



Innovations for agroecological cropping systems

Introduction

The agroecology transition requires the implementation of technical changes, especially in cropping systems.

These changes represent innovations for the farmers who adopt them. These innovations may originate from traditional knowledge and skills (endogenous knowledge), from other regions and countries, or from research experiments or from the farmers themselves. They are generally integrated into broader changes to agricultural production systems, including livestock systems.

This note is one of seven (07) thematic ones resulting from the capitalisation of the ECOWAS Agroecology Programme in West Africa (AEP). It summarizes the various innovations implemented through experiments supported by AEP, the lessons and conclusions related to the development¹ of these innovations, their sustainability and their scaling-up, and recommendations relating to public policies that could promote these various aspects.

The analysis is based on a review of various works related to experiences supported by AEP, interviews with key agroecology stakeholders at the regional level, case studies in six (06) countries of the region (Benin, Côte d'Ivoire, Ghana, Nigeria, Senegal, and Togo), and the conclusions from a regional workshop discussing the provisional results.



▶ In Mali, with support from the NGO AMEDD, farmers are implementing contour farming techniques to better retain water and combat erosion.

¹ The *development of agroecological practices and systems* refers to all the processes of experimentation, adaptation and expansion of agroecological practices and systems, at different scales, i.e. from the plot of land or the livestock unit to the farm as a whole, right up to the territory.

Summary of experiences

The main innovations observed within projects supported by AEP can be classified as follows. Please note the potential for overlap between these categories.

-  **CROP DIVERSIFICATION:** encompassing associations and rotations, notably through the utilization of cover crops or fertilizer plants (typically legumes such as cowpeas, pigeon peas, and mucuna), to enhance soil fertility and substitute fallow periods.
-  **AGROFORESTRY:** involving tree seedling production, plantations, and reforestation initiatives, alongside assisted natural regeneration (ANR), and shaded crops (with a focus on coffee and cocoa cultivation).
-  **AGRICULTURE-LIVESTOCK INTEGRATION:** spanning the production, collection, supply, storage, and enhanced utilization of manure, compost production and application, irrigation/fertilization utilizing water from fish farming, transportation methods, grazing/movement of pigs and poultry within crops and the integration of vegetable production/fish farming. In the words of Kambiré Jean Martin, “the sustainability of cropping systems cannot be achieved without animals and trees.” Additional innovations aim at integrating agriculture and livestock seek to augment animal production (as detailed in Thematic Note 7: Agroecological livestock systems).
-  **RECYCLING OR RECOVERY OF PLANT BY-PRODUCTS:** encompassing (or incorporating) the use of crop residues (including mulch) and diverse forms of plant organic matter for soil covering or incorporation, retaining the roots of leguminous plants within the soil, utilizing grasses, biochar, bokashi, cocoa pods, or ashes for compost production, the creation of briquettes from cocoa pods and bio-energy production.
-  **SOIL AND WATER MANAGEMENT AND CONSERVATION:** focusing on contour land and lowland development through the employment of bunds, conservation agriculture practices, the implementation of covering techniques or incorporation of plant organic matter into the soil, as well as the utilization of zai, half-moons, and staggered ridging methods, etc.
-  **BIOLOGICAL CONTROL AND OTHER ALTERNATIVES TO PESTICIDES:** including the production and application of biopesticides or ash, the use of repellent plants, integrating poultry grazing within crop systems, employing integrated pest management and utilizing Aflasafe to mitigate aflatoxins.
-  **ADAPTED MECHANISATION** (tillage, other cultivation or post-harvest work) **AND ANIMAL TRANSPORT:** these practices contribute to improve and regulate the agricultural yields, to make better utilisation of produce, to protect soil and water, to reduce dependence on pesticides and herbicides, and to reduce the work involved.
-  **IMPROVED TILLAGE PRACTICES (EXCLUDING MECHANISATION):** include zai pits, localised weeding, and staggered ridging combined with tight ridges to increase planting density and to optimise rainwater retention.
-  **IMPROVEMENTS INVOLVING PROTECTION AGAINST GRAZING:** early sowing, crop diversification (longer-cycle or soil-enriching species), maintenance of soil organic matter and the protection of tree seedlings. In this situation, animal-derived organic inputs such as manure or compost are used.
-  **SEEDS:** production and certification of high-quality seeds with enhanced agronomic potential, especially those adapted to climate change (drought resistance, short growth cycles and improved nutritional profiles), establishment of nurseries, seed banks and seed conservation mechanisms. While local seed varieties are often promoted, they are not exclusively used.
-  **INTENSIVE RICE-GROWING SYSTEM (SRI)** combining various techniques (organic soil amendments, selection of high-quality seeds, and direct sowing or transplanting of seedlings from nurseries).
-  **PRODUCTION OF RENEWABLE ENERGY** especially solar power that enables the motorisation of various tasks in order to reduce labour duration and hardness, to enhance water accessibility or to lower specific production costs.

Some innovations involve the use of external inputs or the development of on-farm agroecological resources. Others may require specific equipment or investment in biological assets (livestock and trees). These diverse techniques are typically integrated into broader agroecological production systems. Additionally, certain innovations, although not directly related to farming systems, exert significant indirect influence (improved cooking stoves, innovations in financing, institutional support for agroecology or enhancing market access mechanisms, etc.).

Lessons learnt and conclusions

Benefits and disadvantages

Numerous benefits are yielded from agro-oecology innovations. The limited available quantitative evaluations of the effects of agroecological practices point out that, on degraded soils, restoring soil fertility and intensifying agroecological techniques can lead to significant yield increases (typically ranging from 20% to 100%). These innovations also generate a variety of qualitative benefits, including enhanced soil fertility and health, improved water availability, more effective pest and disease control and greater food security (through increase of production volumes, improved yield stability and therefore better adaptation to climate change and drought, enhanced product quality that can generate better market value), better product health quality, the environmental gains, reduced labour requirements and lower investment costs. [see table on page 4]

The benefits on health are powerful motivator for adopting agroecological practices.

A young farmer trained at the Tcharm Fora training centre in Benin shared:

“I resisted the centre headmaster’s suggestions for a long time but when I saw the results on his farm compared to mine, where chemicals made me constantly sick and cost me a lot of money, I finally gave in and today (.../...) I no longer fall ill and all the produce from my farm last that come out of my field last much longer without deteriorating”.



› The Gagnoa Lakota training centre (Côte d'Ivoire) is successfully experimenting with cocoa cultivation in agroforestry and integrated with poultry farming.

When agroecology innovations result in an increase of agricultural output (situations where soil fertility is reconstituted or improved), productivity rises but that depends on changes in production and labour costs. In some cases (for example, where synthetic fertilisers and pesticides are replaced by organic inputs), productivity improvement may be limited, especially if costs or labour demands increase. So, it is often essential to obtain a better price on the market for the agroecological products to ensure positive income.

Upgrade in soil fertility and health, water management and pest control influence production significantly. In some contexts, increase of per-hectare yields enables a reduction in land allocated to food crops, decrease of labour requirements or devotion of part of the land to forage or soil-enriching crops.

In addition to these various environmental, agronomic and socio-economic effects, there are also positive social effects and impacts: know-how and knowledge, social recognition, organisation of farmers and other stakeholders and governance.

As far as the effects on labour and costs are concerned, there is a variety of situations. While some innovations reduce labour needs (crop associations, adapted mechanisation, improved tillage techniques), others on contrary increase them (composting, soil conservation, manual weeding, etc.). Moreover, while some reduce production costs (and then improve farm autonomy), others require significant investments for (soil conservation, tree planting, composting infrastructure, etc.).

MAIN TYPES OF IMPACT OF AGROECOLOGICAL INNOVATION CATEGORIES ON CROPPING SYSTEMS

	SOIL FERTILITY AND HEALTH	WATER AVAILABILITY	CONTROL OF BIO-AGGRESSORS	PRODUCTION (QUANTITY, REGULARITY, QUALITY)	PRODUCT HEALTH QUALITY, ENVIRONMENTAL QUALITY (BIODIVERSITY, HEALTH)	CONTROL OF WORKING HOURS / REDUCTION OF DRUDGERY		CONTROL OF PRODUCTION COSTS / AUTONOMY	INVESTMENT COSTS
+ possible positive effect									
- possible negative effect									
CROP DIVERSIFICATION AND ROTATION	+		+	+	+	+	-	+	
AGROFORESTRY	+	+	+	+	+		-		-
AGRICULTURE-LIVESTOCK INTEGRATION	+		+	+				+	-
RECYCLING / RECOVERY OF PLANT BY-PRODUCTS	+			+		+	-	+	
SOIL AND WATER MANAGEMENT AND CONSERVATION	+	+		+	+		-		-
BIOLOGICAL AND MECHANICAL CONTROL AND OTHER ALTERNATIVES TO PESTICIDES / HERBICIDES			+	+	+		-	+	
ADAPTED MECHANIZATION, ANIMAL TRANSPORT	+	+	+	+			+		-
IMPROVED TILLAGE PRACTICES	+	+		+		+	-		
PROTECTION AGAINST GRAZING				+					-
SEEDS			+	+	+			+	
SRI	+			+			-	+	
RENEWABLE ENERGY		+		+		+		+	-



› Demonstration of heap compost production by UPPA-HOUET in Burkina Faso.

As for specific benefits for **women** and **young people**, some agroecology innovations can create employment and income opportunities and enable them to specifically build their capacity. For women, they can also boost self-esteem and social standing and enhance household food security. The effects in terms of working time and drudgery (positive in some cases, but negative for certain innovations) may affect women in particular.

Conditions for implementation and success

The conditions for the implementation and success of innovations can be classified as follows:

 **ALIGNMENT OF INNOVATIONS WITH FARMERS' OBJECTIVES** as for their priorities whether economic, food security-related, risk reduction and long-term improvement of the ecosystem, depending on land access and levels of inse-

curity. It is crucial to consider both immediate needs and long-term sustainability (for instance, crops such as pigeon pea contribute to soil restoration while ensuring food production in the short term). Labour opportunity cost is an important factor too, as agroecology often requires more intensive labour.

 **FARMERS' KNOWLEDGE AND SKILLS.** Adopting agro-ecological practices requires specific knowledge and skills. While some of these practices are rooted in tradition, others are new, which means that they should not be too complex and that there should be appropriate support systems to enable farmers to acquire the necessary knowledge and skills.

 **ADAPTATION OF INNOVATIONS TO THE AGRO-ENVIRONMENTAL CONTEXT.** The limited water availability can really impede the adoption of some practices. In such situations, alternative appropriate solutions better suited to the local context should be found (for example, fodder trees instead of fodder crops).



LABOUR ISSUE. Some innovations are labour-intensive and physically demanding sometimes. The existence of appropriate innovations and the availability of equipment to reduce working time (traction animals, ploughs, power tillers, etc.) are therefore essential for the development of agroecology. If young people link agroecology to increased and harder labour, its implementation may be at risk since can get alternative employment opportunities outside agriculture. It therefore seems particularly important to take this constraint into account in the innovations envisaged.

ORGANIC MATERIALS. Organic materials (production, collection, transfer, conservation and recycling) is central to agro-ecological transition. Even though agroecology can increase its production, the challenges to meet include the low initial availability, lack of water for its production and processing, competition for its use and limited means for its collection and recycling.

BUSINESS CONDITIONS AND ENABLING ENVIRONMENT :

› **Availability of and access to inputs** which should be appropriate and of high-quality specific to the agro-ecological transition (infrastructure, equipment, plantations, livestock, seeds, biopesticides, inputs for their manufacture, etc.) and **financing.** Lack of capital, especially among women and youth, can be a particularly strong barrier when agro-ecological innovations require a substantial initial investment or specific resources like organic manure (for instance, unavailability of organic manure).

› Existence of **Outlets and product recognitions.** Agroecology often requires sufficiently remunerative and stable markets, strong value chain relationships between stakeholders or processing facilities, especially when innovations do not result in yields significant increases. Agro-ecological products recognition relies on clear labeling, good packaging, and a suitable quality insurance systems.

ACCESS TO LAND AND NATURAL RESOURCES. A precondition for implementing agro-ecological practices is the security of land tenure and natural resources (in the short term : guaranteed crop protection, plant cover and soil development, in the longer term : land tenure security, and therefore security of benefiting from agro-ecological investments such as improving soil fertility or planting trees) that -often determine whether farmers can implement some agro-ecological innovations. In Côte d'Ivoire, a farmer asserts that “*one does not plant cajanus or mucuna on land [fallow land] that he or she does not own*”. Women's access to land is often more precarious, what may limit their interest in practices aiming at investing in agro-ecological systems and namely in improving soil fertility in the long term. They often face social and legal challenges

(transfer of land and inheritance rights, etc.) since they do not bear any legal rights to the land and are therefore dependent on their household men's decisions. To some extent, the formalisation of individual land rights and land marketing have undermined women's rights, which customary systems used to secure in terms of usufruct.

INTERVENTION METHODS AND MECHANISMS. In addition the practical sessions they attend, the opportunity of experimenting themselves in dedicated fields as well as their own farms, making any necessary adaptations, appears essential. For acceptability purpose, the same applies to the need for external intervention to take account of social realities.

PUBLIC POLICIES. Public policy framework can either facilitate or hinder the development of agroecology innovations. They can also influence farmers' perceptions of agroecology, which are often shaped negatively.

Conditions for sustainability

The external interventions aim at creating enabling conditions for innovations development. Once projects take end, these conditions vanish very often, then calling into question the sustainability of the innovations. The intervention may also end before the farmers get time to fully master and appropriate the proposed innovations.

The main conditions for the sustainability of the agro-ecological innovations identified are listed below.

ADEQUATE PROJECT DURATION to allow time for farmers to experiment with and adapt innovations, acquire new knowledge and skills, gain from agroecology investments with deferred profitability, organise themselves sustainably so as to guarantee the sustainability of favourable conditions to agroecology (see below). Effects of short-term (two to three years), single-phase projects are often not sustainable, unless being part of a pre-existing, long-term strategy on the side of local stakeholders, who can then finance part of this strategy through successive projects.

ECONOMIC VIABILITY OF INOVATIONS WITHOUT SUBSIDIES, unless governments implement long-term support systems to agroecology or pay farmers for ecosystem services.

POST-PROJECT CONTINUITY CONDITIONS: access to credit as well as suitable production resources, equipment servicing, remunerative markets, advisory support & technical exchanges and to rules & agreements with breeders in order to sustain agroecological practices and to ensure the viability of agroecological practices and the management of resources over time.



- › In Burkina Faso, evergreen hedgerows in bocage areas enable an agroecological intensification process as well as an improvement of soil health and an increase of agricultural yields.

EXISTENCE OF A COMMUNITY OR PROFESSIONAL FARMING ORGANISATION AND MULTI-STAKEHOLDER PARTNERSHIP ARRANGEMENTS (that may include local authorities, decentralised government departments, farmers' organisations, private stakeholders and NGOs), so as to permanently guarantee the conditions for the development of agroecology. Thus, this objective must be considered central right from the design phase.

Conditions for scaling-up

As regards a specific project, outdoor support helps to generate favorable conditions for the development of agroecology. Non-beneficiary farmers find it difficult to implement agro-ecological practices because they do not have access to the same enabling conditions. The multiplication of projects can contribute to a change of scale, but it seems difficult in a

given country to multiply the number of projects. The issue is therefore the creation of general conditions favourable to the development of agroecology, and consequently the existence of strong professional agricultural organisations and appropriate structural public policies. The projects can then serve as examples or beginnings of a process of innovation expansion, which implies that they are not isolated in their environment.

The conditions set out below are essential for scaling up the changes.

THE OVERALL HEALTH OF THE FARMING ECONOMY AND THE FOOD SECURITY SITUATION, so that farmers are able to take certain risks and, in addition to the immediate objectives of food security and income, integrate objectives for preserving the environment and improving the cultivated ecosystem.



› Demonstration of biopesticide production by AMEDD in Mali.



- Within a partnership between a yam producers' cooperative (COOPABA), a technical consulting firm (AGRINNOV) and the Swiss Centre for Scientific Research (CSRS) in Tieningboué in the Béré region of Côte d'Ivoire, the introduction of fertilising plants *Mucuna* and *Cajanus cajan* into crop rotations has, according to stakeholders, increased yam yields by up to fourfold.

 **FARMERS ARE TAKING FULL ACCOUNT OF THE OBJECTIVE OF IMPROVING THE ECOSYSTEM**, which raises the question of how to regulate access to land in the short term (the issue of free grazing) and secure access to it in the longer term.

 **EXPANDING THE BUILDING OF CAPACITIES AND SKILLS SPECIFIC TO AGROAEPECOLOGY.** Dr Hgaza from the Centre Suisse de Recherche Scientifique (CSRS, Côte d'Ivoire) points out that “*agroecology will not spread on its own, because it is far too knowledge-intensive*”. The projects can serve as a starting point, provided that they are followed up so as not to lose the human capital (farmers and technicians) that they have helped to build up. Radio programmes, videos and manuals in local languages disseminated to farmers via social networks and new ICTs, the creation of farmer networks and the organisation of public events (fairs, competitions) can also play an essential role.

 **SETTING UP MANUFACTURING AND DISTRIBUTION SECTORS FOR AGRO-ECOLOGICAL INPUTS AND THE NEEDED EQUIPMENT FOR APPROPRIATE MECHANISATION.**

 **SETTING UP AGRICULTURAL FINANCING FACILITIES** to improve the overall health of the peasant economy and finance investment in the agro-ecological transition. Subsidies for certain experiments and investments may also be compulsory.

 **AVAILABILITY OF A FAVOURABLE INSTITUTIONAL AND ECONOMIC ENVIRONMENT** that does not create bias in favour of non-agroecological agriculture, or even favours agroecology agriculture (subsidies, funding, technical advice, etc.).

 **AVAILABILITY OF PROFITABLE OUTLETS** for agro-ecological products, especially in situations where differentiated prices appear necessary for the development of innovations.

 **AVAILABILITY RULES AND AGREEMENTS** with livestock farmers for the management of land and natural resources, to guarantee the viability of agroecology practices.



› Within the ACF project (Burkina Faso), the production and use of bokashi contribute to restore soil fertility.

Public policy recommendations

To boost the sustainability and scaling-up of agroecology innovations, the following recommendations are addressed to local, national, and regional authorities:

INTEGRATING AGROECOLOGY INTO AGRICULTURAL POLICY

- Promote agroecology as a key strategy of agricultural development.
- Establish harmonised regional indicators to distinguish public funding granted to agroecology versus the one granted to conventional agriculture.
- Ensure, for purpose, that agroecology interventions (programs and projects) have a minimum duration of six years or comprise multiple successive phases, with sustainability considerations integrated from its design phase.

FUNDING

- Facilitate access to international funding for the purpose of agroecology initiatives through training and information systems targeted at agroecology stakeholders, especially farmer organisations.
- Set up agricultural credit mechanisms focused on domestic farming and prioritising agroecology investments and equipment to reduce labour intensity, particularly for women and youth. Promote local savings and credit initiatives at the village level.

TRAINING, RESEARCH AND FARM ADVISORY SERVICES

- Overhaul agronomy curricula at universities and college to place agroecology at the core and provide upskilling for trainers.
- Align research topics with farmer priorities, through a) greater involvement of farming organisations in defining agroecology research priorities and topics; b) conducting studies to identify, capitalise on and enhance traditional agroecology practices and c) better assessing of the effects of agroecology practices and the conditions necessary for their development, in order to specify notably the public policies to be undertaken.
- Integrate agroecology and genuinely participative approaches (selection of topics and types of experimentation, peer exchanges and training) as a focus of agricultural support advice, namely for women and young people. Disseminate successful agroecology innovations (for instance : public competitions, fairs, broadcasting programs, digital platforms, etc.).

BUSINESS ENVIRONMENT AND REGULATIONS

- Support the growth of agroecology inputs and processing industries with recognition and protection of farmers' traditional knowledge and practices of bio-inputs and establish standards to prevent them from being impounded for commercial purposes. Better regulate the use of chemical pesticides with a ban on the most hazardous.
- Promote the establishment of agroecology products processing activities and industries including the certification schemes, value chains, and public procurement policies for agro-ecological products. Raise consumers' awareness on their benefits.

MULTI-STAKEHOLDERS' PARTNERSHIPS AND COOPERATION

- Support multi-stakeholders' partnerships among farmers' organisations, research institutions, advisory bodies and sectors upstream & downstream stakeholders for the promotion of agroecology as well as stable and profitable value chains.
- Facilitate local agreements between farmers and breeders on land and resource use to safeguard the sustainability of agroecological systems in order to integrate farmers and breeders in a participative agroecology transition. Encourage inclusive land governance reforms to improve access for women and youth. Encourage local authorities to free up land, especially for women sake for agroecology farming purpose. Initiate, for purpose, land law reforms to support these changes.
- Reinforce multi-stakeholder platforms and networks to promote knowledge-sharing, cooperation and business partnerships.



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