with this technology (Rhaman, 2003; Ormsby and Kaplin, 2005; Allendorf *et al*., 2006; Ramakrishnan, 2007; Vodounhè, 2010). The present working paper aims to examine farmers' perception of Eco-friendly net use and identify factors determining heterogeneity among farmers regarding the perceptions.

MATERIAL AND METHOD

Study area

Surveys were conducted in the Mono and Couffo divisions. They are located in the South-East of Benin between North latitude 6°15-7°30 and East longitude 1°35-2°10. It covers 4009 square kilometers. The population size is about 1,023,870 inhabitants dominated by women (53 %) (INSAE, 2008). The climate is characterized by two rainy and two dry seasons within a year. People derive their income mainly from the agricultural activities

where market gardening is on the rise due to drop in fishing productivity (previously the most important activity).

Sampling and data collection

Data used in the present study derives from a database designed and filled to highlight the farmer's intention of net use and its effects on insecticides spraying. A sub-sample of 115 farmers was surveyed, including direct users of the net trials as well as observers. This sub-sample is part of a larger survey database of 298 farmers directly or indirectly involved in net based trials. Data were collected with a semi-structured interview conducted in august 2011 to get insight on relevant variables. Results were used to design a consensual questionnaire previously tested and then adopted to carry out the main survey in September and October 2011. Sampling procedures combined a stratified and randomized technique based on the probabilistic method of proportion inspired by Moivre-Laplace theorem and applied for Advantages surveys (Advantages, 2004). Data were collected previously with a semi-structured interview conducted in august 2011 to get insight on relevant variables guiding direct and indirect net trials farmers. The results were used to design a consensual questionnaire previously tested and then used to carry out the main survey in September and October 2011.

Survey procedures and analyses

The study started with the identification and ordering of the main basic attributes guiding farmers' choice of pest management innovations through a semi-structured interview. The homogeneity in the ordering has been assessed by the Kendall concordance coefficient as applied by Legendre (2005). Kendall's coefficient of concordance (W) is a measure of the agreement among several (p) survey respondents who are assessing a given set of n objects. Depending on the application field, the survey respondents can be variables, characters, and so on. In the present context, an average rank is computed for each attribute on the basis of the ranks affected by all the farmers in the sample. The level of homogeneity of the ranking of a given attribute is revealed by "W" $\in[0, 1]$. The more W is closer to 1, the more farmers are unanimous on the importance of this attribute.

An in-depth survey has been carried out using a structured survey and a scoring model to describe the socio-economic characteristics of the farmers and to estimate the importance devoted to the attributes. The perceptions' index of each attribute with a farmer is estimated using Likert five point scale (5= strongly suitable, 4= suitable, 3= not so bad, 2= weakly suitable, 1= very weakly suitable). This method is designed by Likert since 1932 and is still applied in behavioral studies (see Kadiri, 2008; Okoedo-Okojie, and Aphunu, 2011). The ranks are weighted considering the unit weight of 0.20 as displayed by Table 1.

The Aggregate perception index for Jth farmer (*APIi*) is given, accorging to Rhaman (2003) by:

$$APIi = \sum_{j=1}^{5}\sum_{m=1}^{5}\sum_{q=0,5}^{1} PRW_{jmq} \forall j = 1,2,...,5; m = 1,2,...,5; q = 0,0,5...1 \quad \text{……. (1)}$$

The overall perception index of the Jth farmer (OPI_i) is given by:

$$OPI_i = \frac{API_i}{N} \quad \textit{(N= is the number of attribute)}\text{…….. (2)}$$

Heterogeneity among farmers regarding opinions is accessed once the perception indexes are obtained. We use the Ordinary Less Square Method. The results of the model have been analyzed based on their quality determined by the significance threshold of Fisher's value at (n-k-1) degree of freedom. Its prediction is revealed by either adjusted R^2 or the value, signs and significance of the coefficients. The overall model applied to both the three aggregate

variables (Model 1) to the effectiveness (Model 2), to the complexity (Model 3) and to cost (Model 4) is:

$$Y = \beta_0 + \beta_i X_i + \mu_i \qquad (3)$$

In this model, Y is the perception index; Xi, the independent variables matrix; β0, the constant; βi the vector of coefficients and μi, the error term.
Production zone has been introduced in the model to assess the variation of farmers' perceptions from Mono where vegetables production system is dominantly intensive and Couffo where it is extensive.

To understand the heterogeneity of the perceptions among the farmers, we use the following explanatory variables: household size (number of persons living in the household), sex of the household head, level of schooling (number of years spent with success at school), professional training (duration in the process of learning a profession), experience in vegetable farming (number of year since he has started vegetable farming), farm size (Land-size allocated to market gardening), Level of income (percentage of farmers earning the corresponding amount of cash per year), participating in a farmers' association (percentage of household members in farmers associations), production zone (MONO as intensive production zone and Couffo as extensive one) and access to credit (proportion of the farmers who have benefited a credit for their activities). We hypothesize a positive influence on the perceptions of attributes by Sex, Level of schooling, Professional training, Level2 and Level3 of income, production zone and Access to credit. We predict a negative influence by Household size, Experience in vegetable farming, Farm-size. Participating in farmers' association could have positive or negative influence.

RESULTS AND DISCUSSIONS

Referring to Figure 2, there is an unanimity on effectiveness (speed of action, i.e., the amount of time after which the farmer can assess the effects of the innovation; and spectrum of activity, i.e., the insect range affected by the innovation) as the main valuable use attributes which guide farmer's choice. The consent is quite full on costs (starting capital and depreciation). An important heterogeneity occurs with labor issues. Less than 60 % of the respondents base their choice on the quantity of labor and less than 50 % on labor quality. These results illustrate the prior farmers' concern is yield increase to meet the growing demand. The combination of rationality and poverty could explain the importance given to the cost in terms of acquisition and depreciation.

Farmers find Eco-friendly net use effective (57 %) and easy to use (51 %) even if these perceptions are at a middle level. At the opposite they worry about the costs (40 %) and focusing their attention on this attribute, their overall index of perception is revealed weak (49 %). Just after a year of eco-friendly net and in the context of purchasing power, such results are not surprising. Table3 shows that the hypothesis is verified for access to credit, professional training, production zone, level of schooling and income as their coefficient are positive. Heterogeneity appears among the influences of these variables according to the models. Access to credit highly influences the perceptions ($p<0, 01$) in both four models (global model 1, model 2 for effectiveness, model 3 for complexity and model 4 for cost). There is a similar level of significance noted with "training" in the global and fourth models (regression on costs), and "Production zone" only at the costs perception. Significant influence ($p<0, 05$) comes from variable such as "Training" in model 2, income levels 2 and 3 in models 1 and 3. A weak significance is observed with production zone in models 1 and 3, "Training" in model 4 and level of schooling in model 4. Sex (coded as 1 =male and 2 = female) shows a negative coefficient (instead of a positive coefficient expected), indicating

that women' perceptions is lower than men 'ones. The other variables do not have any significant effect on the models.

The results show that an increase of the farmers' incomes could lead to higher agricultural investments. For this purpose access to credit seems to be one of the available options to do it given their limited purchase power revealed by the rising monetary poverty incidence (33, 3 % to 35, 2 % between 2007 and 2009) in Benin (MAEP, 2011). Financial support (easy access to credit among others) should complete the technical performance of the Eco-friendly net to if the full commitment of the farmers is targeted. Even if the financial support is guaranteed the farmer have a real need of knowledge about the use of eco-friendly net referring to the significance of training coefficient. The acquisition of knowledge is facilitated by a high level of schooling in terms of advantages related to eco-friendly net and its environmental effects. The production zone (coded as 1 = Couffo and 2 = Mono) with its positive coefficient highlights that perception of the attributes is stronger in Mono (zone of dominant intensive farming) than in Couffo (zone of dominant extensive farming). This implies the necessity to consider territorial characteristics in innovation adoption. Such action could reduce the discrimination among production zones relying on the yearly gross incomes distribution. About 51 % of the households in the Mono division earn at least FCFA 200,000 (Euro 305) per year versus 26 % in Couffo division.

This study highlights the core role of funding facilities and capacity building in farmers' decision to use this Eco-friendly net. Success in such a way is constrained by sufficient technical and financial support in this context where most of rural zone are not covered by agricultural extension workers and where adapted financial providers are scarce.

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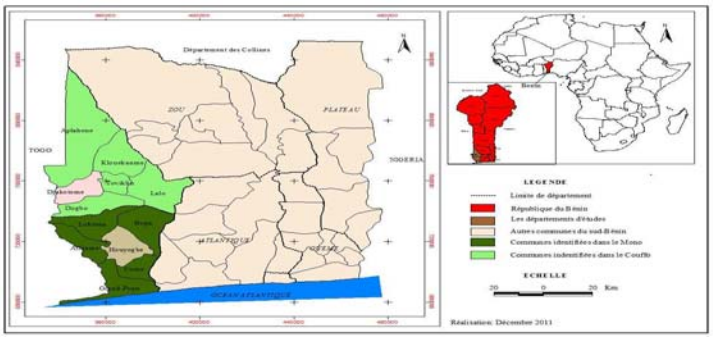

Figure 1: Study area: Mono (dark green) and Couffo (light green)
Source: National Geographic Institute of Benin.

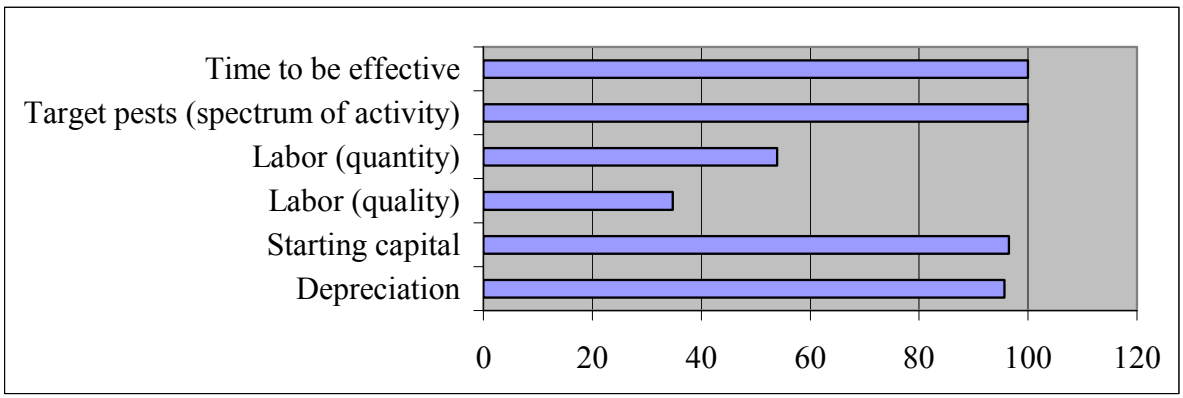

Figure 2: Attributes for choosing pest management innovations among farmers (N=115).
(Kendall's W=0,726; $\chi 2$=145,254; df=5; p =0,000.

Table 1: Farmers' perceptions of the eco-friendly nets attributes (N=115)

Aggregate attributes	Couffo		Mono		Study area	
	Index	Rank	Index	Rank	Index	Rank
Effectiveness (Speed and spectrum)	0,57	1	0,53	2	0,55	1
Complexity (labor quality, and quantity)	0,51	2	0,58	1	0,54	2
Costs (capital and depreciation)	0,40	3	0,43	3	0,41	3
Overall index	0,49	2	0,51	1	0,5	

Source: Survey September-October 2011.

Table 2: Statistics of quantitative and qualitative explanatory variables (N= 115).

Variables	Means ± SD or proportion
Age (year)	43,43± 11,778
Household size (number of persons)	7,49 ±5,08
Female	19
Level of schooling (%)	60
Professional training (%)	41,6
Experience in market gardening (year)	9,77 ±6,825
Land-size allocated to market gardening (ha)	0,7656±0,8868
Level1 of income (%)	24,3
Level2 of income (%)	41,7
Level3 of income (%)	33,9
Participating in a farmer's association (number of persons)	1,60±1,723
Access to credit (%)	51,57

Table 3: Results of the four MCO model (N=115)

Independent variables	Dependent variables			
	Model 1	Model 2	Model 3	Model 4
	IP	$IP_{efficacy}$	$IP_{complexity}$	IP_{cost}
Constant	0,384 *(11,729)*	0,456 *(6,999)* ***	0,377 *(6,515)*	0,319 *(5,973)* ***
Sex	-0,031 *(-1,455)*	-0,005 *(-0,125)*	-0,039 *(-1,034)*	-0,049 *(-1,403)*
Household size	0,00079 *(0,499)*	-0,002 *(-0,784)*	0,00017 *(0,064)*	0,0046 *(1,805)*
Access to credit	**0,094 *(6,199)* *** **	**0,117 *(3,872)* *** **	**0,074 *(2,750)* *** **	**0,092 *(3,695)* *** **
Participating in a farmer's association	0,0014 *(0,086)*	0,014 *(0,430)*	-0,0076 *(-0,260)*	-0,002 *(-0,085)*
Professional training	**0,066 *(4,444)* *** **	**0,063 *(2,141)* ** **	0,029 *(1,107)*	**0,106 *(4,360)* *** **
Production zone	0,014 *(1,943)**	-0,011 *(-0,754)*	0,022 *(1,665)**	**0,033 *(2,692)* *** **
Farm size	-0,0018 *(-0,670)*	-0,002 *(-0,525)*	0,00078 *(0,161)*	-0,003 *(-0,766)*
$INCOME_2$	**0,038 *(2,095)* ** **	0,052 *(1,431)*	**0,059 *(1,819)** **	0,004 *(0,137)*
$INCOME_3$	**0,038 *(2,044)* ** **	0,040 *(1,062)*	**0,070 *(2,105)* ** **	0,005 *(0,182)*
Level of Schooling	0,025 (1,419)	-0,011 *(-0,324)*	0,034 *(1,107)*	0,052 *(1,807)**
Experience	0,0003 *(0,334)*	0,0015 *(0,707)*	0,00046 *(0,244)*	-0,0009 *(-0,514)*
R^2	0,4567	0,2169	0,1758	0,3486
R^2 ajusté	0,3928	0,1247	0,0789	0,2720
F (12, 102)	7,146***	2,354***	1,813**	4,550***

* Significant at 10%, ** Significant at 5%, *** Significant at 1%.