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Experiences with the development and diffusion of conservation agriculture in Ashanti and Brong Ahafo regions of Ghana

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Abstract

This paper synthesizes the preliminary results of a case study about the experiences held with Conservation Agriculture in Sunyani and Atwima districts, in the Brong Ahafo and Ashanti regions of Ghana. Using a combination of literature review and PRA-type assessments, various aspects have been assessed, including a reconstitution of the history of CA, an inventory of the specific technologies which have been developed / promoted, a review of the CA adaptation and diffusion process and finally a qualitative assessment of adoption and impact.

Many farmers in the study areas still rely on slash-and-burn systems, and are struggling to overcome problems of declining soil fertility and low overall productivity. Conservation Agriculture (CA) has been seen as having the potential to reduce soil erosion, sustain soil fertility, conserve soil moisture and increase crop output for small-scale farmers. Experiments with no-tillage, minimum tillage and the use of cover crops have been on-going in the region since the early 1980's, with support from the extension services of the Ministry of Food and Agriculture (MOFA) and a number of external organizations, such as the German Technical Cooperation (GTZ), Danida, Sasakawa Global 2000 (SG 2000) and Monsanto.

The CA practices introduced and promoted in the study areas include slash and mulch without burning, the use of cover crops, minimum tillage with herbicides and direct planting, herbicide being apparently the most commonly promoted and adopted practice so far. CA undoubtedly has a demonstrated positive impact on crop yield, labour needs, weed control and farm incomes in the study areas.

Adoption of CA by farmers has been picking up quickly as long as the projects were active, but decreased significantly afterwards. A number of preconditions seem necessary for sustained adoption to take place. These include long term access to land, availability of inputs, especially cover crop seeds and appropriate CA implements, and also adequate extension support and advice together with institutional support.

Future efforts for improving present-day CA practices include the introduction of multi-purpose cover crops in order to reduce the reliance on herbicides and also to boost soil fertility and enhance yields whilst diversifying crop production. Ghanaian institutions and stakeholders need also to organize themselves better at the national level, which will require that solid evidence be made available to convince policy-makers about the relevance of CA for improving agriculture nation-wide.

Key Words: slash-and-burn, conservation agriculture, herbicide, cover crops, CA equipment, adoption.

Media Summary. Conservation agriculture has made a number significant contributions for improving the livelihoods of small holders in Central Ghana, but efforts still remain to be done to improve the current CA practices and to sustain and scale up adoption beyond the life-time of externally funded projects.

Introduction

In Ghana, most farmers still use shifting cultivation and fire for land clearing. The corresponding degraded slash and burn system is responsible for declining soil fertility, increasing farmers' dependency on external inputs such as mineral fertilizers. More generally, manual traditional

farming practices have not been able to sustain crop yields, with its implications for overall food self sufficiency in recent decades. Moreover, they have contributed to limiting the area under cultivation and are responsible for severe yield losses due to untimely-performed farm operations such as planting or weeding. Conservation Agriculture (CA) is seen as a system with the potential to reduce soil erosion, sustain soil fertility, ensure better water husbandry and reduce production costs. CA may be defined as a set of practices aimed at achieving the following 3 principles simultaneously: (1) maintaining adequate soil cover, (2) causing minimum disturbance to the soil, and (3) maintaining adequate crop rotations (and intercropping)

While not necessarily known under this name, CA is not really new to many Ghanaian farmers: indeed, they have been practicing a related slash-and-mulch system called "proka" as part of their traditional land preparation techniques for decades. Experiments with no-tillage, minimum tillage and the use of cover crops have been on-going since the early 1980's with support from a number of organizations, projects and programmes with mixed results of technology adaptation, adoption and impact.

This paper attempts to present on overview of these efforts, focusing both technical (e.g. related to specific CA technologies and their performance) and process issues (e.g. related to the CA adaptation and diffusion process). The focus area selected for this paper includes 2 districts (Sunyani and Atwima) from the Ashanti and Brong Ahafo regions, respectively.

Beside reviewing formal and grey literature related to CA in these 2 regions, workshops and interviews with key CA stakeholders (including lead farmers, project staff, agricultural extension officers and researchers) as well as focus group discussions were conducted with farmers in 21 communities with varying degrees of contact with CA technology and CA projects. This case study is part of an broader case study project undertaken within the framework of an agreement among FAO, CIRAD, RELMA-in-ICRAF and ACT to document successes, failures and challenges related to CA adaptation and adoption in several countries (Kenya, Tanzania, Ghana, Zambia, Brazil). For its part, the Ghana case study illustrates the following key CA-related issues: labour reduction, weed and weed control, availability and access to agro-inputs.

Ghana and the study area

The agricultural sector dominates the Ghanaian economy with a 45% share of the country's gross domestic product, 65% of employment, and 50% of total exports, cocoa being one of the major contributors to the latter.

Both Sunyani and Atwima districts have similar climatic, vegetation and Ochrosol soil types, even though Atwima lies closest to the forest zone, while Sunyani lies within a transitional savannah zone. The rainfall pattern is bi-modal with average annual precipitation of about 1400 mm. Mean annual temperatures range between 23and 33^{o}C.

Slash and burn is the predominant land use system in both districts: the cropping period lasts between 2 and 5 years, while the duration of fallow is variable. Most of the agriculture is manual. Tractor services where available are mainly for transportation or shelling of maize. Most farmers cultivate 1-3 ha. Maize (*Zea mays*) one of the most important food but also cash crops and is either intercropped with cassava or grown as a sole crop. Crop rotations are practiced with mono cropping, mixed and relay cropping being predominant.

Historical Development of CA in Ghana

According to the Environmental Protection Agency (EPA, 2003), conservation has always been an official concern in the management of natural resources in Ghana, because of the early realization of the threat of the encroachment of the Saharan conditions in the southern regions of the West African sub-region. A number of programmes/projects were implemented which included a CA focus or component (Table 1).

These projects made use of government extension officers to ensure maximum coverage of communities and avoid building parallel structures. Emphasis was placed on demonstrations and field level experimentation of proposed technologies. A number of more participatory approaches were also used during the implementation of project activities in the study areas. Notable ones include Participatory Technology (PTD) used by SFSP, Farmer Field School (FFS) used by SG 2000 and Community-based Natural Resource Management by the Land and Water Management Project.

Table 1: Summary of key projects and programmes implemented in Ghana with a CA focus or component

Name of project	Sponsors	Implementation Partners	CA Focus / component
Ghana Environmental Resources Management Project (GERMP)	World Bank, DANIDA, ODA and the Government of Ghana (GoG)	Environmental Protection Agency (EPA)	Institutional development and strengthening Environmental information systems
Land and Water Management Project (LWMP)	DANIDA	Ministry of Food and Agriculture (MOFA)	Management of soil erosion, fertility and soil conservation
Savannah Resources Management Project (SRMP)	DANIDA	Ministry of Lands and Forestry	Rehabilitation of degraded areas Sustainable management & ownership of renewable natural resources
Sasakawa Global 2000	Sasakawa Global 2000	Ministry of Food and Agriculture	Development & transfer of no-tillage technology for conserving soil fertility
No-Till programme	Monsanto	Monsanto and MOFA	Minimum tillage demonstration and promotion using glyphosate
Sedentary Farming Systems Project (SFSP)	GTZ	GTZ, DED and MOFA	Promotion & use of cover crops, minimum tillage, integrated soil fertility management measures

Overall, these programmes promoted a number of CA-related practices in the study area (Table 2). Most of these practices have remained at the experimental or local implementation stage, because the corresponding projects did not have enough time for large-scale promotion before winding up.

Table 2: Recommended CA practices promoted in Sunyani and Atwima Districts

CA Practice	Description	Stage of development
No-burning, slashing and mulching	Slashing of vegetation Biomass left to serve as mulch No burning Planting directly with dibbler	On-farm experimentation & local promotion
Minimum tillage and direct planting	Land preparation done by slashing vegetation Spray herbicide after re-growth of about 30cm high Direct planting through the mulch without burning	Local promotion
Alley cropping with cover crops	Alleys are established using fast growing shrubs Biomass is harvested and used as mulch Direct planting of maize without burning	On-farm experimentation
crop rotation and intercropping with legumes	Intercropping or relay-intercropping of leguminous cover crops (e.g. *Mucuna*, *Canavalia*) Harvest of main crop, cover crop left on the field as short fallow Direct planting without burning Cover crop biomass protected from bush	Local promotion

	fires and excessive grazing	
Cover crop (Mucuna) & herbicide	Cover crop is established Herbicide is used to kill the biomass Direct planting	On-farm experimentation

Adoption

Based on figures provided by the Sedentary Farming Systems Project, CA adoption rates increased markedly among participating farmers between 2001 ands 2004 in the Brong Ahafo region (Figure 1). Seventy-six percent% of all participating farmers were practicing at least one of the CA practices promoted, while 35% of participating farmers (about a quarter of them being women) were reported to have applied at least one CA practice in two consecutive years and beyond.

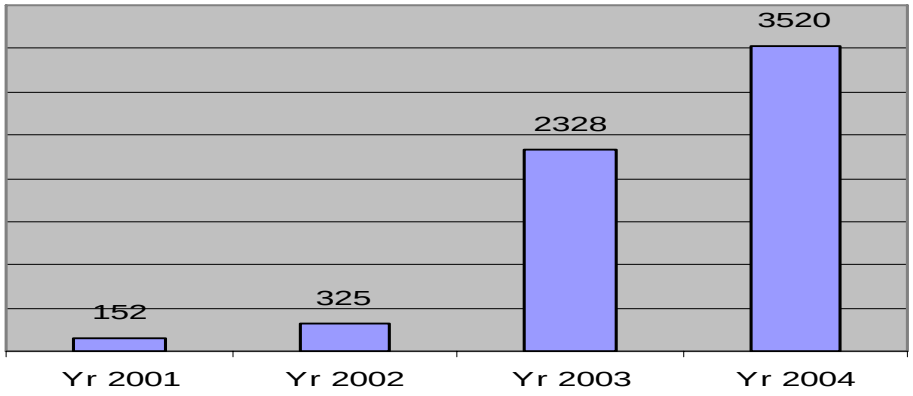

Figure 1: Number of farmers using CA in Brong Ahafo **(Source: SFSP)**

Data on adoption from Land and Water Management Project and SG 2000 were very hard to come by and the few obtained were not coherent.. Based on the increase in the volume of herbicides sold, Monsanto estimates that more than 350,000 farmers in Ghana are today using at least one of the promoted CA practices (Kofi Boa, pers. com.). . Indeed, most farmers in the study area use substantial amounts of herbicide. But other components of the CA system have not proven as popular as herbicides. For example, the adoption and use of cover crops declined in recent years with at least 30% of farmers abandoning their cover crop plots in Sunyani district. CA projects had created an artificial yet alluring market for cover crop seed that they bought for filling their own requirements, but the corresponding markets collapsed after the projects winded down.

Farmers' decision to choose CA vs. Keeping their traditional Slash-and-Burn systems seems to depend on land tenure. Farmers owning land, having a long-term access to hired land or engaged in share-cropping arrangements seem to prefer CA to S/B (Table 3). In this latter type of arrangement, landlords encourage tenants to practise CA, as they expect an increase in their share of the harvest crop. Adoption of CA for maize production however leads to occasional conflicts between land owners and tenants, as some owners try to claim back their fields when they discover productivity has increased as a result of using CA.

Table 3: Farmers' preference for different tillage practices as a function of the land tenure system in Sunyani district (Source: Adjei *et al.,* 2003)

Total farmers = 67			**Preference for Slash and Burn**	**Preference for CA**
Land tenure system	Family land		**	********
	Hired land (cash)	1 year	***	*******
		2-5 years	**	********

		>5 years	**	********
	Hired land (share cropping)	2-5 years	***	*******
		>5 years	***	*******

Farmers adopt cover cropping for two main reasons: improve soil fertility and suppress weeds. The interest of some of them has however proven only temporary: it lasted, as long as cover crop seed buying schemes have been supported by the Government.

Main impacts of CA use

Impact on Yield

Converging sources point to the fact that the use of CA has proven beneficial in terms of yield,. For example, farmers in Sunyani district indicated a maize yield of between 1.8 – 2 t / ha using *Mucuna* short season fallow, compared with 1.2 t / ha with the use of traditional slash and burn system. Farmers' records showed that output per acre using minimum tillage and direct planting has increased from 0.75-1 t ha^{-1} under Slash and Burn to 3 t ha^{-1} (Kroye Farmers Association, Atwima District). Similarly, Mensah Bonsu (1996) reported an increase from 1.8 t ha^{-1} with the traditional slash and burn to 2.7 t ha^{-1} with minimum tillage and direct planting in on-farm trials.

Weed Control

Beside increased yields, CA has also positive effects on weeding, by decreasing the labour requirement. For example, a CA system with maize and mucuna reduced labour input from 38 man. days to 15, and from 3 weedings to only one (Figure 1). This reduction in weeding is accompanied by a shift in weed population, with the disappearance of obnoxious species such as *Chromolaena odorata, Sida sp., and Axonopus compressus* after 2 years of using cover crops *(Boahen , 2002)*.

Figure 2: Maize under Conventional Tillage (left) and under CA (with mucuna) in Sunyani District

More generally, the use of CA helped reduced labour inputs in farming operations, especially for weeding and land preparation. SFSP (2002) estimated that CA led to a 30 % reduction in labour use compared to the Slash-and-Burn system. Similarly, according to our own estimates, a CA system based on minimum tillage and herbicide use allowed a 42% reduction (Table 4). Interestingly, planting under this CA system requires more time, due to the difficulty farmers have with planting through a thick mulch with their usual tools (dibble stick or machete).

Table 4: Labour reduction using Minimum tillage

Activities/ Acre	**Minimum Tillage** (Man days)	**Slash and Burn** (Man days)
Initial land clearing	15	15
Burning	0	1
Uprooting of grasses and de-stumping	0	20
Gathering of residues for second burning	0	10
Planting	15	2

1st weeding	0	15
2nd weeding	0	15
Spraying of pre-emergence herbicide	2	0
Spraying of post-emergence herbicide	1	0
Harvesting	15	5
Total	**48**	**83**

Cost- Benefit Analysis

The sharp reduction in labour, associated with increased yield (from 0.5 to 1.2 ton/ha) explains the marked increase in gross return (indeed, transforming maize cultivation from an activity generating negative returns into a profit-making one). These results are consistent with those obtained by Adjei *et.al.* (2003), who reported a 145% increase in net return

Availability, Accessibility and Affordability of Inputs and implements

Many farmers are still relying on their usual tools to practice CA. However, some implements particularly well-fitted for CA are also increasingly available, which may have a big role to play to ease farmers' job for practicing CA more efficiently.

This includes the ***jab planter*** (whose design comes originally from Brazil). About 100 pieces have been manufactured in 2003 by the Agricultural Engineering Department of the University of Science and Technology, Kumasi with funds from FAO. They have not yet been tested properly (suitability of jab planters to clayey soils may be an issue) nor put on the market. The intended sale price of $20 US is considered too expensive by small holders, unless group purchase takes place. Hence accessibility of jab planters (and training of farmers for using them properly) is still very much an unsolved issue, limiting the adoption of CA because of the difficulty of planting through the mulch without proper equipment.

Knapsack sprayers are also becoming more common, and farmers who cannot not own one (they sell for about $50 US) do not hesitate to rent them from their neighbours, under various modalities depending on who sprays and take care of the equipment. As the number of equipments is still small, and hence, as was the case for the jab planter, accessibility is still a significant issue.

Cover crop seeds are another key input for practicing CA. Canavalia and mucuna seeds were provided free to farmers (along with technical advice) through arrangements between MOFA and the CA projects. Farmers were expected to multiply the small amount of seed received the first year (3 kg) to gradually have enough for expanding cover crop use to the rest of their field / farm and to share with other farmers. However, the market for cover crop does not exist, and farmers cannot easily have access to these seeds outside of the project-supported schemes. Indeed, poor availability of cover crop seeds is one of the main reasons for higher pushing farmers to rely on herbicide to control weeds. An additional difficulty is that farmers would prefer to grow multiple-purpose cover crops, i.e. cover crops which can also be eaten or sold, rather than being solely for the purpose of covering the soil and boosting soil fertility.

Institutional support

Despite the numerous successful experiences with the introduction and use of CA and the existence of a number of well-trained professionals at the local level, national and regional policy makers are yet to be convinced that CA should be supported strongly. For one thing, the extrapolabilty of the success stories to different socio-cultural, ecological and biophysical conditions is still untested. The existing evidence about CA has not been well packaged nor properly presented to policy makers. Also, the Land and Water Management Unit, created by LWMP with the objective of coordinating the implementation of CA-related activities nation-wide, is basically not functional today, due to budget constraints, following the close of the project.

Pest and Disease

There are conflicting reports by farmers regarding pest and diseases associated with the presence of a mulch, some reporting built up of pests such as seed- and seedling eating birds, snakes and rodents while others report declines. This is still however a gray area that needs further research.

Conclusions and perspectives

Today, Ghana stands at a cross-road in terms of large-scale CA diffusion and adoption. Past projects with a CA emphasis have been rather successful in a host of experiences with farm level experimentation of different CA technologies, foremost among them minimum tillage and soil mulching, herbicide use and introduction of cover crops in crop rotations and associations. By doing so, field staff such as extension officers and input suppliers was trained in the principles and practices of CA.

However, the promotion of CA has reduced drastically after the corresponding projects ended. With the end of the projects, the short-lived incentives for CA adoption induced by the purchase of cover crop seeds by the government stopped as well, despite the boost CA induced in terms of maize productivity.

Since then, central government has not bee able, or perhaps more appropriately, not been willing to commit the necessary resources to continue the efforts initiated by the various donor-supported projects, especially in terms of adequately funding large-scale extension work. This may have to do with the lack of solid evidence and proper documentation regarding the tangible benefits and potential of CA in improving rural livelihoods.

Still, use of herbicides is already high and increasing among small holders. This is a consequence of the fact that labour is largely unavailable and expensive in most communities, making a labour-saving technology such as herbicide cost effective and convenient for operations such as land preparation and weed control. Herbicides are however neither readily available nor quite affordable resulting in applications at lower than recommended rates or on a lower acreage than farmers would wish. Availability and access to CA equipment, be it knapsack sprayers but more than anything jab planters is a another major bottleneck for most farmers.

All these unresolved issues constitute avenues for future work on CA development and adoption in Ghana. Harnessing the knowledge and experience built over the past few years, but also adequate external donor support will undoubtedly be critical for implementing activities and achieving the success CA can realistically hope to achieve for the greater benefit of the farmers of today and tomorrow, but also of Ghanaian agriculture and society as a whole. .

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