Proceedings of the 2nd African Forum on Synecoculture

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Sony CSL

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INTRODUCTION

Agriculture contributes to the conservation and sustainable use of biodiversity, but it is also one of the main drivers of serious biodiversity loss we face today. Indeed, land clearing, monoculture and the use of synthetic products in the fields are the main causes. Farmers and agricultural producers are custodians of agricultural biodiversity and need to have the knowledge to manage and maintain it, hence the importance of synecoculture.

Synecoculture is based on the augmentation of biodiversity, therefore the intensive introduction of plants by humans. It is a method of field cultivation based on the association of plants in function of their symbiotic interactions with soil, environment and other plants. This makes it possible to produce useful plants in a state of ecological optimum by making the best use of the characteristics of each plant by building and controlling the ecosystem. Synecoculture is done without plowing, without weeding, without fertilizers or pesticides.

Synecological agriculture has been developed in Japan and is being introduced in Burkina Faso. It is in this dynamic that the African Center for Research and Training in Synecoculture (CARFS) was born of the joint initiative between AFIDRA and Sony Computer Sciences Laboratories, Inc., following the first African Forum on Synecoculture held on 19 to 21 October 2016 in Fada N'Gourma. Supported by the Goverment of Burkina Faso, Sony Computer Sciences Laboratories, Inc. of Japan and UniTwin UNESCO Complex Systems Digital Campus (CS-DC), CARFS is an international institution with new high-level training initiatives.

Thanks to the technical and financial support of Sony Computer Sciences Laboratories, Inc. and CS-DC, AFIDRA through CARFS organized the 2nd African Forum on Syneculture from 24 to 26 May 2017 in Fada N'Gourma under the theme "Synecoculture: Achieving an agriculture that increases biodiversity". This underscores the importance of sustainable agriculture, not only to preserve biodiversity, but also to feed the world and realize sustainable agricultural livelihoods.

The forum was held under the patronage of Mr. Jacob OUEDRAOGO, Minister of Agriculture and Hydraulic Development (MAAH) of Burkina Faso, and brought together experts from agroecology and rural development from several African countries to tackle the problematics and recognize the importance of the reconstruction of biodiversity in the semi-arid tropics.

During three days, the experts of the synecoculture, Dr André TINDANO and Dr Masatoshi FUNABASHI and the ethnobotanist Prof. Patrice ZERBO, enriched the discussion with participants on the themes of the successful start-up strategy of a syecoculture farm, syneroculture in the world, and the enhancement of phyto-genetic resources in Africa.

This forum was attended by 52 researchers, students and agricultural practitioners from 7 countries in sub-Saharan Africa. New research agreement around syecoculture and subscription to CARFS training courses were formed through the communication during the forum.

Chapter I: Lecture note of the symposium

Lecture note of the Forum on Synecoculture held from 24 to 26 May 2017

The opening ceremony was chaired by Colonel Ousmane TRAORE, governor of the Eastern Region represented by his technical advisor. It was punctuated by two speeches: That of Maurice Y. LOMPO, President of l'Association de Formation et d'Ingénierie du Développement Rurale Autogéré (AFIDRA) and the opening speech of the governor of the East region read by its technical advisor. Both welcomed the participants and expressed the view that this forum is timely as it will allow participants to better understand the concept of syecoculture and to reinforce the achievements of the first forum.
Before the opening remarks, Mr. André TINDANO, general secretary of AFIDRA gave a brief presentation of this structure: From this presentation, AFIDRA is a technical structure whose objective is to improve the living conditions of populations through action, research and training, with a view to developing their intrinsic self-management capacities in a quality environment.

DAY I: 24 May 2017

The first day was marked by three presentations:

First presentation: Valorization of Plant Genetic Resources in Africa: Issues and Perspectives, led by Patrice ZERBO, PhD Lecturer in Ethnobotany - Ethnopharmacology at the University of Ouagadougou 1 Pr Joseph KI-ZERBO, Laboratory of Plant Biology and Ecology

Definition - Location

According to the UN Convention on Biological Diversity (UN-CBD), a plant genetic resource (PGR) is the plant material (plant, seed, leaf, ...) containing functional units of heredity, having an actual or potential value.

Plant genetic resources can:
• come from wild or cultivated floras;
• be taken in situ (place of origin) or ex situ (botanical gardens, gene banks or samples (seeds, genes, etc.);
• be found in terrestrial (including aerial) and marine environments.

Ecosystem services of plant genetic resources (PGRs)

According to the United Nations Millennium Ecosystem Assessment, the benefits of the PGRs by populations can be divided into four main categories:
• Provisioning services: food, wood and fiber;
• Regulatory services: climate, flood, disease, waste and water quality;

• Cultural services: spiritual, recreational and aesthetic benefits;
• Supporting services: photosynthesis, soil formation and nutrient cycling.

Role: Biodiversity for Food and Agriculture (BAA)

In Burkina Faso, BAA plays an important role in improving food security and diversifying people's livelihoods.

There are mainly:
• the ecological role of plants or forest formations;
• the role of biological diversity as a source of food for populations;
• the role of biodiversity for health and nutrition;
• the socio-cultural role;
• the role in tourisme.
For example, some plants are used to improve soil fertility through their atmospheric nitrogen-fixing capacities: woody leguminous plants (Acacias ssp, Faidherbia albida, Crotalaria ssp, ...) and herbaceous legumes (Tephrosia purpurea, Alysicarpus ovalifolius, Alysicarpus glumaceus, ...).
Many plant species are cultivated and contribute to food security and income generation for more than 80% of the population in Burkina Faso: cotton, sesame, nut grass (Cyperus esculentus), etc.

Roles of forest resources

Forest resources make a major contribution to food and nutrition security in Burkina Faso through Non-Timber Forest Products (NTFPs). NTFPs provide the diet and nutritional balance of more than 43.4% of households in Burkina Faso, providing 23% of income and employment to rural households. Approximately CFAF 25.6 billion has been generated from NTFP operations and has created an increasing number of small and medium-sized forestry enterprises (MEEVCC).

Factors of degradation of plant genetic resources (PGRs)

However, the degradation of PGRs (timber or non-timber) is perceptible in the various ecological zones of the continent but more in the Sahelian zone (in Burkina Faso). Several factors are at the root of this phenomenon:
• Drought ;
• overexploitation of forest resources (wood, PF, NTFP);
• the impact of agriculture and livestock on vegetation;
• climate change;
• the development of the mining sector with a rapid increase in the number of gold-washing sites. Their presence in forests with the application of toxic polluting chemicals (mercury, cyanide) contributes to decimate the flora and destroy their habitats.
• the decline in rainfall which results in the displacement of isohytes from north to south;
• the bad practice of bushfires in the Sudanian part destroys the flora, changes its floristic composition and modifies its habitat;
• the reduction of water resources linked to climatic hazards;
• the silting / silting up of the water bodies contributing to their drying and thus limiting the amount of water for the flora;
• direct industrial pollution and the drainage of acid from mining industries;
• poor agricultural practices characterized by widespread use of herbicides in many localities;
• the use of cotton pesticides in market gardening that has an impact on the microplankton.

Need for Sustainable Management of Plant Genetic Resources (PGRs)

Consequence: disappearance by decade of 0.1% of species. Faced with this alarming decrease in PGRs, NGOs very sensitive to environmental problems, have led conferences at the international level: Stockholm 1972, Rio de Janeiro 1992, Johannesburg 2002, Nagoya 2010, ... These stressed the need to promote a management for sustainable use of natural resources. This necessity concerns, first and foremost, the African countries which contain the bulk of these biological resources and whose economy and development are based on these resources.

Questions

How can African nations reconcile their urgent needs for socio-economic development with the absolute necessity of preserving the biodiversity whose exploitation to date is the foundation of this development?

How can biodiversity contribute to achieving the sustainable development goal targeted by African countries?

Good management of PGRs

Activities related to plant genetic resources (PGRs) or management (defined by FAO etc.) are grouped into four flagship actions:
• Inventory,
• the caracterization,
• valuation (management),
• the conversation. Most terms are difficult to dissociate (management, protection, valorization, ...

Management of PGRs / Agriculture

The objective of research on the management / protection of PGRs of interest to agriculture is to help reverse the trend of:
• depletion of resources,
• environmental degradation and
• erosion of the genetic heritage ..... in order to satisfy the daily, present and future needs of local populations, particularly in the medical, agricultural, economic, social and cultural fields.

Strategies for Managing PGRs

As in other countries, the sustainable management of PGRs has always been a concern in Burkina Faso:
• constitutional, legislative and regulatory provisions are made for different plant species;
• projects and programs on variety selection are carried out in the different research and higher education structures for the maintenance and improvement of the main cultivated and semi-domesticated species.

Burkina Faso opened very early (1960) to research activities related to the management of PGRs through the establishment of partnerships and collaboration between research structures (INERA), higher education (Universities) and the Ministry of Agriculture (Directorate of Agricultural Services, DSA):
• More than 5000 ecotypes of cereals: millet, sorghum, maize, rice, fonio;
• 1950 ecotypes of all other crops: cowpea, voandzou, soya, peanut, fabirama, yam, okra, *Cucurbitaceae* (melon, watermelon, squash, ...);

The ethnoplurality of Burkina Faso is accompanied by a great diversity in the domesticated vegetation. According to Balma, agricultural production of cultivated plants is ensured by traditional cultivars, most of which are domesticated on the spot, from wild types. At least 60 crop plants are counted:

• 6 species of cereals;
• 4 species of legumes;
• 7 tuber / root species;
• 5 cash crops;
• 28 species of vegetable crops;
• 12 species of fruit-bearing arboriculture;
• 4 species of forage plants

In situ conservation of PGRs

Two options are possible: in situ conservation and ex situ conservation

In situ conservation is conservation in the field. It allows species to continue to evolve by adapting to changes in the environment; Good *in situ* conservation of agricultural diversity requires the involvement of local communities that have developed and protected plants, which form the basis of sustainable agriculture through their traditional know-how.

Ex situ **conservation**

Ex situ conservation involves preserving species outside their natural habitat, in botanical gardens and zoological animal parks, or in gene banks with cold chambers where all conditions are controlled: Some authors have noted that *ex situ* conservation is very important for the conservation of seriously threatened plant species. However, it is difficult to carry out because of the size of samples needed to be retained.

Perspectives

• make an inventory of resources already available;
• identifying ecological zones where genetic diversity is threatened with extinction;
• define exploration and collection programs;
• to promote the creation of a national gene bank (ex situ and in situ) with a multidisciplinary vocation;
• encourage and harmonize technical and scientific exchanges with regional, inter-regional and international gene banks;
• to stimulate and enhance partners' technical, scientific and financial interventions;

• encourage the development of the use of local genetic heritage;
• to assess genetic diversity in order to provide the breeder with genetic resource whose useful characteristics are immediately exploitable;
• to sensitize urban and village populations on the highly deplorable risks of genetic erosion that can be caused by all excessive and uncontrolled activities of human, animal and nature itself;
• to work for the training of researchers, technicians and farmers wishing to work in the field of conservation and use of PGRs;
• share the benefits of PGRs between the provider and the user. Nagoya Protocol on Access and Benefit-Sharing (ABS), the 3rd pillar of the UN Convention on Biological Diversity (CBD Nagoya Protocol Oct. 2010), is seen as a key element in promoting conservation and sustainable use of biodiversity.

This sharing is based on the recognition by the CBD of the sovereignty of states over their natural resources, including genetic resources. In principle, it is no longer possible to use the plant genetic wealth of a country without obtaining its consent and offering it a mutually agreed financial / nature counterpart. This ABS mechanism advocates greater fairness and legal certainty in the use of PGRs and encourages the preservation of biodiversity (Burkina Faso: ratified Sept. 2011)

Introducing new crops:

• neglected plants or during periods of famine;
• valorize the traditional know-how (= inculturate our current practices) for the management of PGRs following the harmful consequences of modern techniques;
• identify and reintroduce the plants used before;
• struggles (against insects, fungi, ...);
• seed conservation;
• cultural practices that have been able to cope with variations in weather (Zaï, demi-lune, ...), water management, etc.

Perspectives : Zaï

Zaï or pooled cultures is a traditional technique rehabilitated in Yatenga. This method is useful on hardened and non-productive degraded soils, as it retains runoff water and makes the soil fertile again.

Half-moons: semi-circular basins from 2 to 6m allowing to exploit poor lands. This method is effective for precipitation below 600mm. One can expect to produce about one ton of grain sorghum per hectare.

Conclusion

Agriculture in Africa is nowadays confronted with the impact of an intensification that has considerably reduced the numbers of cultivated species. This intensification has also replaced many local varieties with elite varieties. In addition, traditional techniques have been abandoned! Given the predictable growth of the population, it is necessary to judiciously combine the technologies available to agriculture, while paying attention to the impact of this technology on PGRs.

RPGs are of vital importance to our countries. However, several factors are already influencing their fate in arid zones and could be even more serious in the future if we continue to ignore them. Despite the establishment of a structured set of laws and regulations for the purpose of rational management, the valuation (inventory, characterization, protection) of the various PGRs should be carried out with the population. A continuous awareness of the different strata of the population is therefore necessary.

<u>Second presentation</u>: State of art of synecoculture in the world, by Masatoshi Funabashi, international expert on synecoculture.

He begins by exposing the Reference Articles:
· All published articles on synecoculture are in the website of Complex Systems Digital Campus e-laboratory: Open Systems Exploration for Ecosystems Leveraging: https://www.elab-ose4el.net/
· Practical manual for the installation and management of synecoculture, mainly in temperate zones: https://www.elab-ose4el.net/?p=327 (Version in 3 languages: French, English, Japanese)
· The results of the production at the Tapoa region 5/2015 - 11/2016: https://www.elab-ose4el.net/?p=394 (Version in 2 languages: French, English)

· YouTube channel of the Synecoculture Project:
https://www.youtube.com/channel/UCUNMrmlW3uy7RzW56jawBbA
· Video of the 1st African Forum on Synecoculture, 19-21/10/2016, Fada N'Gourma: https://www.youtube.com/playlist?list=PLi69deRLkCayrdnSbkdz-In7knc3tQtRI

· Plant Biotechnology Vol. 33, No.4 Special Issue : Environmental responses of plants

- 3 articles on synecoculture:
- Review: Masatoshi Funabashi "Synecological farming: Theoretical foundation on biodiversity responses of plant communities." Vol. 33 (2016) No. 4, 213-234
- Preface: Tsuyoshi Mizoguchi, Masatoshi Funabashi "Environmental responses of plants: Biological interactions in the homogenous population or community (mixed populations)" Vol. 33 (2016) No. 4, 211-212
- Original Paper: Kousaku Ohta, Tsuyoshi Takeshita, Masatoshi Funabashi, Shoji Oda "Naturally grown rucola, Eruca sativa, contains more α-linolenic acid than conventionally grown rucola" Vol. 33 (2016) No. 4, 277-279

Then he gives the **Definition of Synecoculture**:

- Synecoculture farming is an open-field crop cultivation method, which restricts the use of tillage/fertiliser/pesticide/herbicide. It requires nothing but seeds and seedlings to produce useful plants in ecological optimum state. This is accomplished through careful control of the ecosystem by exploiting the natural characteristics of the plant.
- It is a mixed culture of useful plants with high diversity and density (100-200 + species / 1000m^2)

State of art of synecoculture in the world: Japan

Pilot Farm organized by Sakura Shizen Jyuku co.
· Diversity: ~ 250 species (700 varieties) of production
· Area: 3000m^2 in Ise city, Mie prefecture
· Population impacted: 6000 consumers during 2010-2016
· 4000 access / day to pilot farm website
· 200 family gardens and small farms
· The geographical distribution of synecoculture farms in collaboration with Sony CSL in Japan, Taiwan and Burkina Faso

Mr. Masatoshi Funabashi also gave presentation at international conferences including CBD-COP13 (The Thirteenth Meeting of the Conference of the Parties to the Convention on Biodiversity)

Upcoming conference

Smart Africa'17 in the Smart Continent'17 series organized by the UniTwin UNESCO Complex Systems Digital Campus
Objective: Organization of a transdisciplinary team (scientists, practitioners, institutions, etc.) to solve the problems in Africa in relation to the 17 Sustainable Development Goals by 2030 United Nations, and set up a session of synecoculture

Summary of the Proceedings of the 1st Forum on Synecoculture

Q: What distinguishes synecoculture from other modes of agriculture?

R: Productivity and Ecosystem Recovery (Figure 1).

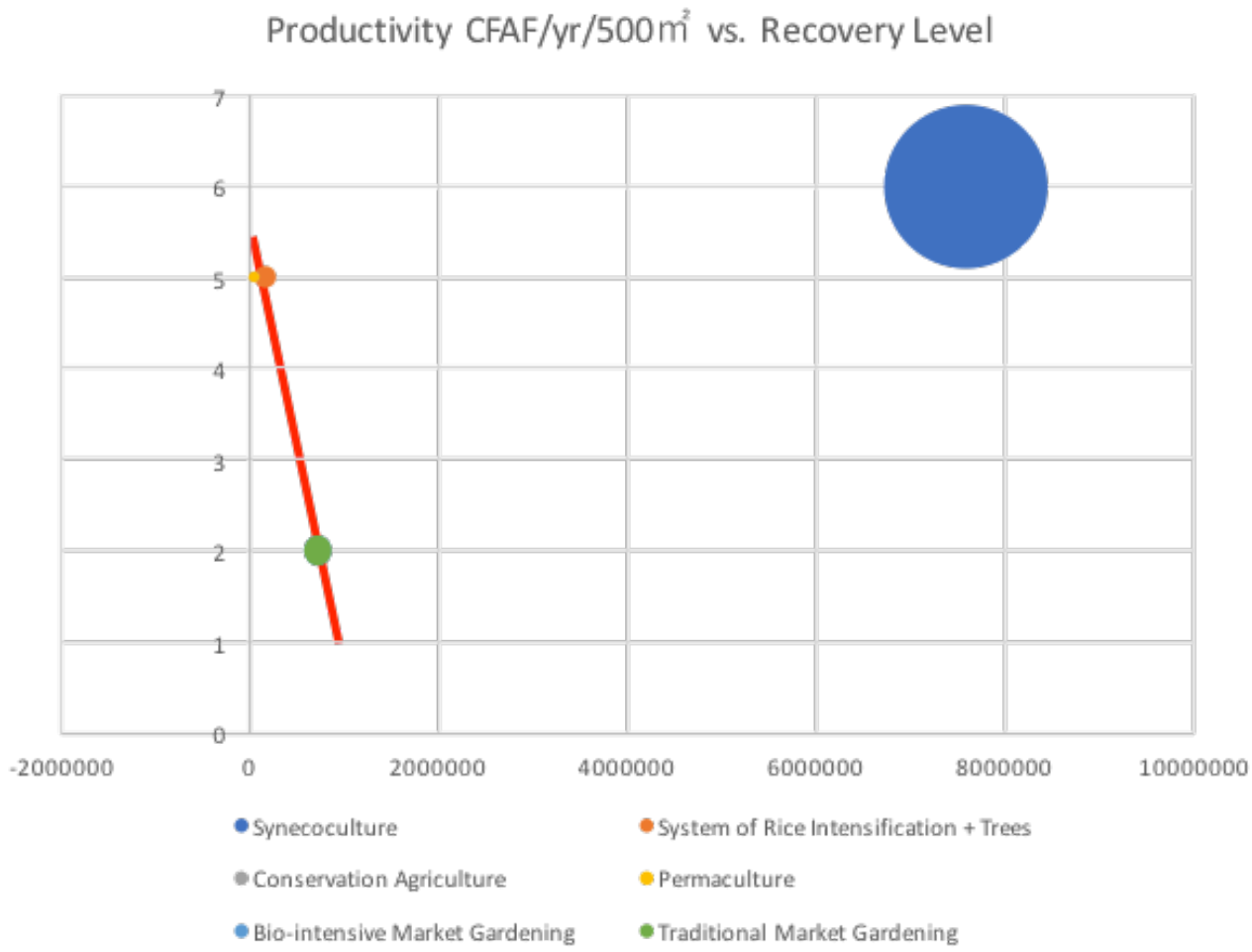

Figure 1. Productivity (X axis) versus ecosystem recovery level (Y axis).

Level of ecosystem recovery in vertical axis:

Level 6: Shade tolerant trees

Level 5: Grasses, shrubs and trees intolerant to shade

Level 4: Grasses and perennials

Level 3: Small annuals and lichens

Level 2: Lichens

Level 1: Bare rocks, sands

- Q: Why is it possible?
- R: Increasing plant diversity and density achieves more productive and resilient ecological optimization, which becomes especially advantageous in the Sahel environment.

Statistics of the experiment in Mahadaga

- 150 species introduced in 500m^2
- Healthy growth of the mixed community
- Harvest 2015 / 6 - 2016 / 11: 865-1053 Euros / month / 500m^2, 1 person working 20hr / week
- In total, 20 times higher than the per capita GNI of Burkina Faso
- 50 times more than the absolute monetary poverty threshold in Ouagadougou
- 40-150 times more productivity than conventional farming

Estimated Future Impact in Burkina Faso

- The sales of the products from 10m^2 with synecoculture reaches the minimum wage for life out of poverty in Ouagadougou

- 7,000 hectares of synecoculture could totally eradicate poverty in Burkina Faso while completing the Aichi 2020 goals and also the 2030 Sustainable Development Goals of the United Nations.
- Which creates 140,000 job opportunities
- Train 10 farmers at each of 13 regions in Burkina Faso, who transmit the know-how to the other 10 farmers in the region next year: The objectives are achievable in 4 years.

Where is the initially trained 130 people from 13 regions, is the rate of knowledge transmission, i.e. 10 people per year by a person already trained in synecoculture.

Objectives of Production and Distribution in Synecoculture

- "Re"-introduction of products grown in natural state into our food systems
- Integration of environmental and health measures with respect to the evolutionary scale of our metabolism

Biodiversity: Source of nutrition

- Expression of various bioactive compounds from ecological interactions
- Primary metabolite: Carbohydrates, lipids (omega 3 fatty acids), minerals (Na, K, Mg, Ca)
- Secondary metabolite: Terpenoids (carotenoids), polyphenols (flavonoids), alkaloids

Sub-Saharan Africa: harbinger of the land of tomorrow for all countries

- The growth of agricultural emission will be highest in Asia and sub-Saharan Africa, which corresponds to 2/3 of the growth of food demand in 2050 in the world.

<u>3rd presentation</u>: Installation of synecoculture field, led by Mr. Masatoshi Funabashi

- Discussion of strategy in 4 teams:
    1. Maximum diversity
    2. Maximum productivity
    3. Minimum cost
    4. Minimum risk

Group one

Subject: Maximum Diversity

- We propose three strategic axes for maximum diversity in the new farm of Fada N'Gourma:
- The conservation of all the vegetation found on site with the FMNR (Farmer-Managed Natural Regeneration)
- The introduction of plants according to their use (forage, traditional medicine, human food, cosmetics, etc.)
- Introduction of stockbreeding

Group two

Subject: Maximum Productivity

- We propose strategies for maximizing productivity such as:
- Setting up a reliable water source
- Introduction of high productivity plants
- A strong diversification and integration between plant and animal production

Group three

Subject: Minimum cost

- We propose as actions to reduce the cost:

- Long-term investment: put a wire fence and stabilize it with a hedge
- Use local species
- Harvest and produce the seeds ourselves and valorize local edible species that are not considered as such

Group four

Subject: Minimal risk

- For operational challenges and motivation, use a franchise type model based on the experience in Tapoa.
- Model AFIDRA: Rather than having extension agents who receive a full-time salary after implementation, they will essentially "rent" AFIDRA's assets and make a living from their training, extension services and sales of agricultural products as well as the benefits of the farm. This helps to maintain motivation not only for production, but also for equipment maintenance.

DAY II: May 25th 2017

The second day started with a presentation of Mr André TINDANO, General Secretary of AFIDRA and representative for practical activities:

The presentation focused on: **Successful Start of a Synecoculture Farm**

Implementation Strategy

For the implementation of a synecoculture farm, the following actions must be undertaken:

- Establishment of a nursery
- Conservation of existing species
- Transplanting seedlings during the winter season
- The presence of a water point
- Protection of the farm against animals and bush fires
- Implementation of a development plan

The association of certain plants with each other makes it possible to obtain good harvests and to establish a beautiful vegetable garden by helping the gardener to avoid the use of inputs.

This is the goal of Synecoculture.

This method requires observation and practice; it is very controversial but why not try!

Association Strategy

To associate the plants, some principles are to know:

- Apiaceae (also called umbelliferae) protect each other.
- Legumes enrich the soil with nitrogen. Associating them with plants such as tomato or cucurbitaceae, which need this contribution, enriches your farm.
- Liliaceae and legumes should be separated because they do not mix well.

Certain aromatic plants, thanks to their particular odors, can remove or even eliminate harmful insects.

Some examples of plant association (Source: Wikipedia)

- **Garlic** and onion keep insects away in general. It goes well with carrots, beets, strawberries and tomatoes. Do not plant garlic near cabbages, beans and peas.
- **Dill** protects carrots and cucumbers. Do not hesitate to plant them together.

- **Basil** is a strong repellent for flies and mosquitoes. It combines perfectly with tomatoes, asparagus, peppers, peppers, eggplants.
- **Borage** attracts bees, scavenges slugs, reduces Colorado potato beetles, moves worms away from tomatoes. It grows well with potatoes, zucchini, cabbage, strawberries, tomatoes.
- **Nasturtium** attracts aphids (then you will only need to pull out the nasturtiums and burn them), removes bugs from zucchini and pumpkins. She adapts with radishes, zucchini, cabbage, tomatoes.
- **Mucuna** reduces the invasion of slugs.
- **Lavender** keeps away aphids.
- **Marigolds** will protect most of vegetables (potatoes, tomatoes, asparagus, beans, cabbages) from pests. To plant on the edge of your garden.
- **Thyme** keeps away white flies, protects cabbages and broccoli.

The field trip and practical work allowed participants to see and better understand the practical implementation of a synecoculture farm.

Photo: Dr. Masatoshi FUNABASHI explaining the implementation strategy of synecoculture in a situation of small production.

DAY III: May 26th 2017

The third day was devoted to the presentation of the African Center for Research and Training in Synecoculture (CARFS) made by Drs André TINDANO and Masatoshi FUNABASHI.

The African Center for Research and Training in Synecoculture is a center specialized in professional training which contains synecoculture. Its mission is to provide the rural world and development agencies with qualified human resources. CARFS is a hub of meeting and exchange between professionals in the rural sector. Thus, it intends to train women and men by allowing them to obtain prestigious diplomas that will make them international experts in rural development with knowledge on synecoculture, to maximize their employability in development projects and programs.

Based on CARFS, the resources of collaboration in synecoculture (Figure 2), its organizational structure (Figure 3), its academic interface (Figure 4) and administrative interface (Figure 5) were presented in schematic form.

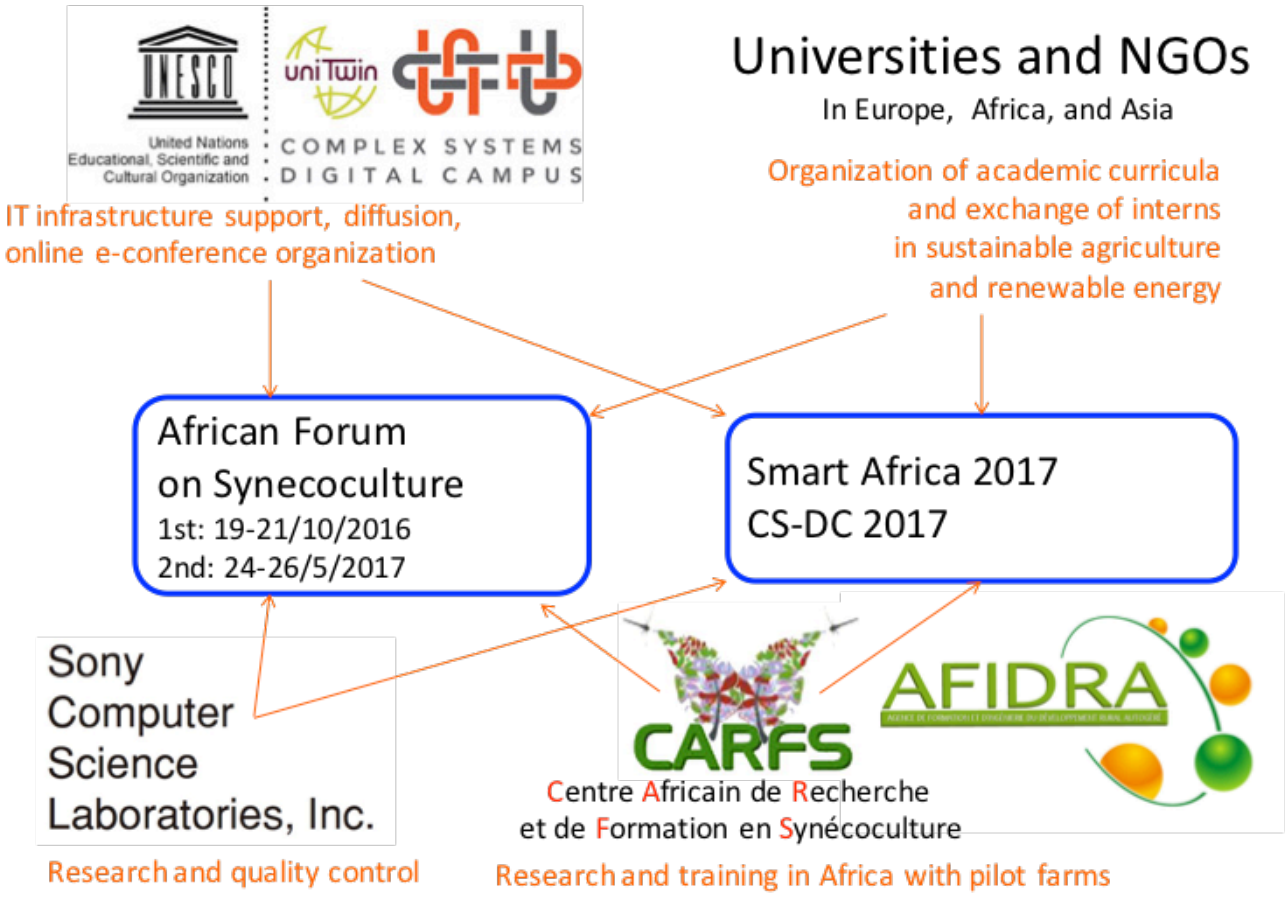

Figure 2. Resources of collaboration in synecoculture.

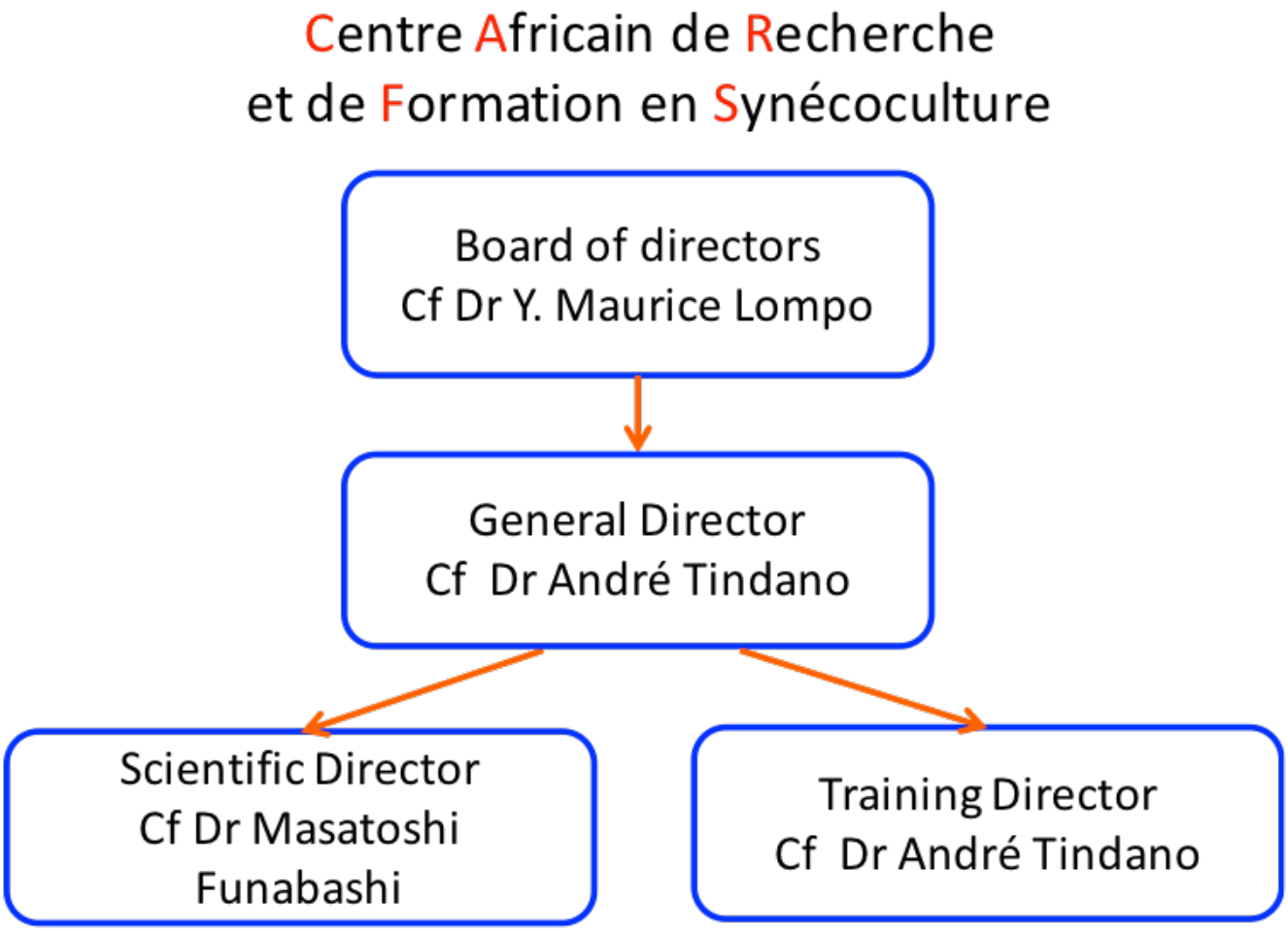

Figure 3. Organizational structure of CARFS.

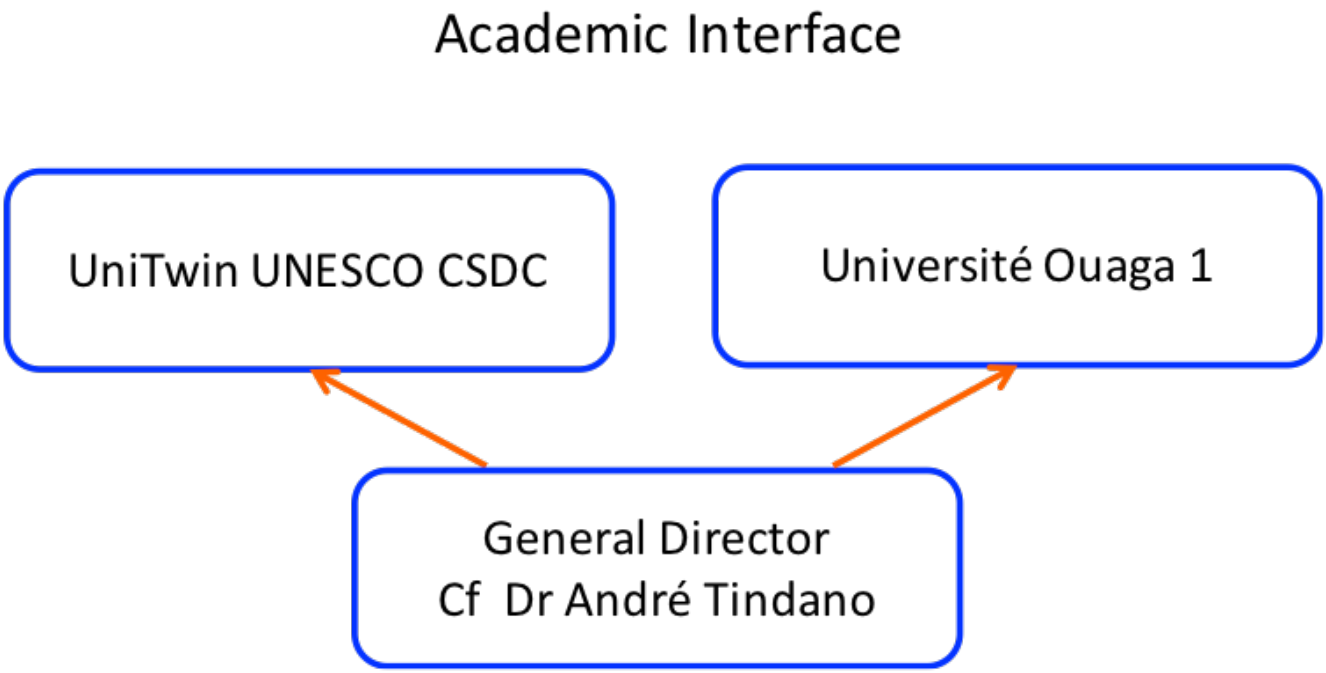

Figure 4. Academic interface of CARFS.

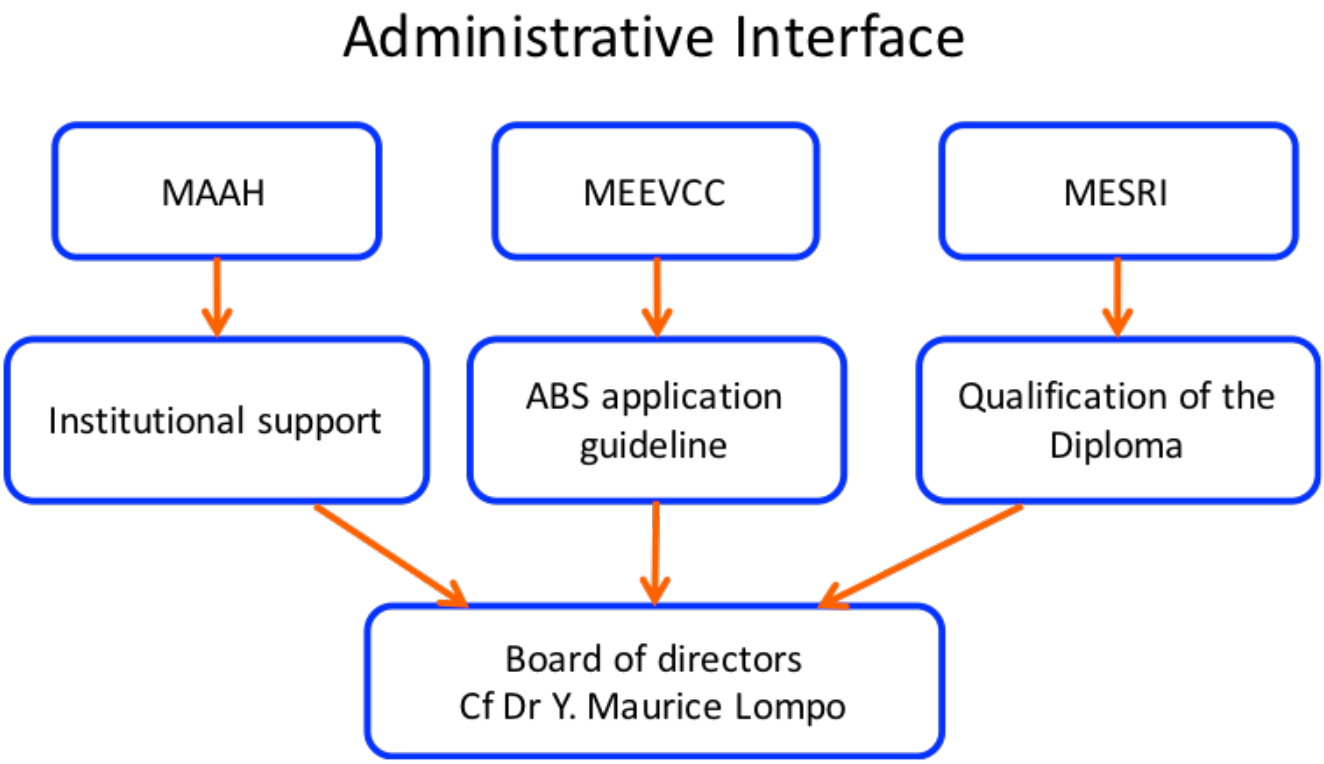

Figure 5. Administrative interface of CARFS.

The scientific committee is henceforth composed of:

- Prof Patrice ZERBO
- Committee of Sony CSL

The forum ended with taking a group picture and handing out the certificates to the participants.

Presentations are filmed and broadcast as an e-event of UniTwin UNESCO Complex Systems Digital Campus. The videos are available on the CARFS website.

Written at Fada N'Gourma on 09/06/2017

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Chapter II: Reports

II.1 Results of the pilot farm in Mahadaga, East region, Tapoa province, Burkina Faso

The tables in this section summarize the productivity and associated costs of synecocuture and 5 other cultivation methods (System of Rice Intensification (SRI) + Trees, Conservation Agriculture, Permaculture, Traditional Market Gardening and Bio-intensive Market Gardening), experimented simultaneously at the pilot farm in Mahadaga between June 2016 - May 2017. The productivity of synecoculture between June - November 2016 is already published in the proceedings of the 1st African forum on synecoculture (Tindano 2016), as well as the definitions of the cultivation methods.

Table 1. Synecoculture productivity (price in FCFA / month / 500m²) in December 2016 - May 2017

	Productivity in December 2016 - May 2017					
Products (in French)	**December**	**JanuaryF**	**ebruary**	**March**	**April**	**May**
Ail	13200	13100	13400	11200	11400	11200
Banane	12400	11200	12500	12500	12400	12500
Betterave	12000	11500	12500	12500	12000	12500
Bissap	20200	20200	20200	20200	20200	20200
Calebasse	9000	9500	5000	5000	5000	5000
Carotte	12100	11100	12100	12100	12100	12100
Chou brocoli	11200	10200	11200	11200	11200	11200
Chou pommé	12300	12100	12600	12600	12300	12600
Citron	16100	16000	15100	15100	16100	15100
Citrouille	10100	10000	11100	11100	10100	11100
Concombre africain	12150	11550	12150	12150	12150	12150
Courge	11200	10200	11200	11200	11200	11200
Courgette africaine	12100	12100	12100	12100	12100	12100
Epinard	11800	10500	11800	11800	11800	11800
Fausse oseille de Guinée	11100	11100	11100	11100	11100	11100
Gombo	12000	10000	12000	12000	12000	12000
Goyave	22100	22100	20700	20700	22100	20700
Haricot mangetout	10000	9000	10000	10000	10000	10000
Haricot vert	9000	9000	9000	9000	19000	9000
Ignam	15600	15600	15600	15600	15600	15600
Manioc	10500	10500	10500	10500	10500	10500
Melon	9300	7300	9300	9300	9800	10300
Moringa	35000	35000	47000	47000	45000	45000
Mucuna	10500	9500	9000	9000	10500	9000
Oignon	11800	11800	9000	10000	11800	10000
Oseille de la brousse	9500	7500	15600	15600	9500	15600
Papaye	9000	9000	10500	11500	9000	11500
Paprika	9400	2400	7300	7300	9400	7300
Pastèque fourragère	11300	10300	35000	21500	11300	21500
Pois d'Angole	10750	10750	9500	9500	10750	9500
Pois de terre	15150	9150	11800	11800	15300	11800
Poivron	11200	9200	7500	7500	11200	7500
Tomate	8750	5250	9000	19000	8750	21300
Somme Totale	417800	383700	442350	438650	432650	439950

Table 2. Number of harvest days / month of synecoculture in December 2016 - May 2017

	Number of harvest days / month in December 2016 – May 2017					
Products (in French)	**December**	**January**	**February**	**March**	**April**	**May**
Ail	6	6	6	6	6	6
Banane	8	8	8	8	8	8
Betterave	6	6	6	6	6	6
Bissap	8	8	8	8	8	8
Calebasse	6	6	6	6	6	6
Carotte	8	8	8	8	8	8
Chou brocoli	9	9	9	9	9	9
Chou pommé	8	8	8	8	8	8
Citron	11	11	11	11	11	11
Citrouille	10	10	10	10	10	10
Concombre africain	12	12	12	12	12	12
Courge	9	9	9	9	9	9
Courgette africaine	8	8	8	8	8	8
Epinard	20	20	20	20	20	20
Fausse oseille de Guinée	15	15	15	15	15	15
Gombo	10	10	10	10	10	10
Goyave	9	9	9	9	9	9
Haricot mangetout	12	12	12	12	12	12
Haricot vert	12	12	12	12	12	12
Ignam	9	9	9	9	9	9
Manioc	8	8	8	8	8	8
Melon	10	10	10	10	10	10
Moringa	30	30	30	30	30	30
Mucuna	8	8	8	8	8	8
Oignon	9	9	9	9	9	9
Oseille de la brousse	8	8	8	8	8	8
Papaye	8	8	8	8	8	8
Paprika	9	9	9	9	9	9
Pastèque fourragère	10	10	10	10	10	10
Pois d'Angole	10	10	10	10	10	10
Pois de terre	15	15	15	15	15	15
Poivron	15	15	15	15	15	15
Tomate	15	15	15	15	15	15

Table 3. Costs of seeds and works

Methods	Seed cost FCFA/ season	Number of working people	Working hours	Period of work (Season)
Synecoculture Jun - Nov 2016	0	1	20h/week	June to November
Synecoculture Dec 2016 - Mai 2017	0	1	20h/week	December to May
System of Rice Intensification + Trees	125000	2	4h/day ; 5day/week	May to November
Conservation Agriculture	130250	2	4h/day; 6day/week	May to November
Permaculture	146200	2	6h/day; 6day/week	May to November
Bio-intensive Market Gardening	376250	2	6h/day; 6day/week	November to May
Traditional Market Gardening	176250	2	6h/day; 6day/week	November to May

Table 4. Costs of materials normalized with 500m^2.

Methods	Water cost CFAF / season / 500m^2	Total inputs CFAF / season / 500m^2	Total tools CFAF / season / 500m^2
Synecoculture Jun - Nov 2016	43725.00	0	52984.17
Synecoculture Dec 2016 - Mai 2017	73070.00	0	34984.17
System of Rice Intensification + Trees	74945.00	5000.00	41542.80
Conservation Agriculture	0	1250.00	49990.37
Permaculture	0	3812.50	49990.37
Bio-intensive Market Gardening	124315.00	106250.00	36873.10
Traditional Market Gardening	107545.00	67500.00	36873.10

Table 5. Productivity, efficiency, and profitability of the methods. Parameter definitions are: Water efficiency = Productivity / Cost of Water; Work efficiency = Productivity / Cost of work; Materials efficiency = Productivity / Cost of tools and total inputs; Total efficiency = Productivity / Total cost; Profitability = Productivity - Total cost.

Methods	Seasonal Productivity FCFA/season/500m^2	Water efficiency	Work efficiency	Materials efficiency	Total efficeincy	Seasonal Profitability FCFA/season/500m^2
Synecoculture Jun - Nov 2016	3807700	87.08	14.60	71.86	10.65	3450276.54
Synecoculture Dec 2016 - Mai 2017	2555100	34.97	9.80	73.04	6.93	2186331.54
System of Rice Intensification + Trees	375650	1.00	0.61	1.61	0.31	-168643.52
Conservation Agriculture	295750	-	0.40	0.29	0.17	-73138.58
Permaculture	266500	-	0.24	0.25	0.12	-95506.44
Bio-intensive Market Gardening	432650	3.48	0.40	3.02	0.32	-925073.82
Traditional Market Gardening	412700	3.84	0.38	3.95	0.32	-889503.82

Observations of the results.

For the sake of improving water management, we continued to test synecoculture with sprinklers during the rainy season Jun - Nov 2016, which is then replaced by irrigation of tap water with hoses during the dry season Dec 2016 - May 2017 to observe the effect of replacement. Other cultivation methods used tap water with hoses, except conservation agriculture and permaculture depended solely on rainwater.

Development of productivity

Compared with the period June 2015 - May 2016, the year June 2016 - May 2017 showed the productivity growth for the System of Rice Intensification + Trees; Conservation Agriculture; and Permaculture. Especially Conservation Agriculture and Permaculture have shown an increase of more than 6 times in productivity and the reduction of inputs, which could be of good ecological influence coming from the field of synecoculture at the side (according to the observation of practitioners).

Water efficiency

Synecoculture during the dry season Dec 2016 - May 2017 has reduced 33% of productivity compared to that of the rainy season Jun-Nov 2016 with watering spray. This means that the water management efficiency (productivity / water cost) is higher by spray (87) than by hoses (35) in dense and mixed vegetation. In addition, compared to the water efficiency of synecoculture during June 2015 - May 2016, these two periods show more efficiency, 10 times (Jun - Nov 2016) and 4 times (Dec 2016 - May 2017) higher than the previous year. This implies the effect of ecosystem building is ongoing on an annual scale that contributes gradually to water efficiency.

Total efficiency and profitability

Again in this year June 2016 - May 2017, among the 6 methods tested, only synecoculture was profitable compared to total efficiency (productivity / total cost) and profitability (productivity - total cost). The difference in total efficiency between synecoculture and other methods becomes more significant, 43 times more for the rainy season with sprinkler irrigation and 28 times more for the dry season with hoses, compared to the total efficiency of synecoculture between June 2015 - May 2016 being 10 times more than the average of the other methods.

Significant reduction in synecoculture is the total suppression of seed cost, which is replaced by on-farm seed production.

The level of ecosystem recovery

The level of ecosystem recovery of all methods remains the same to that of May 2016, published in the proceedings of the 1st forum (Tindano, 2016).

II.2 Report in relation to the FAO guideline

Throughout the activity of synecoculture implementation, we have been intensively promoting biodiversity in culture and nutrition involving regional and national policymakers in accordance with the FAO guideline: Voluntary guidelines for mainstreaming biodiversity into policies, programmes and national and regional plans of action on nutrition (FAO 2016). Synecoculture project could be characterized with respect to the elements presented in the guideline in terms of the action and achievement as follows:

A. RESEARCH

Synecoculture field at Mahadaga in the province of la Tapoa introduced 150 varieties of cultivars, as well as wild, neglected and underutilized species, which substantially supported food diversity in the region by constantly providing qualified products in local markets even during the period of inaccessibility by flooding. General malnutrition and poverty issues are directly addressed by high productivity of diverse produce. Establishment of a research institute (CARFS) in collaboration with the university of Ouagadougou I UFR/SVT is in progress for the implementation of comprehensive research program including nutrition analysis. Scientific publication and online streaming of academic conferences are hosted by the UniTwin UNESCO CS-DC program under the direction of Sony CSL.

B. IMPLEMENTATION

Not only in Mahadaga but in more accessible location nearby Fada N'Gourma, we started the new pilot farm of synecoculture, aiming to involve national scale policy makers and impact farmers expanding the action plans to the countries in the Sahel. The implementation gained the Government institutional support of MAAH (Ministère de l'Agriculture et des Aménagements Hydrauliques), MEEVCC (Ministère de l'Environnement, de l'Économie Verte et du Changement Climatique), MESRI (Ministère de l'Enseignement Supérieur, de la Recherche scientifique et de l'Innovation) in Burkina Faso, as well as the embassy of Japan.

C. AWARENESS

All database obtained from synecoculture project, such as species diversity, productivity and costs, are published under the support of UniTwin UNESCO CS-DC programme as open source for effective replication. Further database integration with nutritional property and traditional knowledge of use of local plant resources is in progress with the university of Ouagadougou I UFR/SVT. The holding of 2 international symposia, 1st and 2nd African forum on synecoculture, was recorded by BF1 and RTV, respectively, which are available on line (Youtube link).

Reporter: Masatoshi FUNABASHI

Chapter III: Notice of Support

Minister of Agriculture and Hydraulic Planning

(Original document in French)

MINISTERE DE L'AGRICULTURE ET
DES AMENAGEMENTS HYDRAULIQUES

CABINET

BURKINA FASO
Unité - Progrès - Justice

N° 2017-047/MAAH/CAB-Dircab

Ouagadougou, le 22 MAI 2017

Le Directeur de Cabinet

A

Docteur André TINDANO
Secrétaire Général de l'Association de Formation et d'Ingénierie du Développement Rural Autogéré (AFIDRA)

FADA N'GOURMA

Objet : V/L Demande de parrainage

Monsieur le Secrétaire Général,

J'accuse réception de votre lettre n°2017-04-043/SG/AFIDRA du 25 avril 2017 relative à une demande de parrainage du Forum Africain sur la Synécoculture prévue se tenir du 24 au 26 mai 2017 à Fada N'Gourma.

Par la présente, j'ai le plaisir de vous informer que Monsieur le Ministre marque son accord de principe pour le parrainage de cette deuxième édition dont le thème *« la synécoculture, réaliser une agriculture qui permet la reconstruction de la biodiversité »* contribuera à n'en point douter, à lutter contre l'insécurité alimentaire et nutritionnelle au Burkina Faso et en Afrique.

A cet effet, je vous invite à entrer en contact avec le Cabinet du Ministre pour les modalités pratiques de sa participation.

Vous en souhaitant bonne réception, je vous prie de recevoir, Monsieur le Secrétaire Général, mes meilleures salutations.

Le Directeur

Pierre Emmanuel OURDRAOGO
Chevalier de l'Ordre National

APPENDICES

Field Photos

20170608-9 17 Photos of 17m^{2}plot installed at AFIDRA headquarter in Fada N'Gourma





20170608-9 Photos of the land of the new farm (6 ~ 10 hectares) near Fada



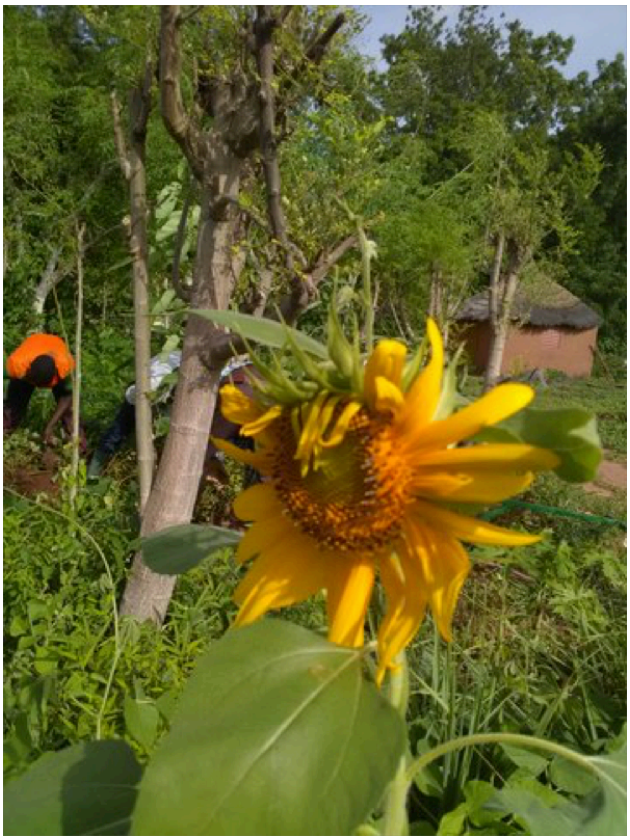


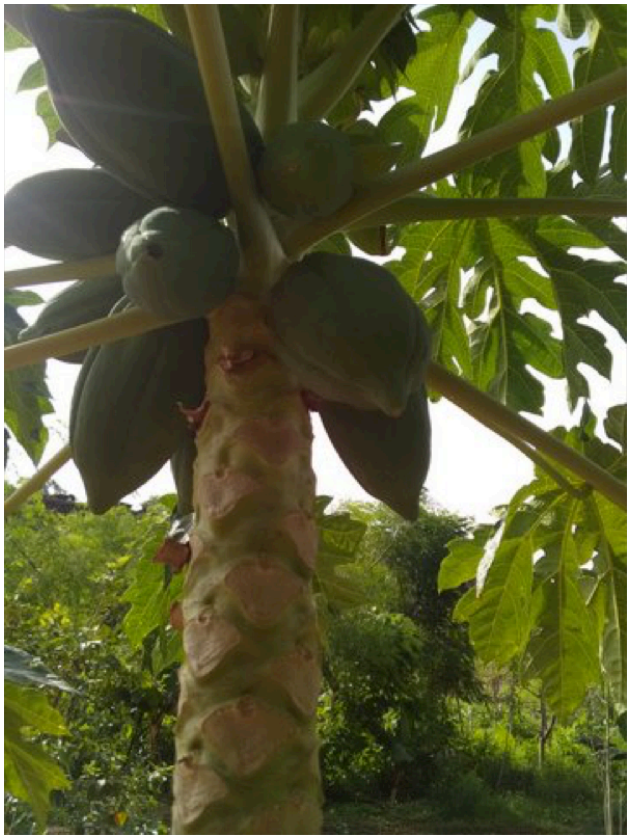


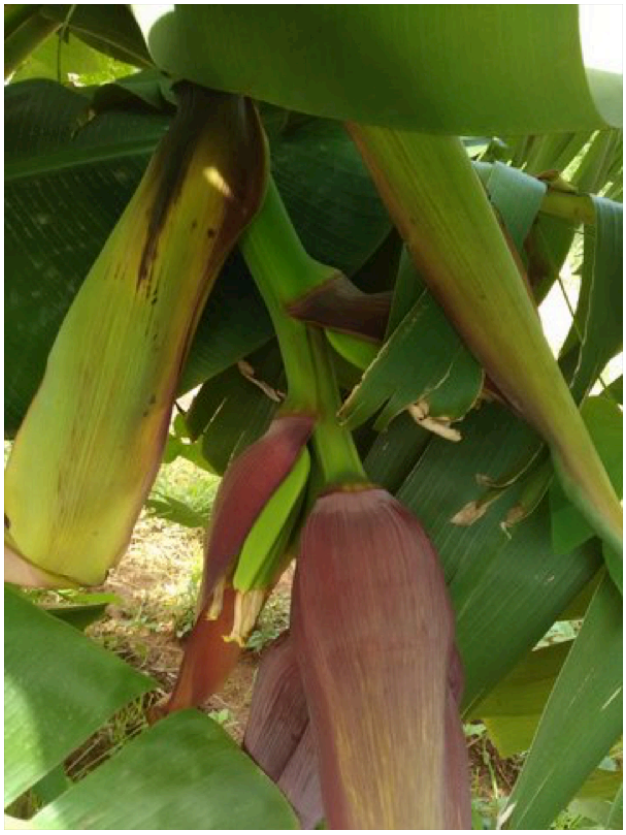


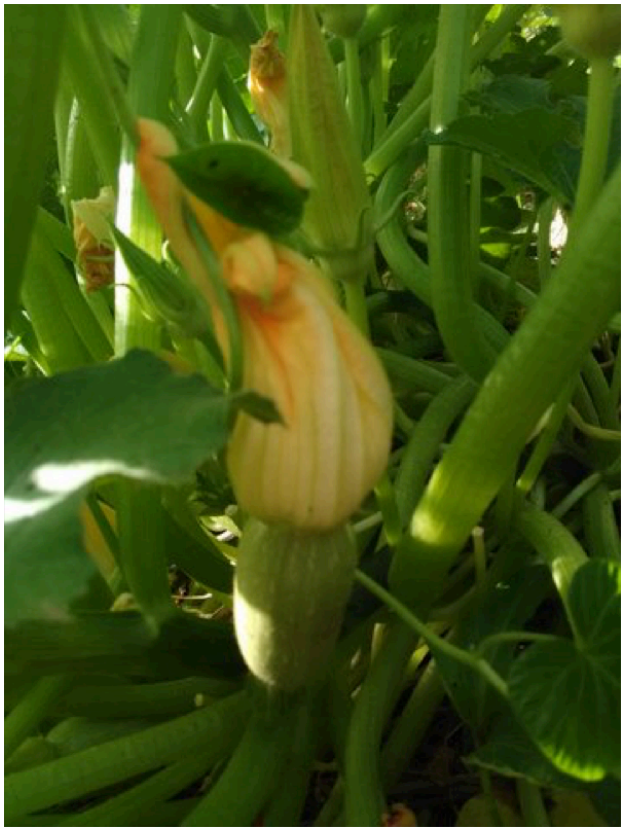


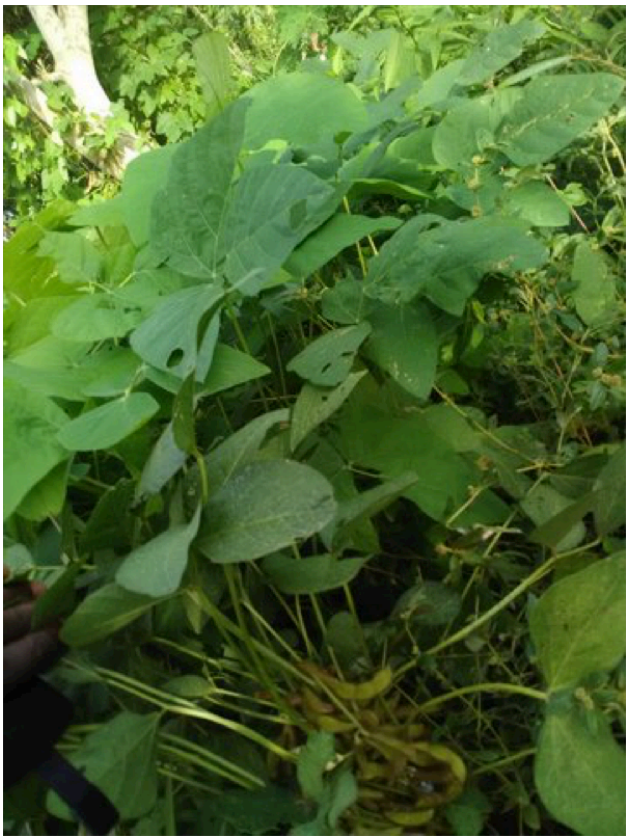
20170616-23 Photos of the pilot farm in Mahadaga, East region

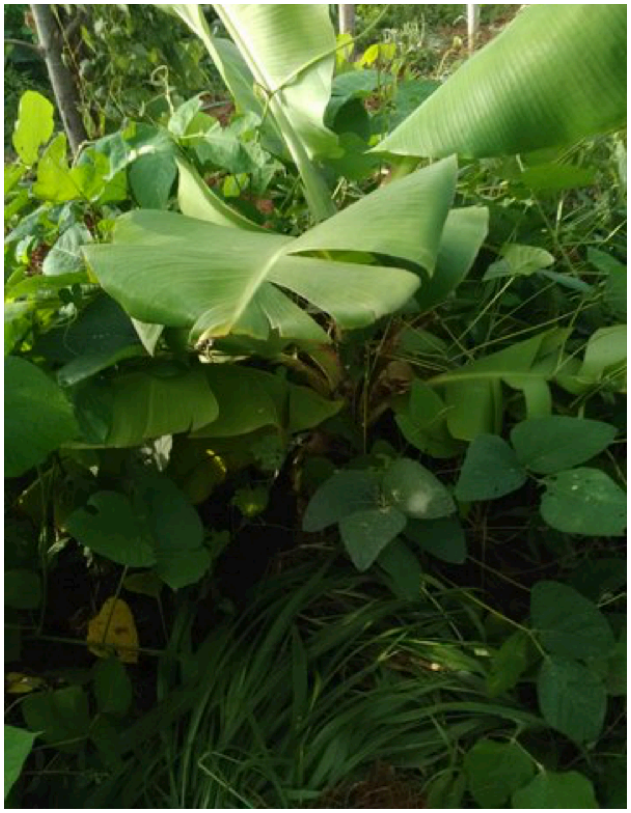


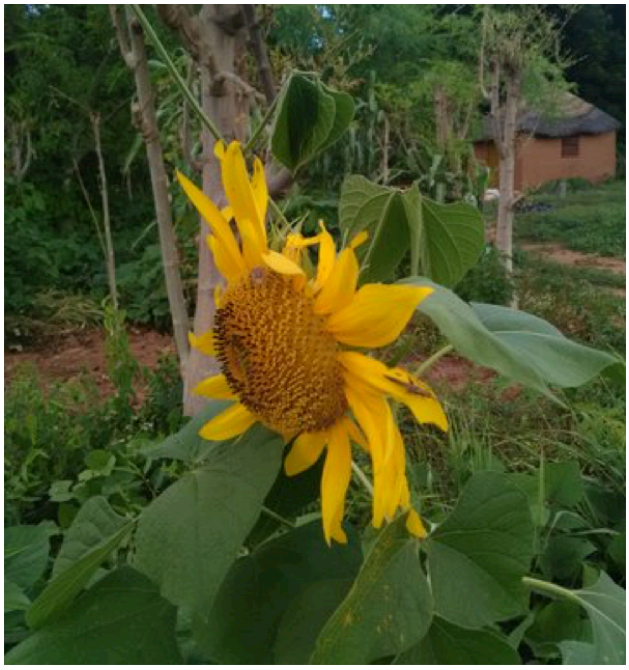


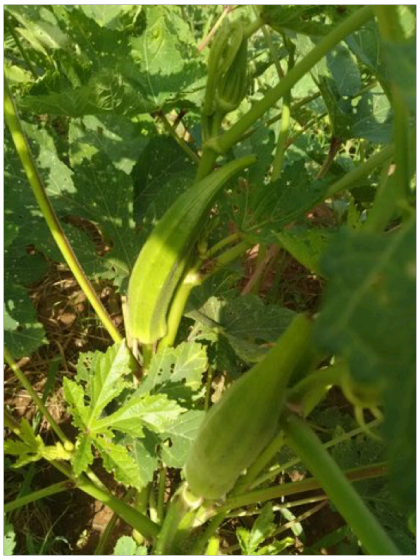


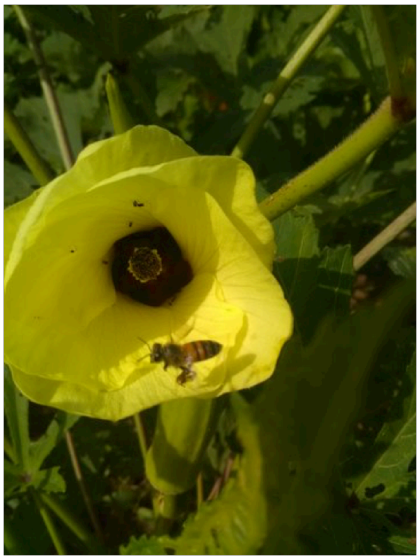


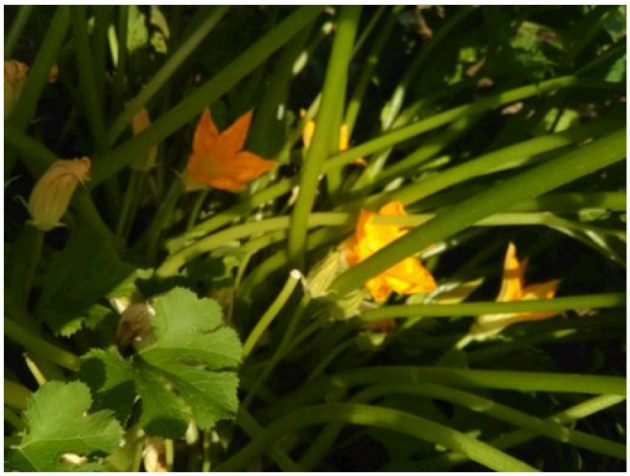


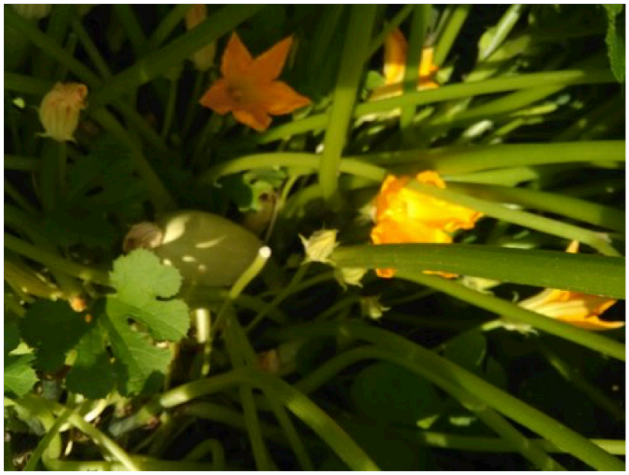


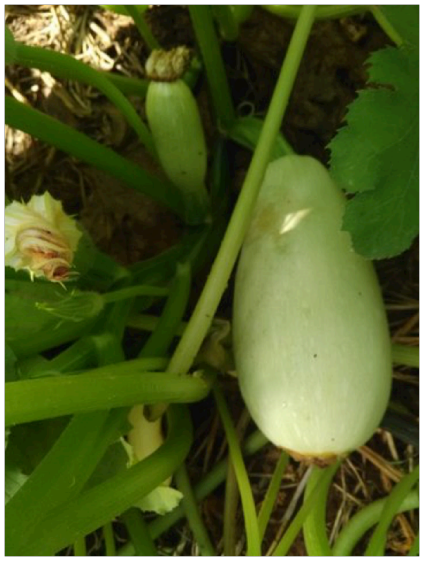












Photos of the forum


AFIDRA
ASSOCIATION DE FORMATION ET D'INGENIERIE
DU DEVELOPPEMENT RURAL AUTOGERE
2ème FORUM AFRICAIN SUR LA SYNECOCULTURE
THEME : LA SYNECOCULTURE "REALISER UNE AGRICULTURE
QUI AUGMENTE LA BIODIVERSITE"
Date : DU 24 AU 26 MAI 2017
A LA SALLE DE CONFERENCE DE LA MAIRIE
DE FADA N'GOURMA
SONY COMPUTER SCIENCE
LABORATOIRES INC

List of participants

Table 6. List of participants on site.

No.	LAST and first name	Affiliation	Country
1	COULIBALY Mariam	DRAAH/Centre Sud	Burkina Faso
2	ZERBO Patrice	Université Ouaga I PJK	Burkina Faso
3	LOMPO Michel	CFBA/Niendouga	Burkina Faso
4	LOMPO Yumali	AFIDRA	Burkina Faso
5	DIABRI Hubert	Representant Maire	Burkina Faso
6	DOLLY S. Ruben	AFIDRA	Burkina Faso
7	HIEN Jean René	Les Moulins de Fleur, Diébougou	Burkina Faso
8	GOUMBANE Andréa Bertille	Entreprise LAAFI GO	Burkina Faso
9	TINDANO André	AFIDRA, Fada	Burkina Faso
10	SONZABRE Chantal	Stch Foundation	Burkina Faso
11	YAGO Drissa	Groupement Moringa/ Réo	Burkina Faso
12	MILLOGO Hassanata	WANNPRES/ Ouaga	Burkina Faso
13	OUEDRAOGO Chantal M. Rachelle	AF 2000/ Ziniaré	Burkina Faso
14	TRAORE Tènin	RPBHC/ Banfora	Burkina Faso
15	OUEDRAOGO Emeline	Centre-Nord/ Kaya	Burkina Faso
16	ALORABOU K. Fati	Fonadja/ Nahouri, Po	Burkina Faso
17	BELEM P. Philibert	TSCPD/B	Burkina Faso
18	OUEDRAOGO Saoudatou	JIB/ Ouaga	Burkina Faso
19	OUALBEOGO Pierre	EDEN AGRO/ AGRO	Burkina Faso
20	COULIBALY Silas	Groupement/DAG	Burkina Faso
21	OUEDRAOGO Jacob	ODIS International	Burkina Faso
22	Pasteur BELLO Laurent	REGI/ Ouaga	Burkina Faso
23	TIAWARA Yemalé	ICODD	Burkina Faso
24	ZON Abdoulaye	ICODD	Burkina Faso
25	SOGOBA Souleymane	Université de Ségou	Mali
26	Lankoandé Diabiougou	AFIDRA	burkina
27	Palamanga OUALI	PALMA MANAGEMENT BU	Burkina Faso
28	Hamadou Soumana Oumarou	Université Abdou Moumouni de Niamey	Niger
29	YOGO Wend Lassida Maurice	Ministère de l'Environnement	Burkina Faso
30	COMTE Nelly-Françoise	CERPAC	République du Congo
31	BAKOUAN Babo Boniface	Centre agricole polyvalent de Matourkou (CAP-Matourkou)	Burkina Faso
32	SODRE Etienne	Institut de l'Environnement et de Recherches Agricoles (INERA) / Farako-Bâ	Burkina Faso
33	Michel Kere	IDR/UPB	Burkina
34	COULIBALY Soumabéré	CNRST / INERA / CREAF	Burkina Faso
35	Bankoamba Emmanuel	Mission évangélique	Burkina Faso
36	SAWADOGO Jacques	(CNRST/INERA)	Burkina Faso
37	BIRBA Sibiri	Institut de l'Environnement et de Recherches Agricoles (INERA)	Burkina Faso
38	GONGOTCHAME Amossou Yébala Sylvestre	ONG LEVIER POUR LE DÉVELOPPEMENT LOCAL DURABLE (LDLD)	Bénin
39	SANOU Abdoul Gafar	Université Polytechnique de Bobo-Dioulasso (UPB)	Burkina Faso
40	Ndiaye Papa Antou	Éducation nationale	Sénégal
41	SAWADOGO/ ILBOUDO Tinkoudougou	(CNRST)/ (IRSAT)	Burkina Faso
42	bonkoungou sayouba	Association apedr	Burkina faso
43	TRAORE Oumarou	IRSAT/CNRST	Burkina Faso
44	Nikièma M philippe	INERA	Burkina faso
45	BOLY Aboubacar	Université Ouaga I Pr JKZ	Burkina Faso
46	Samuel Lompo	Association	Burkina Faso
47	ZONGO OUMAROU	Université Ouaga 1 Professeur Joseph KI-ZERBO/ UFR-SVT/CRSBAN-LABIA	Burkina Faso
48	SANOU Bintou Céline	Université OUAGA I Pr Joseph KI-ZERBO	Burkina Faso
49	KONE Djenebou Macherine		Côte d'Ivoire
50	SAWADOGO Mohamed	etudiant	Burkina Faso
51	SOMDA B. Béatrice	INERA/FADA	Burkina Faso
52	TANKOANO Foldoa	CFBA/Niendouga	Burkina Faso
53	THIOMBIANO J. Jacques	ADE/AACE	Burkina Faso

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✓ CARFS Facebook page :
https://web.facebook.com/carfs.org/
✓ Facebook community of synecoculture Africa :
https://web.facebook.com/groups/1631931377118869/

(Youtube link)
1st African forum on synecoculture:
https://www.youtube.com/playlist?list=PLi69deRLkCayrdnSbkdz-In7knc3tQtRI
2nd African forum on synecoculture:
https://www.youtube.com/playlist?list=PLi69deRLkCaxfsFJiG22opSFjYyI6d8dE

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