World Agroforestry Centre

REALIZING THE POTENTIAL OF AGROFORESTRY IN VIETNAM

Proceedings of the First National Agroforestry Workshop
7 December 2012, Hanoi, Vietnam

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Contents

Acronyms

ACT	Africa Conservation Agriculture Tillage Network
AF	Agroforestry
APAN	Asia-Pacific Agroforestry Network
CA	Conservation Agriculture
CAWT	Conservation Agriculture with Trees
FAO	Food and Agriculture Organization
FCP	Vietnam-Sweden Forestry Cooperation Program
IAAF	Integrated agri-qua-forestry
ICRAF	World Agroforestry Centre
LER	Land Equivalent Ratio
NOMAFSI	Northern Mountainous Agriculture and Forestry Science Institute
NFTP	Non-forest Timber Products
PES	Payment for Environmental Services
PFES	Payments for Forest Environmental Services
PTD	Participatory Technology Development
REDD+	Reducing Emissions from Deforestation and Forest Degradation plus
RVAC	Forest- Garden- Fishpond- Livestock
SALT	Sloping Agricultural Land Technology
SEANAFE	Southeast Asian Agroforestry Education Network
SIDA	Swedish International Development Agency
SSA	Sub-saharan Africa
SWAT	Soil and Water Assessment Tool
UN-REDD	United Nations' Program on Reduction of Emissions from Forest Degradation and Deforestation
VAAS	Vietnam Academy of Agricultural Sciences
VAC	Garden- Fishpond- Livestock
VAF	Vegetable Agroforestry
VNAFE	Vietnam Network of Agroforestry Education
WaNuLCAS	Water Nutrient Light Capture in Agroforestry Systems

Foreword

Much as Vietnam has developed into one of the emerging economies in Asia, the nation still maintains its agricultural base and agriculture remains pivotal to the economy. Vietnamese farmers have for hundreds of years planted trees and staple crops together, in their home gardens and in their fields. However, the practice has neither been well and officially documented nor studied until recently.

Vietnam Academy of Agricultural Sciences (VAAS) was dated back to 1952 when it was named, the Institute of Crops Production Research. Our mission is: to provide comprehensive strategic directions for the agricultural development of Vietnam; to conduct basic and applied research; and to promote technology transfer and human resource development.

One of the five main objectives in our development strategy until 2020 is to promote research on agricultural systems that bring about high economic benefits while protecting the environment. That is why we highly appreciate the continuing collaboration between VAAS and the World Agroforestry Centre (ICRAF) Vietnam, which was marked by a renewed Memorandum of Understanding, signed last year.

This cooperative relationship is of great significance to both sides as the scope of agroforestry has been extended and interlinked with different sectors: forestry, agriculture and aquaculture. Undoubtedly, agroforestry is at the heart not only of the agriculture and forestry sectors, but also in various economic and environmental policies and initiatives of Vietnam.

I believe that with our shared interests in research for development, and with ICRAF Vietnam's wide range of working areas, including Payment for Environmental Services (PES) and REDD+, our collaboration will be further strengthened and expanded in the future.

I am also confident that, publication of the proceedings of the first national agroforestry workshop that we jointly hosted on 7 December 2012 in Hanoi on "Realizing the potential of agroforestry in Vietnam", will provide an updated review of scientific research and development achievement in the area of agroforestry globally as well as nationally. This also helps develop a clearer roadmap for agroforestry research and development in Vietnam.

Nguyen Van Bo, PhD
President, VAAS

Vietnam is a country where both challenges and opportunities abound. Significant economic progress has been seen in the last couple of years, but at the same time, it almost depleted its valuable natural resources. The Government of Vietnam however, has quickly turned the wheel, to avoid a tipping point, where environmental degradation comes at a cost greater than their economic gains.

Agroforestry is in the heart of the debate on economic development, sustainability, resilience, and climate change. Agroforestry is an old practice in Vietnam, yet there is paucity in research. We have seen efforts of the Government of Vietnam to promote agroforestry in various economic development projects in rural areas. Many of these have had success, but in general, and for some reasons, the appreciation of the multiple benefits that agroforestry can offer remains low.

Agroforestry research in Vietnam therefore needs to rise to the level that it can play a potent force in addressing food security and environmental challenges. The First National Agroforestry Workshop, held at the VAAS campus on December 7, 2012, is timely and necessary. The workshop aims to create space to discuss the technical, socio-economic, policy and institutional issues impinging the success of agroforestry development in Vietnam. The rich information and discussions at the workshop brought new insights into the future of agroforestry research and development in Vietnam.

We are deeply honored by the participation of 50 researchers, project implementers and managers in the workshop, and the support of VAAS in organizing it. This volume is therefore a work of many hands.

Delia C. Catacutan, PhD
ICRAF Vietnam Country Representative

Preface

Agroforestry is a recently coined term derived from agriculture and forestry. It describes, however, practices developed and employed by farmers over many centuries to cultivate trees on farmland in different combinations with crops and livestock.

Farmers have practised agroforestry for years, but the science of agroforestry started only formally in 1980s. In Vietnam, traditional agroforestry systems at the landscape level have been adopted since early 1960s under two common practices: garden-fishpond-livestock (known as VAC) and forest-garden-fishpond-livestock (known as RVAC). It was only in 1990s that non-government organizations (NGOs) and government agencies began to introduce innovative agroforestry techniques and systems at the field level. As an alternative to shifting cultivation, agroforestry has been promoted across the country, in conjunction with government efforts in halting shifting cultivation, and in reforestation. Interventions from research and development organizations also play an important role on the evolution of agroforestry in the country.

However, wide scale adoption of agroforestry remains challenged, among others, by lack of market linkages of agroforestry products, low economic attractiveness to farmers, and limited institutional or policy support. Nonetheless, the Government of Vietnam, with its growing concerns on the impacts of climate change is opening up opportunities for agroforestry.

The time for a 'robust' agroforestry research and development effort in Vietnam is ripe, as the government is searching for innovative forest management approaches through such as efforts as REDD+ and Payments for Forest Environmental Services (PFES). Putting more efforts in agroforestry research in consideration of local ecological knowledge and developing agroforestry systems that address the biophysical, cultural and socio-economic conditions of local will be an important milestone for agroforestry research and development in Vietnam.

It is for these reasons that Vietnam Academy of Agricultural Sciences (VAAS) and ICRAF Vietnam co-organized the 'First National Agroforestry Workshop' for Vietnam, on December 7, 2012 at the VAAS Campus.

50 researchers, policy-makers, professionals and practitioners at the workshop actively informed each other on the opportunities and challenges for agroforestry development from various perspectives, be it technical, socio-economic or policy and institutional. Their knowledge and recommendations shared at the workshop helped to lay out a roadmap for agroforestry promotion, research and development in Vietnam.

Actions that ICRAF Vietnam were recommended to take following the workshop were as follows:

1. Review 'previous' agroforestry study findings and data;
2. Re-evaluate 'old' and existing agroforestry models by agro-ecological zones in terms of economic and environmental benefits;
3. Revitalize the Vietnam Network of Agroforestry Education (VNAFE); and
4. Implement trainings for different stakeholders on agroforestry practices.

This volume is a compilation of research papers presented at the workshop under four different themes: (i) History and current status of agroforestry in Vietnam; (ii) Overview of agroforestry in the tropics; (iii) Technical aspects of agroforestry; and (iv) Socio-economic and policy aspects of agroforestry.

The papers not only present the current state of agroforestry research in different locations in Vietnam but also those of international scientists. It is our hope that this volume will stimulate more scholarly work on agroforestry, and inspire fruitful collaboration among researchers within and beyond Vietnam. Finally, it is our wish that the knowledge presented in this volume will translate into meaningful policy actions.

An agroforestry garden of mango, maize, coffee and grass independently-developed by a farmer in Tan Que village, Co Noi commune, Mai Son district, Son La province.

Photo by Pham Huu Thuong, ICRAF Vietnam

HISTORY AND CURRENT STATUS OF AGROFORESTRY IN VIETNAM

History of agroforestry research and development in Vietnam: a review of literature

Nguyen Thi Hoa and Delia Catacutan

Abstract

Agroforestry has been considered as one of the approaches to deal with shifting cultivation and climate change. In Vietnam, the practice of agroforestry has been documented since 1960s under two common practices, namely 'garden-fish pond-livestock' and 'forest-garden-fish pond-livestock'. Not until 1990, innovative agroforestry techniques and systems at the field level were introduced in line with government interventions to halt shifting cultivation. Through intensive literature reviews, this paper outlines the history of agroforestry research and development activities in Vietnam. The paper also discusses the drivers and agents of change for agroforestry in Vietnam.

Keywords: Agroforestry, landscape, Taungya, alley cropping, shifting cultivation, climate change

Introduction

The mountainous areas in Vietnam have been experiencing rapid population growth due to migration from the lowland regions and natural growth. Population increase exerts pressure on land and natural resources as demand for goods and services expand. Intensive use of forestland, especially those under shifting cultivation in order to meet peoples' basic needs has given a toll on the resource-base. The situation requires solutions, which not only improve the livelihood of local people whose subsistence is dependent on forest and forestry land, but also protect the natural environment. By the second half of 1980s, global attention has turn to agroforestry (AF) as an alternative to slash and burn cultivation in mountainous areas (Pollini, 2009). Agroforestry does not only provide livelihood for local people, but is also effective in dealing with climate change impacts (Nair, 1992).

Agroforestry can be observed at different scales, at field (plot) level, farm and landscape level (ICRAF 2009). In Vietnam, traditional agroforestry systems at the landscape level have been adopted since early 1960s. However, not until 1990, innovative agroforestry techniques and systems at the field level were introduced. Recently, considered as one alternative to shifting cultivation, agroforestry has been promoted across the country, especially in line with government efforts in halting shifting cultivation and promoting reforestation. However, it is observed that agroforestry research and development (R&D) are scattered and many initiatives have not been well documented. As a result, it is hard to learn from the success and failures of various agroforestry initiatives, and determine future interventions. In this paper, we looked at the history of agroforestry research and development from scattered literatures, as well as analyzed the drivers and agents of change in agroforestry, and discussed remaining issues and research and development gaps.

Evolution of agroforestry practices in Vietnam

Growth of traditional landscape agroforestry and fallow systems (1960-1990)

In Vietnam, agroforestry has been practiced since 1960s under two traditional landscape models: garden-fish pond-livestock (known as VAC) and forest-garden-fish pond-livestock (known as RVAC). VAC model was adopted by farmers and spread throughout the country in the low lands as a result of paddy field allocation after Decree 100 (Tran, 2001). The practice was then adapted to RVAC for hilly areas and strongly developed throughout the upland regions following massive migration of people from the lowlands to the central highlands (Decision 95/CP in 1980) and mountainous areas. In addition, due to population increase, fallow systems were adopted instead of pioneer shifting cultivation to meet rising food demand (CARES, 2004).

Spread of landscape agroforestry, improved fallow systems and field agroforestry practices: small-scale fruit gardens, alley cropping and Taungya system) (1990-2000).

The landscape systems with terraced fields seem popular during the 1990s in the northern mountains (e.g., Cao Bang, Yen Bai provinces). The forest land allocation and government support encouraged farmers in the northern mountain regions to change their shifting cultivation areas into terraced fields, giving a chance for terraced field-based agroforestry landscapes. In addition, due to lack of land, improved fallow methods were applied to shorten fallow periods and provide additional incomes, such as Melia, cinnamon and N-fixing species (*tephoria, leucaena and desmodium*) in the North central and Northwest provinces (Tran, 2001).

At field level, fruit and home gardens were found throughout the country at a smaller scale since farmers were more active in their allocated lands. Perennial tree-based alley-cropping systems were popular in the central regions due to shifting cultivation issues, increased markets for perennial tree products and allocated lands. By 1992, alley cropping was introduced in Bac Kan and Thai Nguyen provinces (Tran, 2001), and then later tested in other northern provinces. A variety of N-fixing species, indigenous bushes or plants were also used as hedgerows with crops, perennial and fruit trees (Bui, 1996). Adoption of Taungya system was facilitated by the implementation of reforestation program on bare lands (327/CT: 1993-2000; 661 phase 1: 1998-2005). Cultivated agricultural land was reduced due to forest plantation and the Taungya system was adopted to meet short term food demand while waiting for the trees to be harvested, such as *manglieta glauca* with annual crops, particularly in Bac Kan province (Fatoux et al., 2002).

Expansion of field agroforestry practices: fruit gardens at a larger scale across the country, forest gardens in the north and innovative agroforestry systems in the central regions (2000-2004).

A H'Mong farmer collecting buds from Shan-tea tree - a specialty plant of Suoi Giang, Van Chan, Yen Bai province. Photo by NOMAFSI

By 2000-2004, multi-strata systems with fruit and forest gardens expanded throughout the country. Unsustainable shifting cultivation practices, government interventions on poverty reduction and shifting cultivation have driven farmers to adopt more productive alternatives. Intensive capacity building activities in the 1990s has increased farmers' knowledge on agroforestry and facilitated adoption. Reforestation programs and forest land allocation have made farmers more active in planting forest trees and developing forest gardens to meet their own demands (*cinnamon, bamboo, litsea glutinosa, anises, Aquilaria crassna Pierre* with medicinal plants) (CARES, 2004). In addition, alley cropping with perennial trees and crops became popular in Dac Lak province - (cashews, and *cassia siamea* integrated with coffee and/or pepper). Due to reduction in cultivated lands and the need to increase income in coffee monoculture systems, the introduction of multi-purpose timber trees into these systems has become prevalent. Increase in the price of perennial tree products during the first half of 2000s encouraged farmers to expand their plantation area (Garrity et al., 2006).

Furthermore, Taungya system of annual crops with fruit and timber trees have been found in the central regions while it was only available in the North in the 1990s.

Increasing small woodlots, alley-cropping and Taungya systems with a wide range of species in the northern uplands and south central regions, and intercropping of different tree species in the north (2004 to present).

Since 2004, there has been adoption of small woodlots as a type of agroforestry system. Small woodlots are maintained adjacent to agricultural crops for timber production and improving soil quality, such as alder woodlots adjacent to maize plots in Lao Cai province. The expansion of small woodlots has been attributed to reforestation programs. Small woodlots are maintained for timber, but also allow farmers to easily cultivate annual crops both in terms of shading and land preparation. At the field level, green fencing and windbreaks have been adopted in many parts of the country, especially in the central regions. In addition, alley-cropping perennial and forest species were maintained and expanded in the central and north central regions. A wide range of associated species such as cashew, bean with maize or pumpkin, and *cassia siamea* with pepper and passion fruit can be found in Dac Lak province.

There was also a growing trend in the adoption of Taungya systems in the north and south central regions. While the Taungya systems were only available with a limited number of forestry species in the north before, it was adopted for a wide range of species during the period (Nguyen, 2008). Taungya systems with N-fixing species are also found in the north. Issues of shifting cultivation and unsustainable sloping land cultivation drove the adoption of agroforestry systems, especially with N-fixing species by farmers. In addition, the Taungya systems with perennial trees were recognized in the south central and the north due to governmental interventions to expand perennial tree plantations in the country (Decision 750/QĐ-TTg).

Furthermore, intercropping different tree species were quite popular in the northern mountains and central highlands. Non-timber forest tree species and perennial trees are intercropped under forest canopy in the later stage such as *cardamom* under *alder*; *amomum* under forest in Lao Cai province; tea under *manglieta glauca* or *acacia* in Phu Tho and Yen Bai provinces; and coffee, rubber, cocoa under forest species in the central areas. Like small woodlots, the systems were developed following phase of Taungya systems. Due to shading (from year 4 of forestry species), farmers adopt shade-tolerant species for additional incomes.

Agroforestry research and development interventions in Vietnam

Since 1990, non-government organizations (NGOs), research institutions and government agencies have greatly contributed to agroforestry promotion and adoption in Vietnam. While most of the practices before 1990 were self-initiated by farmers, the later period saw various interventions from different organizations.

Both development organizations and research institutes were proactive in testing and demonstrating alley-cropping systems (e.g., SALT techniques) with N-fixing species (1990-2000).

In the 1990s, while research interventions focus on the establishment of on-farm and on-station Sloping Agricultural Land Technology (SALT) experiments, development organizations showed more interest in demonstrating and integrating SALT techniques on farms at the household level. By 1991, the Vietnam-Sweden Forestry Cooperation Program (FCP) has established SALT trials in the northern provinces. A variety of SALT techniques have been adopted, while the common technique was contour- hedgerows (Bui, 1996). In addition, by 1998, the Southeast Asian Agroforestry Education Network (SEANAFE) established by the World Agroforestry Centre (ICRAF) with funding support from the Swedish International Development Agency (SIDA) focuses on increasing agroforestry capacity and setting up SALT trial in Thai Nguyen province (Hoang et al., 2011).

Maize-mango-Mulato grass complex trial in Van Chan, Yen Bai province

Photo by Pham Huu Thuong ICRAF Vietnam

In terms of development projects, many interventions focused on capacity building, demonstrating and integrating agroforestry on farms. The Asia-Pacific Agroforestry Network (APAN) (1991-1998) supported demonstration plots and disseminated successful farming systems in the country (FAO, 2008). In addition, a variety of development projects integrated SALT on farms in the northern uplands with technical and seedling support for N-fixing species (CARES, 2004).

Research and governmental agencies focused on testing and demonstrating forest species-based Taungya system, while NGOs show more interest on forest gardens (2004-present).

Since 2004, there have been a variety of development projects and research activities focusing on expanding agroforestry systems in the country. In term of research, forest species-based Taungya system (such as rubber with grass/crops) was tested by Thai Nguyen University in Bac Kan province, while rubber-based agroforestry was tested by NOMAFSI in Son La province.

Government agencies accelerated the demonstration of Taungya agroforestry systems with forestry species such as *aquilaria carassan* or hybrid *acacia* with banana in Quang Nam (Khuyennongvn, 2011), and *eucalyptus sp/hybrid acacia/pine* with upland rice in Dien Bien. Furthermore, by 2011, Thua Thien Hue province has developed agroforestry for improving livelihoods in combination with biodiversity conservation through the development of forest and fruit gardens. In Yen bai province, the government focused on developing integrated farming system in sloping lands through agroforestry and technology transfer.

NGO activities on the other hand, focused on the acceleration of multi-strata agroforestry systems in the country. A development project funded by Food and Agriculture Organization (FAO) in 2004-2012 focuses on agroforestry garden development in allocated forestlands with fruit and industrial trees, in six communes in Quang Nam province. Specifically, the project provided capacity building, extension improvement, demonstration and technical support for the development of market-oriented forest gardens and agroforestry systems in the province (FAO, 2004).

Conclusion

In summary, agroforestry research and development in Vietnam has achieved some level of success. Starting as a traditional practice at the landscape level, more innovative systems at the field level have later been adopted such as phased-intercropping and alley cropping. The adoption of agroforestry can largely be attributed to the efforts of the government to reforest degraded lands and halt shifting cultivation, but research and development organizations have to some extent, also contributed to agroforestry development in the country.

However, myriad issues and challenges remain - lack of market linkages of agroforestry products, low economic attractiveness to farmers, small scale investments, and limited policy support at the local level have hindered wide-scale adoption of agroforestry, and are critical issues for research. Nonetheless, the recognition of the national government on the potential of agroforestry, the ongoing expansion of perennial tree plantations, and growing concerns on climate change in Vietnam are opportunities for agroforestry development. Putting more efforts in researching agroforestry systems in consideration of local ecological knowledge, practices that enhance the multi-functionality of landscapes, and demonstrating improvements in local livelihoods, enhancing resilience, and in climate change mitigation and adaption will be an important milestone for agroforestry research and development in Vietnam.

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State of agroforestry research and development in Vietnam

Bao Huy and Vo Hung

Abstract

Agroforestry research in Vietnam has been conducted based on scientific and local ecological knowledge. However, sustainable implementation of agroforestry practices, which constitutes an important component in natural resources management, still faces many challenges. Thorough evaluation of the current state of agroforestry research and development in Vietnam is indeed, necessary to re-orient its future direction. However, evaluating agroforestry research and development in Vietnam is a difficult undertaking for four reasons: i) many agroforestry studies in the past were at best, documented only in 'grey literature" form; ii) there was no system to document agroforestry practices developed by farmers; iii) agroforestry pilots were not scientifically evaluated in terms of their extrapolation domains, and hence, were not recommended for scaling up; and finally, iv) the temporal and spatial dimensions of agroforestry vis a vis the multiple factors that influence change make it harder to predict their sustainability. This paper attempts to summarize existing research on agroforestry, analyze research gaps, and presents priority research topics that need to be addressed, to unleash the potential of agroforestry in Vietnam.

Keywords: Sustainability, scaling up, agroforestry research and develoment

Introduction

Agroforestry not only refers to technological solutions, but it is also closely connected with economy, society, humanity and environment. Agroforestry research has experienced significant change, the most prominent of which, is the use of demand-driven and participatory approaches with greater farmer involvement.

Vietnam is a country with rich ecological and ethnological diversity. Addressing this diversity requires constant adjustments and new innovations in agroforestry research. Local experience combined with scientific knowledge have resulted in various agroforestry models designed to address the unique conditions of each ecological and ethnological area in Vietnam. These models have been analyzed based on their technical appropriateness, socio-economic viability and environmental integrity before they were expanded. The landscape-approach to agroforestry research has long been practiced by farmers through the establishment of forest on hilltops, terrace fields on hillsides and steep slopes, and gardens and rice fields in the foothills. However, this planning approach has only been recently studied.

Jackfruit and pineapple intercropping in sloping farm

Photo by Vo Hung

Agroforestry has contributed significantly to the economic growth and sustainable natural resources management of rural and mountainous areas. Agroforestry systems have been adopted in regions that have steeply sloping lands, and where arable land is limited. These models have basically been designed based on the experiences of local people and their demand for land and water management. The economic benefits of agroforestry are well founded. It provides diverse products and income sources, and helps to manage market-related risks. In some regions, large-scale agroforestry farms produced huge amounts of agroforestry products and created jobs for rural people. With high economic orientation, many rich or large holder farmers and private enterprises adopt these models.

Some government policies are supportive to agroforestry development. Referred as 'pro-agroforestry policies', they facilitate land use rights allocation and technology transfer, which in turn, promotes afforestation and agroforestry. As a result, many remote areas have successfully adopted a range of agroforestry systems and practices.

Researchers and farmers working in an agroforestry trial on sloping land. Photo by Vo Hung

Research gaps and priority research issues

Despite the above mentioned advances in agroforestry research, policy and practice, challenges arise from rapid shift to market-orientated economic development and climate change. Several aspects/issues have been identified as priorities for agroforestry research in Vietnam, in the next five years. These are summarized in Table 1, and discussed in turn.

Methodology and approach in agroforestry research and development: The dominant research approach is oriented towards economic and technical aspects. In addition, most studies have neither combined new techniques with local experiences nor paid due attention to the unique traditional, cultural and ethnological characteristics of specific community. In some places, agroforestry techniques are adopted in a mandatory, "top-down" manner and failed to capitalize on local farmers' contribution. This approach lends itself to the vicious cycle of unsustainability of government-driven interventions.

Landscape approach to agroforestry planning and formulation of policies on sustainable upland natural resources management: Agroforestry development planning is usually conducted separately from land use planning processes in many places. As a result, agroforestry is used as a replacement of existing land uses. Meanwhile, in theory, agroforestry development advocates finding appropriate adjustments to improve the weaknesses of current land uses, instead of finding a complete replacement. There is thus, a need to coordinate and integrate agroforestry planning into land use and watershed management planning. Research-based evidence that supports policy formulation for sustainable sloping land management is also inadequate, if not missing.

Technical issues in agroforestry research: Despite some agroforestry advances, there is paucity in research on the socioeconomic and

environmental aspects of agroforestry. Tradeoffs and complementarity among components of agroforestry models have not been sufficiently studied. Current agroforestry models are more oriented towards economic returns with little or no consideration of externalities, and designing temporal and spatial components of agroforestry is still spontaneous.

Traditional crops like rice, maize, bean, sugarcane, cassava, and industrial trees such as coffee, rubber, pepper and tea have been incorporated in agroforestry systems, but there is no study on indigenous forest tree species and Non-forest Timber Products (NFTP) and the possibility of combining them with agricultural crops in the context of agroforestry.

The role of agroforestry in climate change mitigation and payment for environmental services: Vietnam has promulgated a national policy on "Payments for Forest Environmental Services' (PFES) and has actively joined the United Nation's Program on Reduction of Emissions from Forest Degradation and Deforestation (UN-REDD). Many adopted agroforestry systems not only provide significant socio-economic benefits but also environmental services such as water quality and quantity and carbon sequestration. However, there is lack of scientifically credible assessments on the value of these environmental services, which are urgently needed to inform decision makers and PFES implementers in the design of PFES schemes.

Land use change in the uplands: Land use change has become more complicated. In the uplands, shifting from multi-cropping to monocropping of cassava on degraded lands and monocropping rubber and fast-growing timber trees such as *acacia* and *eucalyptus spp*, is pervasive. More research is needed to establish scientific, practical and policy bases for sustainable resources management of large-scale cultivation in the uplands, such as rubber plantations.

Economic benefits and market development for agroforestry products: although there have been many studies on the economic benefits of agroforestry systems, their results are time-bounded, due to lack of understanding or due consideration to changing market conditions, as well as the drivers and actors of those changes in the market.

Mango-maize-coffe-grass garden of a farmer in Tan Que, Co Noi commune, Mai Son district, Son La province.
Photo by Pham Huu Thuong, ICRAF Vietnam

Table 1: Summary of agroforestry research gaps and needs in the next five years

Expected research results	**Available Knowledge – experience – policies**	**Research gaps and needs**
Comprehensive approach in agroforestry research and development	Participatory technology development (PTD)	Technical, socio-economic, humanitarian and environmental aspects of agroforestry
Approaches and methodologies and/or solutions to shifting cultivation	Documentation of indigenous knowledge on shifting cultivation	Improved shifting cultivation or fallow methods based on local ecological knowledge Policies on management of abandoned and degraded lands
Develop and expand market for agroforestry products	Evaluation of market value chains of agroforestry products in remote areas	Methods to assess markets for agroforestry products. Methods to develop sustainable markets for agroforestry products
Scientific and practical basis in support of agroforestry planning	Initial establishment of concepts of and approaches to landscape agroforestry management Participatory and use planning	Landscape approach to land use planning Participatory methods on land use planning, land and forest land allocation Policies on sloping land management
Agroforestry systems based on socio-economic and environmental factors	Techniques for designing space and timing of long-day and short-day crops in different ecological zones	Spatial and temporal arrangement of agroforestry components based on ecological, economic and environmental factors
Indigenous multi-purpose forest tree species and NTFPs in agroforestry	List of forest tree and non-timber species in some ecological zones Cultivation techniques of some forest trees and non-timber species in some ecological zones	Updated list of multi-purpose forest tree and non-timber species that could be integrated in agroforestry models. Cultivation techniques of indigenous timber and non-timber species that have potential to be integrated in agroforestry systems.
Quantifying environmental services from agroforestry systems, such as soil and water conservation, and carbon sequestration	Initial research on carbon sequestration of agroforestry systems	Quantification of: Extent of soil and water conservation and protection in agroforestry systems Extent of estimated carbon sequestration of agroforestry systems; and Developing policies on payment for environmental services from agroforestry systems

Finally, the potential of agroforestry in Vietnam is enormous, but serious bottlenecks need to be addressed, and significant investments and commitment from the government and its research and development partners are needed to unleash this potential.

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OVERVIEW OF AGROFORESTRY IN THE TROPICS

Conservation Agriculture with Trees in sub-Saharan Africa: case studies from four countries

Jeremias Mowo, Jonathan Muriuki, Saidi Mkomwa and Dennis Garrity

Abstract

Conservation agriculture (CA) and agroforestry can provide a practical and sustainable solution to addressing the poor performance of agriculture in sub-Saharan Africa (SSA), where the majority of smallholder farmers cannot afford costly inputs. This study was conducted using community and farm-level qualitative and quantitative surveys to establish the extent of and factors affecting adoption of CA and agroforestry, which will help derive a comprehensive strategy for scaling up of conservation agriculture with trees (CAWT) in SSA. The study found that only 5% of farmers in Ghana and Tanzania and 4% in Kenya had adopted conservation agriculture as a complete package in that they were undertaking practices that fitted all the three recommended principles. In most cases, only one or two principles were evidently practised. Agroforestry is fairly adopted especially in Kenya, Tanzania and Zambia where on average 51% of farmers intercrop trees with crops compared to 25% in Ghana. Specific policy statements targeting promotion of CAWT lack but favourable policies exist in the natural resources management domain. While there are adequate institutional frameworks favourable to CAWT up-scaling, the initiatives lack proper coordination. Therefore, promotion of CAWT needs to aim at the broad sense of contributing to livelihood strategies and move towards forming more structures/frameworks with appropriate commercial/ agribusiness strategies to create an environment for increased rural employment in areas where it gets adopted.

Keywords: Agroforestry, soil fertility, ecosystem resilience, climate change, Sub-Saharan Africa

Introduction

CA and agroforestry are being promoted as practices that can reverse the poor performance of the agricultural sector in sub Saharan Africa (SSA) where the gap between population growth and agricultural production is increasing. To avert large scale hunger, food production must double by 2030 (ACT, 2008); a target that is hardly feasible under the current land management practices largely characterized by maximum soil disturbance, low use of inputs, mono-cropping and deforestation. For instance, average fertilizer use intensity in SSA is 7 kg/ha, significantly lower than in other developing regions of the world. This accounts for only 3% of global fertilizer consumption a figure which has stagnated over the past two decades (Druilhe and Barreiro-Hurlé, 2012.) Poor agricultural practices have led to nutrient mining, soil erosion, declining soil organic matter and global warming.

In response to this scenario, the African Union Ministers of Agriculture, Land and Livestock meeting in Addis Ababa in 2009 declared support for the imperative of scaling-up conservation agriculture and agroforestry across the continent. CA combines the simultaneous principles of reduced tillage or no till, soil surface cover and crop rotations and/ or associations and aims at achieving sustained production levels while conserving the natural resource base (Bayala et al., 2011). Meanwhile, agroforestry refers to land-use systems and technologies where trees and shrubs are grown in association with crops and/or livestock in a spatial arrangement, a rotation or both. Agroforestry helps in enhancing biodiversity conservation, climate change adaptation and mitigation, food and energy security, and reducing rural poverty by increasing soil fertility and crop and livestock yields. CA and agroforestry can therefore provide a practical and sustainable solution to addressing the poor performance of agriculture in SSA (Garrity et al., 2011) where the majority smallholder farmers cannot afford costly inputs.

The benefits of CA and agroforestry notwithstanding, the uptake of these practices in Africa is disappointingly low. The two practices have commonly been promoted individually and at times under different institutional settings. It was therefore hypothesized that adopting a tree based CA strategy (Conservation Agriculture with Trees (CAWT) would combine the best of each practice and hence stimulate their adoption. The role of trees in promoting CA is best illustrated when you consider the aspect of adequate soil cover where farmers are encouraged to leave part of the crop residues on the land after harvest. This is difficult given the multiple uses of crop residue in SSA (fodder, fuel, construction). Trees will provide year round soil cover and hence release crop residues for other uses.

Effective scaling up of CAWT in Africa requires a solid knowledge and strong partnership base. We need knowledge on where and when trees can contribute to the CA principles and the institutional and policy setup necessary for enhancing CAWT adoption. This paper is an attempt to fill the knowledge gap by establishing the extent of and factors affecting adoption of CA and agroforestry to be able to derive a comprehensive strategy for combined scaling up of both under CAWT in sub-Saharan Africa. The study was guided by the following research questions: (i) What is the extent of adoption of CA and agroforestry by smallholder farmers in SSA? (ii) What are the policies and institutional factors promoting or hindering large-scale adoption of CA and agroforestry? and (iii) What are the institutional and organizational infrastructure required for the scaling-up of CAWT.

Maize farming in a Faidherbia agroforest in Mbarall District, Southern Highlands, Tanzania, 2008.

Photo by Danyell Odhiambo

Methodology

The study was conducted during 2011 – 2012 in four countries in SSA (Zambia in Southern Africa, Kenya and Tanzania in East Africa and Ghana in West Africa) where there was strong evidence of the potential for upscaling of CA. A rapid appraisal by the Africa Conservation Agriculture Tillage Network (ACT) and the Food and Agriculture Organization of the United Nations (FAO) between February and April 2009 showed that Zambia has the largest area under CA (120,000ha), followed by Ghana (30,000ha), Kenya (15,000ha) and Tanzania (10,000) ha. Of the four countries, Zambia has advanced in integrating trees in CA with 100,000 farmers already practicing CAWT.

Community and farm-level qualitative and quantitative surveys assessed the extent of adoption of CA and agroforestry by smallholder farmers, biophysical, policy and institutional factors influencing scaling up of CA and agroforestry, and opportunities for

policy reforms and institutional strengthening to support the scaling-up of CAWT. Successful policy reforms, such as fertilizer subsidies, seeds and provision of CA tools for farmers practicing CA were analyzed to derive key lessons. Qualitative data was analyzed using explorative methods (descriptive, correlation and non-parametric) while logistic regression analysis was used to estimate the extent and factors of CAWT adoption at farm level.

Results and Discussion

This study found that very few farmers had adopted CA as a complete package in that they were not undertaking practices that fitted all the three recommended principles. In most cases, only one or two principles were evidently practised. simultaneous adoption of the three principles was reported by only 5% of the survey respondents in Ghana and Tanzania, and 4% in Kenya. The principle(s) most preferred for adoption varied across different region intra and inter countries. Minimum tillage was the least adopted CA component while crop rotation was widely adopted in Tanzania, Ghana and Kenya. This finding could imply that minimum tillage may be a difficult principle for the majority of farmers to perceive and implement, probably because they are accustomed to conventional tillage or because they are not fully aware of the benefits of minimum tillage and the drawbacks of conventional tillage. In Zambia, manual minimum tillage through the use of the basin technique was the most commonly adopted CA principle.

The factors influencing adoption of CA varied across countries and included age of the household head, household size, access to training resources, access to information and knowledge and farmers' perception of CA as potentially mitigating climate change (Table 1).

Table 1: Summary logistic regression analysis on factors influencing adoption of CA in Kenya and Tanzania

Variables	df	Kenya			Tanzania		
		Coefficient	S.E.	Sig.	Coefficient	S.E.	Sig.
Age of head of household	1	-0.04	0.01	0.00***	-0.01	0.02	0.67
Gender of head of household	1	0.18	0.47	0.71	-0.07	0.93	0.94
Education of head of household	1	-0.05	0.05	0.30	0.54	0.56	0.34
Household size	1	0.49	0.14	0.00***	0.07	0.15	0.63
Livestock keeping	1	-1.15	0.67	0.83	-1.27	0.80	0.11
Access to free training resources	1	0.29	0.37	0.43	3.07	1.27	0.02**
Access to subsidized farm inputs	1	-0.25	0.42	0.55	-0.97	0.89	0.28
Access to credit	1	0.05	0.70	0.95	0.63	0.83	0.45
Farm size	1	0.12	0.10	0.25	0.05	0.04	0.19
Mitigation against climate change	1	1.23	0.59	0.04**	0.94	1.50	0.53
Knowledge dissemination through Farmer field schools (FFS)	1	1.30	0.37	0.00***	0.82	1.29	0.53
Knowledge dissemination through Farmer research groups	1	-0.12	0.41	0.79	-1.62	0.79	0.04**
Knowledge dissemination through Contact farmer approach	1	0.82	0.34	0.02**	2.29	1.19	0.06*
Constant		-0.22	1.47	0.88	-2.49	1.26	0.05*

Df = degrees of freedom; S.E. = Standard error; Significant at *=10%; **=5%, ***=1%

In Kenya, older farmers were found to be less receptive of new ideas and risk averse whilst household size (proxy for labour availability) was positively correlated to adoption. In Tanzania, access to training resources, knowledge dissemination through farmer research groups and contact farmers were more important. This finding agrees with an earlier study in the country which observed that knowledge dissemination through approaches such as farmer research groups and contact farmers enhances the sharing of knowledge and experiences among farmers and between farmers and technical experts. Farmers who participate in knowledge dissemination sessions are better informed and more willing to adopt CA practices than those who do not (Owenya et al., 2012). Thus, CA may not be adopted as a one size fits all intervention and hence it is needed to target interventions to specific local conditions.

Agroforestry is fairly supported by farmers especially in Kenya, Tanzania and Zambia where on average 51% of farmers intercrop trees with crops compared to Ghana (25%) (Figure 1). Other agroforestry practices exist but intercropping trees with crops was the only one quantified as it has a direct bearing on adoption of CAWT - the practice that depicts crops to be established together with trees under CA. Farmers cited fuel wood, timber/ poles, shade, wind breakers, fruits, fodder, mulch, soil erosion control and apiculture as factors motivating them to adopt agroforestry. The reasons given by non-adopting farmers include the long period needed for trees to mature, competition with crops, lack of germplasm, lack of knowledge on management of trees and land tenure. Agroforestry can potentially be used to drive the adoption of CA, and hence the importance of packaging them together under CAWT.

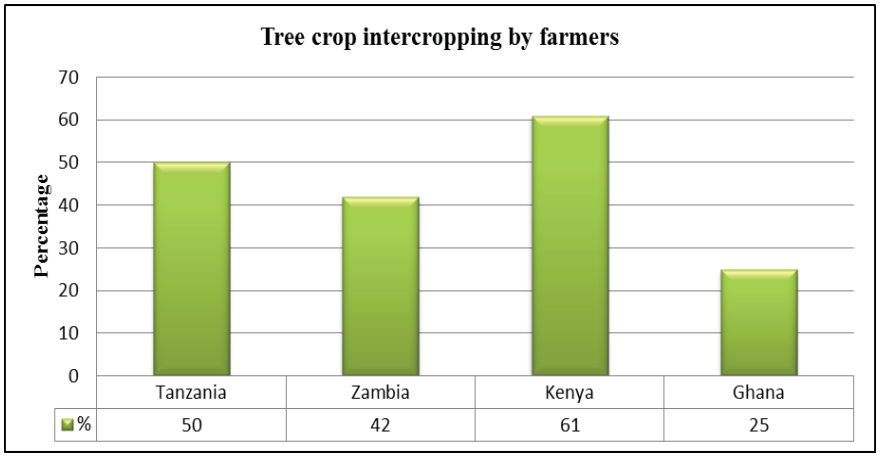

Figure 1: The proportion of smallholder farmers in four countries of Africa who intercrop trees with annual crops

Policy studies showed that there lacks a single comprehensive policy document on CA at individual country level. However, policy statements and government strategies within sectors such as the environment, land, agriculture, forestry, and water support CAWT activities under the framework of broader conservation and sustainable resource management programs. The study also observed that a uniform policy prescription to favour specific countries and regions would not be realistic due to varying agro ecological, socio economic, physical and cultural factors. Scaling up of CAWT can be implemented under a number of existing policies related to sustainable land and water management where CAWT becomes integral to amendments to existing policies aimed at mitigating problems regarding land use and management rather than deploying efforts to develop a stand-alone CAWT policy framework.

The study established that, in general, adequate institutional frameworks that are favourable to CAWT upscaling exist in the four countries. However, there is low level of awareness of CAWT practices and poor coordination of such practices/activities in the countries with possible exception of Zambia where a national CA taskforce was in place. There is also very little or no coordination among all the various actors and stakeholders that develop and promote CAWT technologies in the other three countries. In many instances, CAWT related various actors and institutions carry out activities in isolation. Experience in Zambia showed that presence of a coordinating national taskforce can improve effectiveness of the institutions and resource efficiency. A national structure that recognizes and mops up adequate funds for the taskforce is however necessary for the taskforce to continue performing.

Conclusion

Smallholder adoption of CA as a complete package (the three principles) is below 10% on average in the four countries and, in most cases only one or two components were evidently practised. The principle(s) most preferred for adoption varied across different regions with minimum tillage being the least adopted principle although study in Zambia showed hope in that many farmers were adopting the principle by using the basin technique. Agroforestry is more adopted in the countries and more than a third of the farmers were inter-planting trees with annual crops. No country had a specific policy statement targeting promotion of CAWT but favourable policies exist in the sustainable agriculture and natural resources management domain. Adequate institutional frameworks exist in the four countries that are favourable to CAWT upscaling but the initiatives lack proper coordination. Therefore, promotion of CAWT needs to aim at the broad sense of contributing to livelihood strategies and move towards forming more structures/frameworks with appropriate commercial/agribusiness strategies to create an environment for increased rural employment in areas where it gets adopted. These results suggest that there is also need for formal institutional frameworks to incorporate existing local institutions in the efforts to scale up the adoption of CAWT. Institutional mechanisms are required to ensure that CAWT is seen as a concept beyond agriculture and promote it as a theme to ensure effective linkages between research and development activities.

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