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著者	Akowuah Patrick
journal or publication title	Journal of Developments in Sustainable Agriculture
volume	7
number	2
page range	129-133
year	2012
URL	http://hdl.handle.net/2241/00125557

Promoting Conservation Agriculture Approaches for Sustainable Agricultural Production through Capacity Building of Field Extension Agents

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Agro biodiversity is the foundation upon which human civilizations have been built, and its conservation is critical for sustainable development in Africa. In Ghana, land degradation has resulted in serious environmental problems with devastating socio-economic impacts on rural populations. Traditional methods of farming, including slash-and-burn land preparation and repeated mono-cropping on the same field, have led to a loss of organic matter in the soil and contributed to reductions in crop yield. Conservation agriculture (CA) aims to achieve sustainable and profitable agriculture and improved livelihoods of farmers through the application of three key principles: minimal soil disturbance, permanent soil cover, and crop rotation. This evaluation of factors affecting the promotion, adoption, and impacts of no-tillage agriculture revealed the need for agricultural extension agents (AEAs) to be trained in multipurpose conservation farming approaches for sustainable crop production. Currently in Ghana, there is a gap between the development and the delivery, adoption, and maintenance of agricultural technologies, and AEAs have been blamed for failing to transfer technologies developed by agricultural research institutes. Farmers and AEAs need to receive adequate training and education in CA technologies. To meet this objective, a CA manual for extension agents was developed in collaboration with Mr. Kofi Boa (a CA consultant) and AEA training sessions were conducted. A CA training and demonstration site was also created with the support of the Farm Front Services (CA service providers) to provide hands-on training in CA practices in Atwima Nwabiagya District in Ghana.

Key words: degradation, conservation, extension services, technology, training

Introduction

Agriculture is an important cause of biodiversity loss and overconsumption of water resources. Large areas of farmland are deteriorating because they are not used in a sustainable way. Agrobiodiversity is the foundation upon which human civilizations have been built. Its conservation is a prerequisite for sustainable development and, as such, constitutes one of the greatest challenges in Africa.

According to the German Advisory Council on Global Change (2011), degradation affects about one-third of the world's arable land today. Eighty percent of the most desperately poor in Africa are subsistence farmers. Cereal crop yields have been stagnant at

about 1 tonne per ha during the past 50 years. Land degradation, erosion, drought, and climate change have caused agricultural yields in parts of Africa to fall by as much as 50% (UNEP, 2011). Furthermore, the gap between agricultural production and population growth in sub-Saharan Africa is increasing. The continent's population is growing at an annual rate of approximately 3% while food production lags behind at a growth rate of only 1–2% (IIRR and ACT, 2005). Pressures from human and livestock populations coupled with the effect of recurrent drought have led to serious degradation of vegetation cover, erosion, and depletion of soil fertility on a large scale in many parts of sub-Saharan Africa (Owusu-Sekyere *et al.*, 1977). A significant effect of land degradation and low

Received: August 31, 2012, Accepted: December 26, 2012

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agricultural productivity is the migration of rural young people to urban areas, which has had negative social implications such as stealing and creating violence in public.

In Ghana, land degradation has resulted in serious environmental problems accompanied by devastating socio-economic impacts on rural populations, whose poverty is exacerbated by the steady deterioration of their natural resource base. Land degradation is harshly felt, notably in the Savannah zones of Ghana. Traditional methods of farming and ill-adapted land-use practices (e. g., setting brush fires to clear dry standing brush to cause green flushes for grazing livestock), overgrazing, and the use of land preparation tools and practices that lead to the loss of organic matter have all contributed to soil impoverishment. This situation has been aggravated by harsh climatic conditions that have further exposed the environment to land degradation, deforestation, biodiversity loss, and a decrease in soil fertility. As a result, crop yields have decreased and there is widespread hunger in many rural areas.

In forested areas, the production and recycling of foliage leads to biological activity, humus formation, and the creation of dark colored topsoil with a large number of organisms. Such soils are productive and can support excellent crop growth. However, when the traditional slash-and-burn and conventional soil inversion techniques are employed to prepare land for annual crops, leaf production is much lower, the biomass is greatly reduced, and the soil remains bare and drier for longer periods (Ekboir *et al.*, 2002).

The aim of this study was to evaluate the factors affecting the promotion, adoption, and impacts of no-tillage agriculture in Ghana, with a focus on agricultural extension agents (AEAs) and farmers. A training manual was created and training sessions were implemented for agricultural extension agents who are engaged with the farmers at the farm level to understand the principles and practices of CA to be able to confidently transfer same to the farmers.

Sustainable Agriculture

Sustainable agricultural development is essential for rural people to enhance production, food security, incomes and livelihood for the present and future generations, and the maintenance of ecosystems (Derpsch, 2005). Even small decisions and actions can make a difference and contribute to a meaningful agricultural

development; the key is the will to take action. The way in which agriculture is perceived has changed, and a growing movement has emerged over the past decade that questions the role of the agricultural practices that contribute to social problems (Breth, 2000). The concept of sustainable agriculture is gaining increasing support and acceptance within mainstream agriculture. Sustainable agriculture addresses many environmental and social concerns, and it also offers innovative and economically viable opportunities for many people in the entire food system.

Sustainable agriculture development requires the integration of policy, society, and institutions. It is imperative that all stakeholders are involved in the system, including farmers, farm workers, AEAs, traditional authorities, researchers, consumers, and policy-makers. In this paper, I focus on AEAs and farmers as targets in improving the advocacy for sustainable agricultural practices.

Agricultural Extension Services and Technology Transfer

Agricultural extension service providers and farmers in Ghana face a serious credibility problem. Extension services in Ghana have been blamed for failing to transfer technologies developed by agricultural research institutes (Landers *et al.*, 2002). Although other factors certainly contribute to the slow uptake of modern technologies, the inadequate of training provided by institutions of higher learning to future extension workers undoubtedly contributes to the credibility problems. The reliability of extension services must be addressed if extension services and the extension profession in sub-Saharan Africa are to remain relevant. There is a growing recognition of the need to integrate modern scientific knowledge with indigenous technical knowledge to enhance technology generation and dissemination. The wider use of participatory methods and the accepted relevance and value of indigenous technical knowledge suggests that farmers should be treated as bona fide sources of substantive information in promoting agrarian change.

Farmers are the primary decision-makers and movers of change, but they have also suffered because of the adverse impacts of agrarian changes. Extension workers need to facilitate farmer self-development through empowering them and helping to improve their ability to manage change. As change agents, extension workers should therefore acquire skills in accessing, in-

terpreting, and using indigenous technical knowledge. This remains a challenge for agricultural colleges, universities, and particularly the Ministry of Food and Agriculture in Ghana.

Policies that bring about the devolution of power to sub national units to manage extension services are beneficial, but many such units lack the human and financial resources to ensure the vibrancy of the extension services. In the following sections, I identify ideas, practices, and policies that will promote the development of sustainable agriculture.

Conservation Agriculture

For agriculture to be sustainable and economically viable, farmers need to create and maintain favorable soil conditions and manage soil organic matter so as to create a fertile soil in which healthy plants can grow (Oduro, 2011). Over the last two decades, increasing pressure on arable land as a result of increasing human population, accelerated urbanization, surface mining, and other factors has reduced farmers' ability to engage in the shifting cultivation practices that have traditionally been used to restore lands to arable status. Thus, the old paradigms of agricultural production and management must be changed to simulate the closed-nutrient recycling of the forests to support sustainable crop production.

Conservation agriculture (CA) is a set of practices and procedures that ensures higher agricultural productivity and profitability while also improving soil health and the environment. CA aims to produce high crop yields while reducing production costs, maintaining soil fertility, and conserving water (Ekboir *et al.*, 2002). CA can best be achieved by using practices that continuously enhance the physical and biological properties of the soil and that ensure that nutrients are efficiently cycled. CA is based on three key principles: little or no soil disturbance, permanent soil cover, and crop rotation (Landers *et al.*, 2002). One aspect of CA, conservation tillage, has many advantages compared with traditional slash-and-burn practices. These advantages include reversed soil degradation, expansion of agriculture into marginal areas, increased profitability, and increased sustainability of biodiversity and of the agriculture system (Landers *et al.*, 2002). The ideal practice to ensure minimal disturbance to the soil is to plant directly into the soil without plowing (no-tillage). In certain situations, some tillage is performed but restricted to only the

planting lines (zonal tillage) or to the creation of permanent holes for planting (planting basins). Soil cover is needed to protect the soil against the impacts of rain and sun and also to provide nutrients for soil organisms. In CA, crop residues are left on the soil surface or special cover crops are planted so that the soil is never bare. In addition, planting the right mix of crops in the same field and rotating crops from season to season helps to minimize the harmful effects of pests and diseases.

Land Preparation: Slash-and-Burn Versus No-Tillage

Land preparation is the first major field activity in many food production systems. In Ghana, traditional land preparation for crop planting is achieved by slashing and burning. The fallow vegetation is burnt during the dry season or slashed and allowed to dry and then the residues are burnt before planting. This practice results in a clean seed bed free from all debris. Crops are then planted on the bare land by opening a small hole or a narrow trench to receive the seeds or seedlings.

The disadvantages of this method of land preparation include increased soil erosion, loss of fertility, and increased evaporation and moisture loss resulting in poor growth of crops such as maize (Fig. 1). It also accelerates runoff and decreases the soil's capacity to retain water (Derpsch, 2005). Such conditions are in conflict with sustainable crop production.

No-tillage involves slashing or mowing the weeds and previous crop residues or spraying herbicides for pre-plant weed control to obtain a seed bed covered



Fig. 1. Poor maize plant growth in bare soil resulting from use of the slash-and-burn method.



Fig. 2. (a) Direct planting method, (b) robust maize plants grown in a covered field.



Fig. 3. Examples of (a) zonal tillage and (b) planting basins.

with mulch (Fig. 2a). This technique produces robust crops such as the maize crop shown in Fig. 2b. Planting is done directly in the mulch-covered undisturbed soil by opening a small hole or trench just large enough to plant the seed, which then covered with soil and mulch. All crop residues are left on the soil surface for as long as possible. In the drier regions where mulch materials are scarce, minimum tillage techniques such as zonal tillage (Fig. 3a) or planting basins (Fig. 3b) are used to facilitate infiltration and prevent runoff.

Cover Crops

Cover crops have several beneficial attributes. They can contribute to the nitrogen and phosphorus content of the soil and can help to reduce soil compaction and be used as fodder for animals if carefully managed. Cover crops and mulch provide excellent weed control

because they create conditions that inhibit the germination and establishment of weeds.

Maintaining soil cover throughout the season is the ideal condition for a sustainable CA system. Although farmers may want to keep the soil covered year round, problems such as the presence of termites may be encountered at the farm level. Termites can be very devastating to commercial crops and have an affinity for dead material. They also attack green crops when no dead materials exist. The use of plant materials (mulch) on the soil surface can reduce termite damage because the termites attack the mulch instead of the crop. In addition, measures such as early harvesting (just after physiological maturity) and adequate drying prior to storage can also reduce termite damage.

Aea Training

AEAs and farmers need to receive adequate training and education in CA technologies for sustainable food production. To meet this objective, I created a CA manual for training extension officers in Atwima Nwabiagya district in Ghana in collaboration with Mr. Kofi Boa (a CA consultant). The manual has been used to train extension officers since May 2012. Further CA training and a demonstration site have been planned with the support of the Farm Front Services (CA service providers) to provide hands-on training in CA practices for interested farmers. Major areas covered in the training were approaches of CA land preparation, planting, weed management, harvesting and cover crops management.

Conclusions

Implementing sustainable agriculture practices will require a commitment to change. A diverse set of strategies and approaches are necessary to create more sustainable food production, and it is critically important to avoid agricultural practices that contribute to the degradation of valuable arable lands. Farmers are the most important decision-makers and movers of change, and extension workers need to facilitate the change process. Extension workers should therefore acquire skills in accessing, interpreting, and using indigenous technical knowledge.

Sustainable agriculture production should be featured prominently in the curriculum of colleges and universities. Land use for food and animal production must be given priority to alternative development for sustainable agriculture. Much more effort is needed to investigate multipurpose conservation farming approaches suitable for crop production that replaces the traditional slash-and-burn method of farming practiced in most African countries.

Acknowledgements

I am grateful to Mr. Kofi Boa, a CA consultant who

co-authored a CA manual that was produced as part of this study and financially supported the establishment of demonstration plots to provide hands-on training in CA practices for trainers. I extend my thanks to Prof. Hiroshi Gemma of the Faculty of Life and Environmental Sciences, University of Tsukuba, for his guidance. My utmost thanks goes to the Organizing Committee of Ag-ESD Symposium 2012 and the Agricultural and Forestry Research Center, University of Tsukuba, and the co-sponsors of the Ag-ESD Symposium 2012.

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