



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

ADOPTION AND IMPACT OF SOIL CONSERVATION PRACTICES ON FARM INCOME: EVIDENCE FROM NORTHERN HAITI

Sènakpon. E. Haroll. KOKOYE

Graduate Research Assistant, Department of Agricultural Economics and Rural Sociology, College of Agriculture, Auburn University, 310 Comer Hall, Auburn, AL 36849. Email: sek0013@auburn.edu

Curtis.M. JOLLY

Professor, Department of Agricultural Economics and Rural Sociology, College of Agriculture, Auburn University, 203 Comer Hall, Auburn, AL 36849. Email: jollycm@auburn.edu

Joseph J. MOLNAR

Professor, Department of Agricultural Economics and Rural Sociology, College of Agriculture, Auburn University, 301 Comer Hall, Auburn, AL 36849. Email: molnaji@auburn.edu

Dennis SHANNON

Professor, Department of Crop, Soil & Environmental Sciences, College of Agriculture, Auburn University, 202 FUNCHESS HALL, Auburn, Alabama, 36849, USA. . Email: shannda@auburn.edu

Budry BAYARD

Consultant, AgroConsult, Port au prince, Haiti Email: bbayard@hotmail.com

***Selected Poster prepared for presentation at the Southern Agricultural
Economics Association's 2016 Annual Meeting, San Antonio, Texas, February 6-
9, 2016***

Copyright 2016 by Sènakpon. E. Haroll. KOKOYE, Curtis.M. JOLLY, Joseph J. MOLNAR, Dennis SHANNON, Budry BAYARD. All rights reserved.

PRELIMINARY DRAFT - PLEASE DO NOT CITE

Abstract

Soil conservation practices (SCP) play a fundamental role in reduction of soil loss due to soil erosion and improvement of soil fertility. In this paper we assess the adoption and the impact of SCP on Farm income in Northern Haiti as a consequence agricultural productivity increase. Based on data collected from 483 farmers in six watersheds --- Borgne/Limbé, Haut-du-Cap, Grand-Rivière-du-Nord, Marion/Trou-du-Nord, Jassa and Grisongarde --- in Northern Haiti, this study investigates the impact of adoption of SCP on farm income using Heckman two steps selection model. The results from the probit model reveal adoption of SCP is influenced by gender, group membership, land ownership, access to credit, the interaction between education and group, the size of the plot and the interaction between slope and the size of the plot. The outcome model of the Heckman selection shows household size, access to credit and off-farm activities improve farmers' income.

Key words: Soil conservation practices, propensity score, Northern Haiti

Introduction

In developing countries, agriculture remains a key activity for providing people the capacity to feed themselves by producing their own food or the source of employment and income to access to food supplies (Andzo-Bika and Kamitewoko, 2004; Kokoye et al., 2013). It represents the major subsistence activity for rural Haitians, (WEF, 2011; Bargout and Raizada, 2013) and contributes to 25 per cent of the gross domestic product of Haiti (Singh and Cohen, 2014). However, Haitian agricultural sector is facing serious soil erosion that widely impacts agricultural land fertility (Bayard et al., 2003; Jolly et al., 2006). In Haiti, reduction in soil fertility leading to the decrease of agricultural productivity was listed as a major cause of soil erosion (Bayard et al., 2007). Given that agricultural productivity is critical determinant in developing countries' ability to meet food security and economic development objectives in times of rapid population growth (Wiebe et al., 2001; Kokoye et al., 2013); the implication for food security and livelihoods of Haitian farmers is obvious. In face of the current global challenge of increasing and stabilizing farmers' income to achieve poverty reduction and environmental

management, adoption of sustainable practices become inevitable (FAO, 2012a; Arslan et al., 2014).

Soil conservation techniques have been largely popularized by development projects over the years as sustainable solution to soil loss and decrease of agricultural productivity in Haiti. These techniques include *bann manje* (crop bands), rocks wall, hedge rows and *rampaye*. Most of these primarily address soil erosion, soil fertility improvement and farm income diversification.

However, despite the proven benefits of soil conservation practices farmers are still reluctant to adopt them. Reasons for that are various and related to farmers' socio-economics characteristics, production factors and geo climatic factors (Bayard et al., 2006). Several studies have been done to investigate on factors affecting the adoption of soil conservation practices. Most of these studies have been done in China, Africa and other developing countries where soil erosion is a serious problem. In China, while Wang et al., (2010) focused their study on farmers' adoption of conservation agriculture, Liu and Huang (2013) studied the adoption and continued use of contour cultivation in the highlands of southwest China. Both studies gave an insight on how farmers' socio economics characteristics affect their decision to adopt soil conservation practices and conservation agriculture. In most African countries, land degradation has led to severe soil erosion and the use of soil conservation practices become an inevitable option for farmers. Agbamu (1995) has investigated on farmers' characteristics that guide adoption of soil management practices in the Ikorodu area of Nigeria. Arslan et al., (2014) analyzed the determinants of farmer adoption of conservation farming practices in Zambia using panel data. Adesina et al., (2000) studied adoption of alley farming by farmers in the forest zone of southwest Cameroon. Ng'ombe et al., (2014) investigate on factors affecting adoption of Conservation Farming Practices by Smallholder Farmers in Zambia. Kassie et al. (2012) analyzed determinants of adoption of sustainable agricultural practices including terracing and plant barriers in Tanzania. Chiputwa et al., (2011) used tobit model to study the adoption of Conservation Agriculture Technologies by Smallholder Farmers in the Shamva District of Zimbabwe. In Ethiopia, Amsalu and de Graaff (2007) studied the factors affecting adoption and continued use of stone terraces. Tesfaye et al. (2013) also analyzed adoption of

three soil conservation practices -- soil bunds, stone bunds and fanya juu bunds (terraces) --- in Ethiopia. These studies used various methodologies to identify determinants of soil conservation practices.

In Haiti, Bayard et al., (2003) and Jolly et al., (2006) have investigated the factors affecting adoption of soil conservation techniques such as alley cropping, rock walls, gully plugs and crop band in Southern Haiti. Furthermore, Jolly et al, (2006) have studied the impact of some of these techniques on net income of farmers. However, conditions for adoption might be different for each, or set of practices and vary from one location to the next. To our knowledge there is no study in northern Haiti on factors affecting choice of soil conservation practices and their impact on farmers' income. Given the agricultural potential of the Northern corridor, it is important to evaluate the practices that reduce soil erosion and influence crop yields. Therefore, this study contributes to the previous literature by empirically identifying factors affecting the adoption of selected soil conservation techniques in Northern Haiti and their impact on farmers' income.

The impact evaluation may suffer from selection bias as the process of adoption of soil conservation techniques by farmers might not be random. So identify causal effect of soil conservation techniques is quite difficult as adoption process tend to be endogenous. Two main reasons are behind these difficulties: 1) we cannot observe the counterfactual, that is, what income or revenue would look like in the absence of adoption, 2) as the process of adoption is seldom random it is very difficult to isolate the true causal impact of soil conservation techniques adoption. Using data from individual farmers in Northern Haiti, this paper applies the Heckman two-stage procedure to address self-selection problems in nonexperimental data.

The remainder of the paper is organized as follows. The second section provides a theoretical framework, the third section describes the data collection procedures, and the fourth section presents the results and discussions, and the last section concludes and summarizes the paper.

2. Theoretical Model and Empirical Specification

Impact evaluation involves the use of experimental and non-experimental approaches. Experimental approach consists of having a group of persons or individuals or any other measurement unit that have the same characteristics and accept to participate in the experiment and assign them randomly to two groups: treatment group and control group. Since in this experiment participants were chosen randomly, any difference with non-participant is attributed to the treatment. Therefore sample selection bias was not considered a problem in randomized experiments because randomization renders selection effects irrelevant (Guo and Fraser, 2014). For these reasons the experimental approaches are considered as more accurate (unbiased estimates) and gives results that easy to interpret (Cochrane et Rubin, 1973; Bassi, 1984). However this approach is difficult to implement in social science.

Economist and social scientist uses the non-experimental approach by using economic and econometric theories for guiding the analysis and minimize the potential error that might occur in the estimation of impact (Diagne, 2003). Indeed this approach is used when it is impossible to select control or comparison group. One can compare the participant to the project or program with the non- participant by using statistical method to control the observed difference between both groups. It is possible with a regression analysis to control for age, revenue, gender and other characteristics of the participant. This approach is less difficult and easy to apply but the results might be less accurate.

In this paper we use the Heckman two step selection models to evaluation the impact of the adoption of soil conservation techniques on farmer net income. This model has been used to address selection bias when the correlation between the two error terms is greater than zero (Hoffman and Kassouf, 2005; Adeoti, 2009; Johannes et al., 2010; Siziba et al., 2010; Ibrahim et al., 2012). The Heckman slection model involves two equations: (1) The regression equation considering mechanisms determining the outcome variable here income and (2) the selection equation considering a portion of the sample whose outcome is observed and mechanism determining the selection process (Heckman, 1978, 1979).

The regression can be written as follows:

$$Y_i = \beta_0 + \sum_j \alpha_j X_{ij} + \delta_i W_i + \varepsilon_i \quad [1]$$

With: β_0 the constant term, α_j the parameters to be estimated, X_{ij} is the set of independent variables, W_i is a dummy variable for adoption of SCP and ε_i the error term

The election equation can be written as follows:

$$W_i^* = \gamma_0 + \sum_j \alpha_j X_{ij} + \mu_i \quad [2]$$

$$W_i = \begin{cases} 1 & \text{if } W_i^* > 0, \\ 0 & \text{otherwise} \end{cases} \quad [3]$$

where W_i^* is a latent variable denoting the difference between utility from adopting SCP and the utility from not adopting SCP. The table 1 summarized the variable used in the models.

3. Materiel and methods

Study area and data collection

Haiti, with a total area of 27,750 square kilometers is located in Caribbean island and lies between the Caribbean Sea and North Atlantic Ocean and has a latitude of 19° 00' N and a longitude 72° 25' W. Data used in this study were collected in North Haiti (figure 4) by the USAID/AVANSE project as part of a baseline survey. The area covers 6 watersheds in North Haiti. These include Marion, Trou du Nord, Grande riviere du Nord, Haut du Cap, Jassa and Limbe. The average annual rainfall is about 1,200 mm in the plain and 1,780 mm in the high mountains. Annual rainfall decreases from West to East, with precipitation varying from 800 mm to 1,900 mm in the East and from 1,500 to over 2,000 mm in the West. The two rainy seasons are September to January and April to June (DAI, 2014).

Farmers participating in this study are those who were registered by the project in the opening phase of implementation. From September 2013 to January 2014, the project registered 6,400 farmers. Four hundreds eighty three (483) farmers were randomly selected from the list of farmers who registered with the project. Table 1 shows the number of households surveyed in each watershed.

A survey instrument composed of open-ended and closed-ended questions was used. Information collected are related to farm households socio-economics and demographics data – age, location, type of household, education, off-farm activity—agricultural activities from October 2012 to September 2013 and household use of soil conservation techniques.

4. Results

The table 1 presents the descriptive statistics of variables used in the Heckman selection model. The control group comprises farmers who do not adopt the soil conservation techniques (204 farmers) and farmers who adopted (279 farmers). Given the socio-economics characteristics, farmers in the treated group in the treated group are different from their counterpart in the control groups. We used the log of net income as variable of interest for the outcome model.

Adoption of SCP is influenced by gender, group membership, land ownership, access to credit, the interaction between education and group, the size of the plot and the interaction between slope and the size of the plot. Men are more likely to adopt SCP than women. Similar results were found by Adesina et al., (2000) in their study on factors affecting adoption of alley farming in Cameroon. As it was the case in Cameroon, men in Haiti might have more access to resources including contact with international projects that popularize these techniques. Fabiyi et al. (1991), cited in Adesina et al., (2000) also found that in southwest Nigeria men farmers were more likely to use alley farming than women. Studies of Liu and Huang (2013) in China indicate that households with female decision makers are less likely to use contour cultivation. The limited access to resources by women might prevent them to adopt agricultural technologies. Doss and Morris (2001) found that access to inputs is the main factor that justifies the difference in adoption of agricultural technology between men and women in Ghana. Unexpectedly group membership has negative impact on hedge rows adoption. This result is in contrast with many studies (Lapar and Pandey, 1999; Adesina et al., 2000, Yegbemey et al., 2013) that found farmers groups and associations to be an asset for agricultural technology adoption. Land ownership positively influences the adoption of SCP. This results confirm previous studies (Lapar and Pandey, 1999; Soule et al., 2000; Schuck et al., 2002; Kabubo-Mariara, 2006; Yegbemey et al., 2013) that demonstrated that ownership of the land has positive effect on adoption of any technology especially SCP. Adesina et al., (2000) have found a

positive relation between adoption of alley farming and the possession of right over three in Cameroon. Land ownership defines the property right on the land and could consequently determine the type of investment – including establishment of SCP for soil fertility improvement--- farmers will put on the land for agriculture. Thus unsecure property rights expose farmers to expropriation, which reduces their incentive to enhance the value of the property (Kokoye et al., 2013). The interaction between education level and group membership positively influences farmers decision to adopt SCP. The results show that there is a marginal increase in the probability of adoption for those who belong to local groups and have some measure of education. The size of the plot has positive effect on the adoption of SCP. Liu and Huang (2013) in their study in China found that households with larger plots are more likely to use contour cultivation. The interaction between slope and the size of the treated plot has negative effect on the adoption of SCP. One plausible explanation of this result is that it is recommended that the farmer reduces the space between each row whenever the slope is high but farmers are reluctant to that; thus reducing their chance of adopting SCP whenever the size of the field and the slope are high.

In the outcome model (second stage) the inverse Mills ratio (IMR) has been incorporated. The IMR (λ) was not significant implying that adoption of SCP does not necessarily increase farmer's income. Three variables significantly influenced farm income, household size, access to credit and off-farm activities.

Conclusions

This paper investigates the impact of soil conservation adoption techniques on farmers' net income using Heckman two steps selection. The treatment group consists of farmers who adopted soil conservation techniques and the control group of farmers who did not. Results show that adoption of SCP is influenced by gender, group membership, land ownership, access to credit, the interaction between education and group, the size of the plot and the interaction between slope and the size of the plot. From the outcome model, three variables significantly influenced farm income, household size, access to credit and off-farm activities.

Table 1: Explanatory variables considered in the models

Variables	Types^a	Definition
Age	C	Number of years from birth
Gender	D	0=Female ; 1=Male
Schooling level	D	No = 0 ; Yes = 1
Per capita income	C	Level of per capita income
Off farm activity	D	No = 0 ; Yes = 1
Household's size	C	Number of people living in the household
Access to credit	D	No = 0 ; Yes = 1
Group membership	D	No = 0 ; Yes = 1
Size of plot treated	C	Area in hectare of plot treated
Crop dependency ¹	C	Agricultural income share
Slope	D	No = 0 ; Yes = 1
Land ownership	D	No = 0 ; Yes = 1

^aTypes : D = Discontinuous variables ; C = Continuous variables

Table 2: Distribution of household surveyed by watershed

Watersheds	Frequencies	Percentage
Marion	65	13.46
Trou du Nord	60	12.42
Grande Rivière du Nord	81	16.77
Jassa	68	14.08
Limbé	138	28.57
Haut du Cap	71	14.70
Number of observations	483	100

¹ Crop dependency is a ration between agricultural income and total income of the household

Table 3: Descriptive statistics of the variables used for estimation

Variables	Description	Treatment group (N=279)		Control group (N=204)	
		Mean	Stdev¹	Mean	Stdev¹
Age	Age of respondent	50.92832	11.59642	53.30392	13.07371
Gender	Sex of respondent	0.842293	0.365120	0.8676471	0.339707
School	If the respondent went to school or not	0.587813	0.493112	0.5098039	0.5011337
Net income	Net income	26311.97	11172.9	34301.09	18762.5
Person	Number of persons	4.978495	1.958078	4.97549	1.963807
Credit	Access to credit	0.107526	0.310338	0.0882353	0.2843345
Age^2	Square of age	2727.688	1200.544	3011.392	1415.207
Ownership	Ownership of the land	0.100358	0.301017	0.0882353	0.2843345
Crop dependency	Share of Agricultural income	0.437570	0.835051	0.432066	0.6100604
Group membership	Farmer belong to a group	0.078853	0.269993	0.068627	0.253441
Off farm activity	Has off farm activity	0.473118	0.500174	0.495098	0.5012059

Note: 1. Stdev means standard deviation

References

- Adesina, A., Mbila, D., Nkamleu, B. and Endamana, D., 2000. Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of Southwest Cameroon, *Agriculture, Ecosystems and Environment*, 80(3): 255-265.
- Agbamu, J.U., 1995. Analysis of farmers' characteristics in relation to adoption of soil management practices in the Ikorodu area of Nigeria. *Japanese Journal of Tropical Agriculture* 39 (4), 213–222.
- Amsalu, A., de Graaff, J., 2007. Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. *Ecological Economics*, 61(2- 3), 294-302.
- Andzo-Bika, H.L.W., Kamitewoko, E., 2004. Role of agriculture in economic development of developing countries: case study of China and Sub-Saharan Africa (SSA). *J. Agric. Soc. Res.* 4 (2).
- Arslan, A., McCarthy, N., Lipper, L., Asfaw, S. & Cattaneo, A., 2014. Adoption and intensity of adoption of conservation farming practices in Zambia. *Agr. Ecosyst. Environ.* 187 (2014) 72–86.
- Asfaw, S., McCarthy, N., Lipper, L., Arslan, A., Cattaneo, A., and Kachulu, M. 2014. Climate variability, adaptation strategies and food security in Malawi, *ESA Working Paper*, 14-08. Rome, FAO.
- Bannister, M.E., Nair, P.K.R., 1990. Alley cropping as a sustainable agricultural technology for the hillsides of Haiti: experience of an agroforestry outreach project. *American Journal of Alternative Agriculture* 5, 51–592.
- Bargout, Remy N. and Manish N. Raizada., 2013. Soil nutrient management in Haiti, pre-Columbus to the present day: lessons for future agricultural interventions. *Agriculture & Food Security*, 2:11 doi: 10.1186/2048-7010-2-11.
- Bayard, B, Jolly, CM & Shannon, D.A., 2007. The economics of adoption and management of alley cropping in Haiti. *Journal of Environmental Management* 84, 62–70.
- Bayard, B., C. M. Jolly, and Shannon, D. A., 2006. The adoption and management of soil conservation practices in Haiti: The case of rock walls, *Agricultural Economic Review* Vol. 7. (2):28-38.

- Bekele W, Drake L., 2003. Soil and water conservation decision behavior of subsistence farmers in the Eastern Highlands of Ethiopia: a case study of the Hunde-Lafto area. *Ecological Economics* 46: 437–451.
- Belderbos, R., M. Carree, B. Diederer, B. Lokshin, and Veugelers. R., 2004. Heterogeneity in R&D Cooperation Strategies. *International Journal of Industrial Organization* 22: 1237– 63.
- Ben-Akiva, M., D. Bulduc, and M. Bradley., 1993. Estimation of Travel Model Choice Models with Randomly Distributed Values of Time. *Transportation Research Record* 1413:88-97.
- Chiputwa, B., Langyintuo, A.S., & Wall, P., 2011. Adoption of Conservation Agriculture Technologies by Smallholder Farmers in the Shamva District of Zimbabwe: A Tobit application. *Paper accepted for the 2011 meeting of the Southern Agricultural Economics Association (SAEA) in Texas, USA.*
- Doss, C. R. and M. L. Morris., 2001. How Does Gender Affect the Adoption of Agricultural Innovations? The Case of Improved Maize Technology in Ghana. *Agricultural Economics* 25:27-39.
- Ervin, C.A., Ervin, D.E., 1982. Factors affecting the use of soil conservation practices: hypothesis, evidence and policy implications. *Land Economics* 58, 277–292.
- FAO, 2012a. Towards the Future We Want: end hunger and make the transition to sustainable agricultural and food systems. Report on Rio+20. FAO of the UN. <http://www.fao.org/docrep/015/an894e/an894e00.pdf>
- Featherstone, A.M., Goodwin, B.K., 1993. Factors influencing a farmer's decision to invest in long-term conservation improvements. *Land Economics* 69, 67–81.
- Gould, B.W., Saupe, W.E., Klemme, R.M., 1989. Conservation tillage: the role of farm and operator characteristics and the perception of soil erosion. *Land Economics* 65, 167–182.
- Halcrow, H.G., Heady, E.O. and Corner, M.L., 1982. Soil Conservation Policies, Institutions and Incentives. Soil and Water Conservation Society of America Press, Ankeny, IA, 330 pp.
- Jolly, C.M, Shannon, D.A, Bannister, M., Flauretin, G., Dale, J., Binns A., and Pauline L., 2007. Income Efficiency of Soil Conservation Techniques in Haiti. Conference proceeding. CAES 26th West Indies Agricultural Economic Conference, Puerto Rico, July 2006 pp.156-163.
- Jumbe, C.B.L. and Angelsen, A., 2011. Modeling choice of fuelwood source among rural households in Malawi: A multinomial probit analysis. *Energy Economics*, 33(5). 732–38. doi:10.1016/j.eneco.2010.12.011.

- KABUBO-MARIARA J., 2006. Land Conservation in Kenya: The Role of Property Rights. Final report submitted to African Economic Research Consortium. African Economic Research Consortium, Research Paper Series. Research Paper 153. University of Nairobi Press; 2006.
- Kassie, M., Moti, J., Shiferaw, B., Mmbando, F., Muricho, G., 2012. Plot and household level determinants of sustainable agricultural practices in rural Tanzania. Discussion Papers dp-12-02-efd, Resources for the Future.
- Kokoye, S.E.H, Yabi, J.A, Tovignan, D.S, Yegbemey,R.N, Ernst-August Nuppenau, E-A., 2013. Simultaneous Modelling of the Determinants of the Partial Inputs Productivity in the Municipality of Banikoara, Northern Benin. *Journal of Agricultural systems*, 122 (2013):53-59. <http://dx.doi.org/10.1016/j.agsy.2013.08.002>.
- Kokoye, S.E.H., Tovignan, D.S., Yabi, J.A., Yegbemey, R.N., 2013. Econometric modeling of farm household land allocation in the municipality of Banikoara in northern Benin. *Land use policy* 34 (2013), 72–79, <http://dx.doi.org/10.1016/j.landusepol.2013.02.004>.
- Lal R 1989. Agroforestry systems and soil surface management of a tropical alfisol: II Water runoff, soil erosion, and nutrient loss. *Agrofor Syst* 8:239–242. doi:10.1007/ BF00129651.
- Lapar, M. L. A., & Pandey, S., 1999. Adoption of soil conservation: the case of the Philippine uplands. *Agricultural Economics*, 21(3), 241-256.
- Lin, C.T.J., K.L. Jensen, and S.T. Yen., 2005. Awareness of Food-Borne Pathogens among U.S. Consumers. *Food Quality and Preference* 16:401–412.
- Liu H, Huang Q., 2013. Adoption and continued use of contour cultivation in the highlands of southwest China. *Ecol Econ* 91:28–37.
- Lovejoy, S.B. and Napier, T.L., 1988. Institutional constraints to soil conservation on steep slopes. In: W.C. Moldenhauer and N. Hudson (Editors), *Conservation Farming on Steep Slopes*. Soil and Water Conservation Society of America Press, Ankeny, IA, pp. 107-114.
- Lutz, E., Pagiola, S., Reiche, C., 1994. The costs and benefits of soil conservation: the farmers' viewpoint. *The World Bank Research Observer*, vol. 9, no. 2 (July 1994), pp. 273-95.
- Ng, S.L., Q.G Cai, S.W. Ding, K.C. Chau & J. Qin, 2008. Effects of Contour Hedgerows on Water and Soil Conservation, Crop Productivity and Nutrient Budget for Slope Farmland in the Three Gorges Region (TGR) of China. *Agroforestry Systems* 74:279-291.
- Nhemachena, C., Hassan, R., 2007. Micro-Level Analysis of Farmers' Adaptation to Climate Change in Southern Africa. IFPRI Discussion Paper No. 00714. International Food Policy Research Institute, Washington, DC.

- Schuck, E., Nganje, W., & Yantio, D., 2002. The role of land tenure and extension education in the adoption of slash and burn agriculture. *Ecological Economics* 43: 61–70.
- Shannon, D.A., L. Isaac, C.R. Bernard, and C.W. Wood., 2003. Long-term effects of Soil conservation barriers on crop yield on a tropical steepland in Haiti. United States Agency for International Development, Soil Management Collaborative Research Support Program, Auburn University Technical Bulletin 2003-01.40pp.
- Singh, B., and Cohen, M., 2014. Climate Change Resilience: the Case of Haiti. London: Oxfam Research Reports. pp36.
- Soule, M. J., Abebayehu Tegene, and Keith D. Wiebe, 2000. Land Tenure and the Adoption of Conservation Practices. *Amer. J. Agr. Econ.* 82(4) (November 2000): 993–1005
- Swanson, L.E., Camboni, S.M. and Napier, T.L., 1986. Barriers to adoption of soil conservation practices on farms. In: S.B. Lovejoy and T.L. Napier (Editors), *Conserving Soil: Insights from Socioeconomic Research*. Soil and Water Conservation Society of America Press, Ankeny, IA, pp.108-120.
- Tesfaye, A., Negatu, W., Brouwer, R., Van Der Zaag, P., 2013. Understanding Soil Conservation Decision of Farmers in the Gedeb Watershed, Ethiopia, *Land Degradation & Development*. *Land Degrad. Develop.* 25: 71–79 (2014). DOI: 10.1002/ldr.2187.
- Train, K. E., 2003. *Discrete choice methods simulation*. Cambridge University Press. p.342
- Verbeek, M., 2003. A guide to modern econometrics. pp.156-195.
- Wang, J., Huang, J., Zhang, L., Rozelle, S., Farnsworth, H.F., 2010. Why is China's blue revolution so “blue”? The determinants of conservation tillage in China. *Journal of Soil and Water Conservation* 65 (2), 113–129.
- Wiebe, K.D., Soule, M.J., Schimmelpfennig, D.E., 2001. Agricultural productivity for sustainable food security in Sub-Saharan Africa. In: *FAO Economic and Social Development Paper*. Agricultural investment and productivity in developing countries, pp. 55–74.
- World Economic Forum, 2011. Private Sector Development in Haiti: Opportunities for Investment, Job Creation and Growth. Report. Geneva: World Environmental Fund. Retrieved 7 April, 2015 http://www3.weforum.org/docs/WEF_Haiti_PrivateSectorDevelopment_Report_2011.pdf
- Yegbemey, R.N., Yabi, J.A., Tovignan, S.D., Gantoli, G., Kokoye, S.E.H., 2013. Farmers’ decisions to adapt to climate change under various property rights: a case study of maize farming in northern Benin (West Africa). *Land Use Policy* 34, 168–175.