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Factors Influencing the Adoption of Mucuna Pruriens as a Land Conservation Strategy, Evidence From Northern Ghana

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Abstract: In Ghana, the Ministry of Food and Agriculture (MoFA) in collaboration with Environmental Protection Agency (EPA) introduced *Mucuna pruriens* (velvet beans) to farmers to help arrest degrading soils low in fertility and prone to erosion and leaching during seasons of floods. Researchers on the Climate and Ecosystem Change adaptation Research Project in Africa (CECAR-Africa) undertook an assessment of farmers' adoption of *Mucuna pruriens* in six communities in Wa West District (a predominantly flooded area from the Black Volta River). The study soughtto(i) investigate the driving forces behind the adoption of the *Mucuna pruriens* amongst the small-holder farmers in selected villages with an emphasis on land access;(ii) assess farmers' perceived attribute of the innovation and correlate that to their behavior towards adoption (iii) analyze the relationship between the perceived attributes of Mucuna technology and adoption of Mucuna innovation in particular. Sixty four (64) respondents composed of 32 *Mucunapruriens* adopters and 32 non-adopters were purposively sampled for individual interviews. Focus group discussions were also conducted with both sets of farmers. The findings reveal a positive correlation between land tenure arrangements and the level of Mucuna adoption but of mixed significance in all the study villages. All farmers interviewed generally felt a sense of security on the land irrespective of their title and most likely to adopt *Mucuna pruriens*. Ability to maintain Mucuna plots during annual bushfires was found to be a critical determinant to adoption. The extent to which farmers perceive of the characteristics of the innovation influences their behaviour towards adoption. Study findings are expected to help review the opportunities for Mucuna adoption as a form of capacity building for rural farmers.

Keyword:*Mucuna pruriens,* land tenure systems, small holder farmers, perceived attributes adoption

1.0 Introduction

1.1 Context

Rural small holder farmers in Ghana are increasingly being vulnerable to extreme weather events. Drought periods are prolonged with shorter but erratic rainfall, especially in Northern Ghana. Bushfires have become rampant and burns away the biomass from trees, shrubs and grass. Soil nutrient conditions are said to be depleting at an alarming rate. This is compounded by the popular cropping methods in the area which the making of fresh ridges each farming

season which creates a hard pan in the furrows as well as loose soil on the ridges. This predisposes the farm plots to erosion and nutrient loss. In response, Conservation Agriculture (CA) technologies among others are being introduced by the government and development partners to help improve soil conditions for food production. CA is defined as a system of crop production based on the three principles of minimum soil disturbance, continuous soil cover and crop rotation. The objectives of conservation farming are to increase crop production, while at the same time protecting and enhancing land resources on which production depends. It integrates ecological principles with modern agricultural technologies (Food and Agricultural Organization [FAO], 2008).

The 2010 Population and Housing Census of Ghana estimated that more than half of the population (56.2%) lived in rural areas and about 85% of them were engaged in agriculture and related activities (Ghana statistical Service [GSS], 2010). The agricultural sector contributes 21.3% of Gross Domestic Product (GDP) in 2013 (Government of Ghana [GOG], 2013), and employs 60% of the populations. Agriculture is predominantly small scale, based on traditional technology, and is rain-fed. There are some 2.7 million farms, with an average size of 1.2 hectares, which account for about 80% of agricultural production (GSS, 2011, ISSER, 2008). Improvement in agricultural productivity would improve food supply, provide raw materials for industries, and help raise tax revenue to effect overall development of the country. Most women living in rural areas are engaged in agriculture; therefore, increase in agricultural productivity will also ensure domestic food security, which contributes to health and nutrition of the population.

Although, agriculture throughout the country is predominantly practiced with little technical inputs, variations exist on the regional and sub-regional level. In Northern Ghana, composed of Northern, Upper East and Upper West Regions, farming systems are typically traditional, subsistence and rain-fed. Thus, the hoe and cutlass are the main farming tools. There is little mechanized farming, but bullock farming is practiced in many communities across northern Ghana. Agricultural production varies with the amount and distribution of rainfall. Farmers report that drought periods are becoming longer in recent years and that when the rains come, they tend to be erratic with unpredictable amounts (Armah, 2011). This is said to be affected productivity of farmlands and threatening food security. The Wa West and Nadowli districtslike the other parts of the Upper West Region has a predominantly grassland vegetation, which is easily burnt away by bushfires during the annual harmattan[1] season. This situation renders the soil bare exposing it to both wind and water erosion in the dry and rainy seasons respectively. This results in depletion of the macro-nutrients, such as Nitrogen, Phosphorus and Potassium (NPK) and organic matter from the soil. As part of measures to improve soil fertility and combat the desertification, the EPA under the its Ghana Environmental Management Project (GEMP) recently collaborated with the Ministry of Agriculture to introduce *Mucuna pruriens* (Velvet Beans) as a conservation agriculture technology to farmers in the Wa West and Nadowlidistricts of the Upper West Region. Three years down the line, the rate of adoption of this technology has been mixed.

This study was undertaken by a team of researchers working on Climate and Ecosystem Change Adaption in the Wa West area as part of efforts to build capacity of local communities for resilience against climate and ecosystem change events. Farmers adopting the Mucuna technology as well as non–adopters were interviewed in the study. The focus was on the security

of land tenure as a possible factor in adoption as well as farmers perceived attributes of the technology since the EPA and MoFA simply introduced the technology enbloc to all farmers in the area. Land tenure arrangements and traditional land title rights for indigenous people as well as settler farmers have generated a lot of interest among researchers in recent times.
The study went further to collect farmers own narratives on why they considered the adoption of the velvet beans technology as good for conservation agriculture. The study categorized these narratives along Mucuna adoption as a driver of production levels; affecting volume of work that a farmer has to carry out on the farm such as weeding; soil productivity and nutrient conservation; feed for livestock; moisture conservation; pest control and bushfire control.
Institutional factors, such as property rights and land tenure also affect agricultural production in Ghana (MOFA, 1998). In most farming communities, especially in Southern Ghana, land tenure systems tend not to motivate migrant farmers to adopt conservation practices largely because of security of tenure. Many studies show that limited tenure security often tend to undermine incentives for farmers to invest in their lands. For instance, those farmers with limited land tenure security are unlikely to adopt soil fertility management practices with long gestation period. The experience with Mucuna adopters in Northern Ghana reveals a significant variation from this long held notion a negative correlation between adoption and tenure security.

1.2 Current Cropping Systems

In Ghana, there are three dominant farming systems according to the intensity of cultivation: bush fallow systems (temporary systems), permanent systems, and combined systems. Bush fallow systems represent the most extensive farming systems in Ghana, while the permanent systems are the most intensive. The combined systems include bush fallow and short fallow. Under a relatively low population density up until the beginning of this century, the main system of farming in Ghana was forest fallow. In the northern part of the country, this involved the intercropping of the drought-resistant principal crops, millet (*Panicummiliaceum*) and guinea corn (*Sorghum guinense*), with yam (*Dioscoreadumetorum*), pulses, vegetables, and other crops; and in the South, intercropping of tree cash crops, such as cocoa and others. Over time, this farming system has transformed into a less extensive and more sedentary system known as the bush fallow system (Gyasi 1995). The bush fallow system typically involves intercropping trees in outfields used on a rotational basis that are located 1–6 kilometers from the compound house. Bush fallow is characterized by the rotation of fields rather than of crops, easy acquisition of land for cultivation, use of fire for clearing vegetation, dependence on muscle power, and use of simple implements, such as dibble sticks, machetes, and hand hoes, for cultivation. As population density increases, however, bush fallow systems become unsustainable, failing to produce enough food for the growing population.

1.3 *Mucuna Pruriens*(Velvet Beans*)*

The EPA in Ghana has been introducing technologies and programs aimed at protecting and preserving the natural resources of the country(EPA, 2005).Haven reviewed the Mucuna programs in neighboring Burkina Faso and Benin, the EPA in collaboration with the Ministry of Agriculture decided to introduce the technology to farmers in Northern Ghana. The technology consists of planting *Mucuna pruriens*in a relay cropping with food crops. Mucuna seeds are sown about 3-4weeks after planting food crops (mainly maize) in the cropping season. Mucuna remains in the field left after the maize is harvested in around November. By the beginning of the

next cropping season in June the following year, Mucuna would have weathered and serve as mulch and biodegradable biomass for the soil to support the next batch of maize. It also allows groundcover to fully develop for biomass accumulation and nitrogen fixation. It is able to smoother recalcitrant weeds and lessens the number of times farmers will need to weed their fields.

According to both MOFA extension officers and farmers, weed control has been effective with the use of Mucuna. CA is achieved through direct seeding and this involves growing crops without mechanical seedbed preparation and with minimal soil disturbance after the harvest of the previous crop. CA land preparation for seeding or planting involves slashing or rolling the weeds, previous crop residues or cover crops; or spraying herbicides for weed control, and seeding directly through the mulch (FAO, 2008).In a research to assess the impact of Mucuna spp. on weeds in maize-based cropping systems, Boahen et al (2002) reported a big change in weed population when comparing the situations of a natural fallow plot and one where Mucuna had been planted visited, farmers mentioned that one of the factors that influenced their decision to use this practice was the ability of cover crops and herbicides to control weeds. Adade et al. (2001) posits that the effect of Mucuna on weed suppression was due to higher biomass and better soil cover.

1.3 Land Tenure Arrangements

Land is the most important farm resource. Though land is generally available, it exists at varying levels of soil fertility. In some areas in Northern Ghana, land is increasingly becoming scarce due to population pressure. Land ownership in the zone is mainly communal. Use rights are only leased to the farm household by the village earth priests (called *Tendaamba*, *Tendanaa*) free of charge. Therefore, the selling of land is not allowed. Land is usually given to the household or compound head, but all household members have access to it. Apart from land, the household head is in charge of all other resources and he retains the final decision on the use of these resources. Most of the farmers we interviewed have small land holdings of about an average of 1.2ha. The category of famers interviewed who described themselves as settlers also said they had lived in the area over three generations and that, they the present generation has no other home to go to. The relationship with their landlords is said to be peaceful and that they have been discharging all their obligations as settlers which include land pacification, contribution of food and animals for festivals and related events. The decision to adopt a particular technology or otherwise, lies squarely with the individual farmer in this context.

In Southern Ghana, Customary land tenure arrangements prevail in both districts. Communal landtenuresystems and family land-tenure arrangements are the predominant tenure forms. Land ownership is normally held by the ruling families of the original settlers. Indigenous people, both men and women, have user rights to family land and generally do not rent land. Family land tenure accords farmers user rights to the land they operate. Under this system, landholders have the right to bequeath land and to give out land on a contractual basis. Children can inherit land from their parents, in which case a piece of land is shared among the children. Land can also be rented for cash or on a sharecropping basis. The common terms used in sharecropping are abunu (produceis shared equally or 50:50) for yam and cassava, and *abusa*, where the tenant receives two-thirds of the maize and the landlord one-third.

2.0 Materials and Methods

2.1 Study Sites

The study was undertaken in six communities; Fiang and Jang in the Nadowli District and Tendoma, Maase, Naaha and Tokaali in the Wa West district. These communities have been the main location where Mucuna as a CA technology has been introduced over the past three years by the MOFA and EPA, Ghana. Figure 1 shows the districts where the study communities are located.

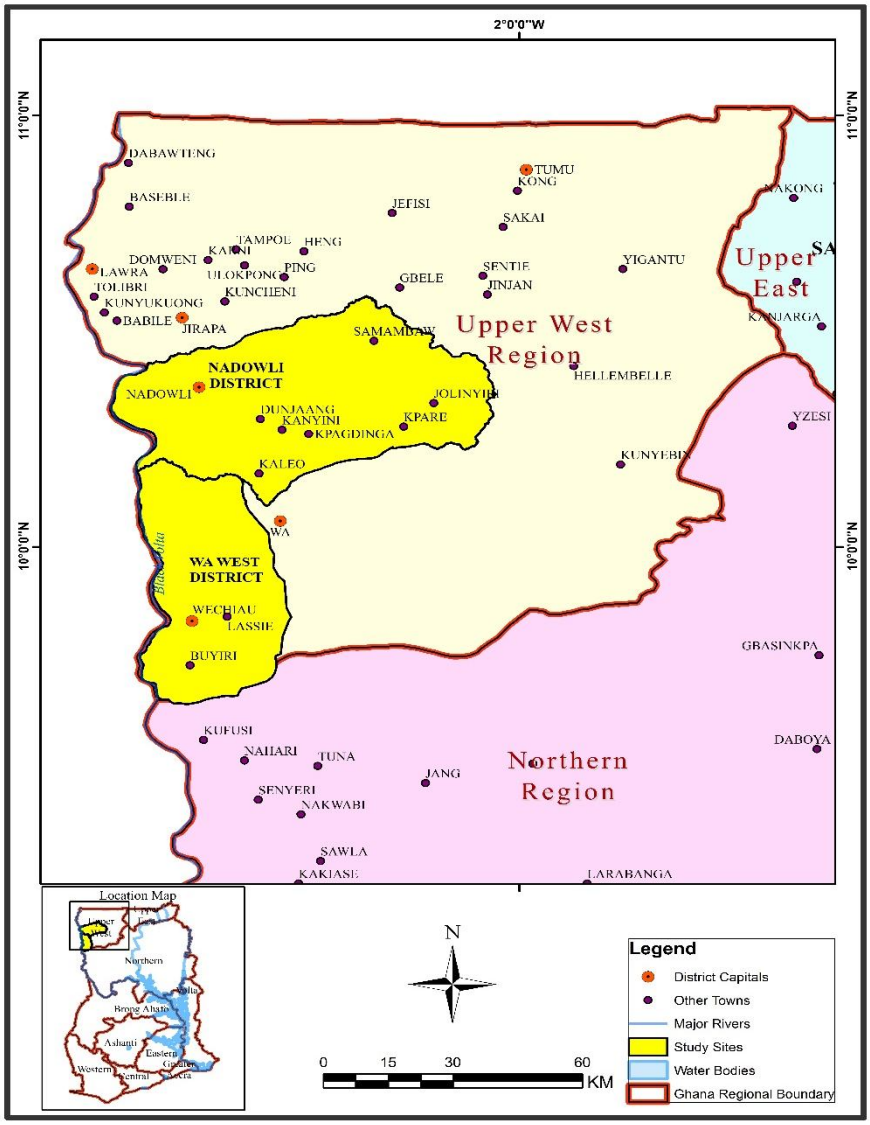

Figure 1: Map of Northern Ghana showing the location of the study areas
Source: fieldwork, 2013

The study areas have two main seasons; wet and dry. The areas experience a unimodal rainfall regime lasting for maximum of four months. Annual rainfall in the area varies from 800mm to 1100mm. Mean annual temperatures range between 24°C-26° C (GMet, 2013). Vegetation here is composed of grass with scattered drought resistant trees. Like most grasslands, the dominant trees here include Shea (*Vitellariaparadoxa*), dawadawa (*Parkia biglobosa*), Kapok (*Ceiba pentandra*), Baobab (*Adansonia dipitata*). Deforestation due mainly to human activities, such as bush burning, poor farming practices, overgrazing by livestock and charcoal production are rife in both study districts.Mixed agriculture involving crop production and animal rearing is the dominant livelihood activities in the area with almost 70% of inhabitants engaged in it (GSS, 2008). Crop rotation, irrigation, ploughing and soil fertilization are common agronomical practices amongst farmers.

2.2 Data Collection Method

The first level was to carry out key informant interviews with Agric Extension Agents (AEAs) in the study communities. Then, we moved to Wa, the Regional Capital to conduct similar key informant interviews with the MoFA desk officer in charge of Conservation Agriculture at the Regional level. We also interviewed the Mucuna Programme Director at the Environmental Protection Agency. With the insights gained including lists of adopters in each community, we proceeded to conduct household interviews, structured and unstructured questionnaire administration and focus group discussions as well as key informant interviews. A total of 32 farmers were known to be using Mucuna technology in their farms for past three years though the adoption duration varied. Based on this number, the survey decided to interview the same number for non-adopters (32) in order to establish the relationship. Thus a total of 64 respondents were interviewed with structured questionnaires to elicit answers. The second aspect held individual open ended interview session that allowed adopters and non-adopters to give expanded narratives on attributes, land tenure arrangements amongst others. After the individual surveys, a focus group discussion(FGD) was conducted in each study village composed of adopters and non-adopters to illicit their views on Conservation Agriculture and reasons for adoption or no adoption of particular technologies including Mucuna.

2.2.1 Data Analysis

The data were coded and entered into the Statistical Product and Service Solutions (SPSS) for statistical analysis and presentation. Descriptive statistics in the form of frequencies and percentages were used in the analysis, presentation and interpretation of the data. The qualitative data were categorized and assigned frequencies to determine the dominant line of responses. In some instances, Chi-square was used to determine the goodness fit for some variables on Mucuna adoption from farmers' narratives.

3. Results and Discussions

3.1 Table 1: Socio-Demographic Characteristics

Demographic Characteristic	Study Community						TOTAL
	Fian	Jang	Maasse	Naaha	Tendoma	Tokaali	
Education							
• **No Education**	**5**	**7**	**8**	**5**	**9**	**3**	**37 (58%)**
• **Primary**	**2**	**3**	**1**	**4**	**3**	**5**	**18 (28%)**
• **JHS**	**0**	**1**	**2**	**0**	**3**	**1**	**7 (11%)**
• **SHS**	**0**	**0**	**0**	**0**	**2**	**0**	**2 (3%)**
Household size							
• **1-5**	**1**	**2**	**1**	**0**	**3**	**1**	**8 (13%)**
• **6-10**	**3**	**4**	**6**	**4**	**7**	**2**	**26 (41%)**
• **11-15**	**1**	**4**	**1**	**2**	**4**	**4**	**16 (25%)**
• **>15**	**2**	**1**	**3**	**3**	**3**	**1**	**13 (20%)**
Annual Household Income (GHS)							
• **100-500**	6	5	4	3	10	4	**32 (50%)**
• **600-1000**	1	4	4	3	4	4	**20 (31%)**
• **1100-1500**	0	2	1	3	3	0	**9 (14%)**
• **>1600**	0	0	2	0	0	1	**3 (5%)**
Residential Status							
• **Native**	5	10	11	7	13	8	54 (84%)
• **Settler**	2	1	0	2	4	1	10 (16%)

Source: Field Survey, 2013

3.2: General factors Influencing the Adoption and Non-Adoption of Mucuna amongst farmers

The 32 Mucuna farmers interviewed mentioned soil fertility improvement, bushfire control, pest & disease control, moisture conservation and feed for livestock as some of the reasons for the adoption (Table 2). Soil Fertility improvement and Pest and Disease control ranked highest with 30 mentions by farmers as their primary reason for adoption.

Table 2: Reasons for farmers' adoption of *Mucuna Pruriens*

	Reason for adoption	No of times mentioned	Percentage
1	Control of Weed	28	87.5%
2	Use of beans for livestock feed	14	44%
3	Conserve moisture	18	56%
4	Control pests and diseases	30	94%
5	Manage Bush Fires	29	91%
6	Soil Fertility Improvement	30	94%

Source: Field Survey, 2013

Surprisingly, even though livestock rearing is predominant in the area, use of Mucunaasp. seed as livestock feed was mentioned just 14 times. Being a predominantly bushfire prone zone, it was revealing that farmers see Mucunasp. cultivation as helpful in managing bushfires. The 29 adopters who shared this view explained that at the time bushfires start, Mucunasp. is usually still green and therefore, protect their plots from bushfire devastation. However, they added that once Mucuna dries out, you must ensure your create fire belts to protect the biomass from burning out eventually.

Regarding non-adoption of Mucuna, the most cited reason by farmers was inadequate information on usage and applicability with 30 mentions. This was followed by non-edibility of Mucuna as respondents said it was a waste of resources. Other farmers feared competition with edible crops for nutrients. Fear of bushfires destroying Mucuna plants was also mentioned 22 times whiles land access was also cited as a constraint. Table 3 shows the responses.

Table 3: Reasons cited by Non-Adopters of Mucuna

	Reason for non-adoption	Frequency	Percentage
1	Inadequate information on usage and applicability from Agric. Extension staff	**30**	**94%**
2	Fear over bush fires destroying Mucuna	**22**	**69%**
3	Non-edible plants -Does not allow for usual crops like cowpea, soybean to be intercropped with maize or sorghum	**28**	**87.5%**
4	Competition with minerals in soil	**25**	**78%**
5	Land ownership structure	**16**	**50%**

Source: Field Survey, 2013

3.3. Nexus between Land and Adoption of Mucuna

The analysis on the relationship between land ownership and Mucuna adoption was interesting. Many studies show that land owners were usually likely to adopt conservation agricultural practices than non-owners (Boahen et al, 2005; Kambiok et al. 2012). None of the 64 farmers interviewed mentioned landownership as a factor for adoption or non-adoption. Further, they explained that they had lived in the area for over 3 generations with settlers and landlords/owners co-existing peacefully. Land for cultivation is generally available to everyone in so far as you seek permission from the landlords (*tendaana)*. Therefore, managing the land in ways that makes it more productive is considered very important for all. In Southern Ghana, the land tenure arrangements is generally on a share cropping basis where the settler farmers usually cultivate and share the produce in a pre-agreed proportion with the land owners(Gyasi, 1995). This could have an influence on Mucuna adoption. In the study area however, land ownership and non-ownership did not vary significantly at 95% confidence level.

3.4 Farmers Perceived Attributes of Mucuna and Implications for Adoption

Rogers's theory of innovation diffusion describes adoption of innovation amongst members of a social system as a reductionist process (Rogers, 2003). The theory then proposes attributes of innovations that help to decrease uncertainty about the innovation; relative advantage, compatibility, complexity, trialability, and observability. Using Rogers (2003) framework therefore, rate of adoption was rated along farmers' perceived attributes of compatibility, observability, complexity, trialability, observability of Mucuna pruriens as a CA technology:

Table 4: Farmer's Perceived Attributes of Mucuna using Roger's Framework for Innovation Diffusion

	Perceived Attribute		
	Compatibility		
Perception of Mucuna	Highly suitable	Somehow suitable	Not suitable
Percentage of respondents	60%	25%	15%
	Observability		
Perception of Mucuna	Results are clearly visible	Results are somewhat visible	Results are not visible
Percentage of respondents	70%	20%	10%
	Triability		
Perception of Mucuna	Highly agree	Somewhat agree	Highly disagree
Percentage of respondents	85%	15%	0
	Complexity		
Perception of Mucuna	Highly agree	Somewhat agree	Highly disagree
Percentage of respondents	50%	20%	30%
	Relative advantage		
Perception of Mucuna	Highly agree	Somewhat agree	Highly disagree
Percentage of respondents	80%	10%	10%

Source: Field Survey, 2013

As shown in Table 4, the perceived attributes of *Mucuna pruriens* were all highly rated along the Rogers framework as positive. Farmers reported that the Mucuna was highly compatible with existing practices. Seventy percent (70%) of the respondents found Mucuna contribution to their farming highly visible and obvious. About half (50%)of the farmers also found the technology as simple to use and indicated their readiness to adopt it.

4.0 Conclusion and Recommendations

The purpose of the study was to assess the adoption of *Mucuna pruriens* as a Conservation Agriculture technology in Semi-arid Ghana. The results show that farmers are generally satisfied with the technology and are willing to upscale with dynamism. The reasons they give for adoption are generally consistent with the principles of conservation agriculture; low tillage, cover soil surface and support biological processes. At the same time, farmers expressed other reasons for non-adoption including adequate information on the technology to help in decision making. Seed availability is another significant factor to take particular note of in effective diffusion of the Mucuna. The current model by MoFA and EPA has no arrangement to distribute seed from current adopters. An arrangement to buy seed from current adopters to distribute to other farmers could be a good motivation for higher diffusion. The nexus between land ownership and adoption was more about security of tenure rather than ownership. Generalizations about the effect of land tenure on technology diffusion to smallholder farmers should be done with caution.

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