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FROM AGROECOLOGY TO ORGANIC FARMING :



A review of best practices and Lessons learnt in Madagascar

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From Agroecology to Organic Farming: a review of best practices and Lessons learnt in Madagascar

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(This article was accepted for oral presentation at the 1st EASTERN AFRICA AGROECOLOGY CONFERENCE, 21 to 24 march 2023 Nairobi.)

Key words: GSDM, Agroecology, rice, erosion, *Striga asiatica*, compost, lombricompost, biopesticides, advocacy

ABSTRACT

Madagascar is one of the African countries that is a major consumer of rice with rice produced mainly in the irrigated lowlands, but the surfaces available in this production system are saturated and no longer cope with population growth. For this reason, production of food crops, particularly that of rice, must be intensified in the hills with steep slopes. This review concerns not only good practices on rice but also those of other crops in the Malagasy food system.

Repetitive bush fires and slash and burn cultivation in forest areas lead to a sharp reduction in cover crops and forest covers and are the cause of extreme climatic events and the drying up of springs. The poverty rate in rural areas, particularly in the Great South and South East of the Country, makes the fight against deforestation difficult.

In the context of this poverty, the production systems can no longer be made using fossil inputs and must then move towards good agricultural practices and biopesticides.

The former "Groupement Semis

Direct de Madagascar" (GSDM) has changed its name to "GSDM, *Professionnels de l'Agroécologie*" following the change of its statutes and is now recognized as a national reference in Agroecology. The review of the articles presented in this publication was made mainly on the publications in GSDM "[Journal de l'Agroécologie](#)", in its official reports and in its project reports. The publications of this Journal are peer reviewed while the official reports of GSDM are validated by its Board of Directors. Best practices and lessons learnt published are from project reports implemented by GSDM or his members or from partners organizations. Most of the results reported are good practices tending towards organic farming rather than organic farming as such.

The main objective of this article is to review research results and lessons learned in Agroecology and in particular good agricultural practices in matters of restoration of soil fertility and organic matter management (composts, vermicompost, basket compost, liquid compost and biopesticides, etc.) to move towards organic farming, in particular for market

gardening around large cities which still use high doses of chemical products. The article also reviews the results of research on the restoration of degraded soils, the fight against bio-aggressors of concern in Madagascar.

In terms of restoration of degraded soils, the results of long-term trials (since 1998) and lessons learned from farmers supported by GSDM projects have demonstrated the effectiveness of systems based on climbing legumes in association with maize, in rotation with rice associated with *Cajanus cajan* under Conservation Agriculture. No-till systems yield on average 3 times more than tilled systems, and the yields of the tilled plots even with cover crops decrease each year between the reviewed period from 2015 to 2021 while the no tilled plots with cover crops are more stable over time. These results confirm the decline of soil carbon in the plowed plots even in the presence of cover crops.

The rice husk-based biochar has been also tested by the CEFTEL¹ center as an alternative to the use of chemical fertilizers.

¹ CEFTEL : Conseil Expérimentation Formation en Fruits et Légumes



The biochar resulting from an artisanal pyrolysis technique has given good results in trials on tomato yield, but this technique has not yet been up scaled in the dissemination.

The use of liquid compost with biocidal plants such as neem, agave, *Crotalaria*, comfrey, *Lantana camara* etc. helps protect market garden crops against the main pests and diseases but does not provide sufficient protection against the caterpillars (*Helicoverpa armigera*) that destroy the pods of legumes, which poses a problem in particular in seed production of most of legumes used as cover crops (cowpea, mucuna, *Tephrosia sp.*, *Cajan cajan*).

The article will also review the possibilities offered for food security and the high rate of malnutrition. Food security and malnutrition have always been concerns in certain regions of the country.

Opportunities include orange-fleshed sweet potato varieties and the basket compost technique for cassava. Sweet potatoes with orange flesh rich in beta-carotene, non-photoperiodic and with a short cycle have known a strong adoption in the Country allowing to produce practically all the year around as long as there is humidity. The basket compost technique makes it possible to produce high yield of cassava or yam and makes

it possible to prepare planting holes enriched with organic matter for the establishment of cash crops (cloves, coffee, vanilla, etc.).

Scaling these technical innovations has always been a challenge. Because there is a long way to go for a paradigm shift with poor small farmers. GSDM's experiences with schools have resulted in what we call "reverse education" where students influence parents. Advocacy at national and donor level is also essential.

1. INTRODUCTION

Rice is the main Malagasy agricultural production ahead of tubers (cassava, sweet potato) and legumes (peanuts, beans, etc.) but this production is mainly done in irrigated rice fields in the lowlands. In 2018, Madagascar had a total of 5,060,888 agricultural households, i.e. 83.2% of all households, of which 592,644 households (11.7%) resided in urban areas and 4,468,244 (88.3%) in rural areas (INSTAT², 2018). For agriculture, 68.6% of households practice rice cultivation, the staple food of the Malagasy; 46.0% cultivate other cereals; 56.3% grow tubers and 37.0% grow legumes. Industrial crops and cash crops are only grown by 27.3% and 17.1% of agricultural households in Madagascar, respectively.

Because of the high rate of population growth (3% per year), the irrigated surfaces available are no longer sufficient, so production is increasingly done on

the hills, often with steep slopes, very susceptible to erosion. The country is known for its exposure to extreme events (cyclones, floods, etc.) due to climate change. The topography of the main cropping areas expose them to severe erosion. The repeated bush fires cause the vegetation to disappear more and more, leading to strong erosion at the start of the rains. The loss in earth only appears after the passage of a fire. It varies considerably with the slope. It is estimated at 2.1t/ha/year and 4.1t/ha/year before and after the passage of a fire (ANDRIANAVALONA H. M. *et al*, 2008).

As a result of excessive erosion, the restoration of degraded soils has been one of the concerns of our researchers over many years: indeed, excessive erosion, the nature of the parent rock and excessive leaching lead to acidic ferral soils and strong invasions of

the parasitic weed *Striga asiatica* on rice and maize. GSDM was involved on a long term [Ivory reference Site](#) testing different cover crops to restore soil fertility and to fight against *Striga*.

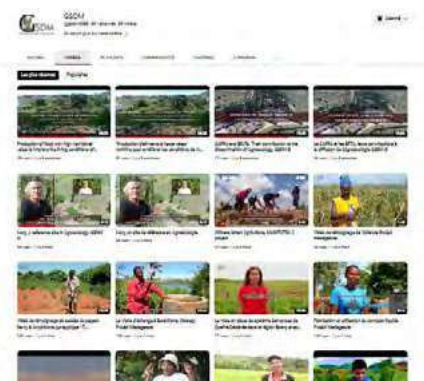
According to the World Bank report, the number of Malagasy people living below the poverty line increased further in 2022. It was 73.7% in 2017, it is now 81%. The Covid crisis, the increase in energy and food prices, the fall in exports and the reduction in jobs have hit the economy hard. Under these conditions, small Malagasy producers cannot buy exogenous inputs such as fertilizers or chemicals, so GSDM has opted for production systems close to organic farming, prioritizing in particular composts and biopesticides as well as use of repellent plants.

² INSTAT: Institut National de la Statistique



2. METHODOLOGY

GSDM³ is an association of 15 member organizations (NGOs, associations, public entities, private companies), all involved in Agroecology (research, disseminations.). The review of the articles presented in this publication was made mainly on the publications in GSDM "Journal de l'Agroécologie", in its official reports and in its project reports. The publications of this Journal are peer reviewed while the official reports of GSDM are validated by its Board of Directors. Best practices and lessons learnt published are from project reports implemented by GSDM or his members or from partners organizations. Most of the results reported are good practices tending towards organic farming rather than organic farming as such. GSDM publishes a periodical journal called [Journal de l'Agroécologie](#) and regularly organizes exchanges visits and fields days between stakeholders, including farmers' organizations. Different films in different formats are also produced and can be viewed on the GSDM Youtube page: [Films GSDM](#).



The main objective of this article is to review research results and lessons learned in Agroecology and in particular good agricultural

practices in matters of restoration of soil fertility and organic matter management (composts, vermicompost, basket compost, liquid compost and biopesticides, etc.) to move towards organic farming, in particular for market gardening around large cities which still use high doses of chemical products. The article also reviews the results of research on the restoration of degraded soils, the fight against bio-aggressors of concern in Madagascar.

In terms of restoration of degraded soils, the results of long-term trials (since 1998) and lessons learned from farmers supported by GSDM are reviewed from 2015 to 2021. Results of the [Ivory site](#) have been analyzed over a 8 years periods testing under Conservation Agriculture cropping systems associating maize with legume cover crops in rotation with rice. Crop residues are left and crushed



with an animal-drawn roller in the dry season. No soil plowing was done in the ploughed plots while the controls were plowed every year. The plots of farmers adopting around the Ivory site are also presented to visitors and also promote exchanges between farmers. As the Ivory site is surrounded by experimental plots

of researchers or students, new varieties also come out of this site and at the request of visitors and are taken to the different regions of the country. Rainfall was recorded by an automatic system all year around.

Since organic farming is currently expanding, the prospects for supporting organic territories with the technologies developed are possible not only for export but also for local consumption (market gardening, upland rice etc.)

The actions of GSDM are carried out mainly in the region of Vakinankaratra but its actions are also of a national nature because it implements projects, expertise and training in the different regions of the Country. In terms of training, GSDM has been involved for more than ten years in the introduction of Agroecology in schools in collaboration with the Ministry of Education.

The purpose of this publication is to review GSDM's results and its partners in terms of restoring soil fertility, best practices both on soils and on the fight against bio aggressors. Most of the results relate to rainfed rice, which is currently expanding strongly due to the long years of research supported by CIRAD. The surfaces cultivated in rainfed rice are of the order of 60,000 ha in Vakinankaratra only. Unfortunately, most cultivated areas are still in conventional systems and often conducted in the form of mining agriculture or slush and burn known in Madagascar as *tavy*.

³ GSDM : former Groupement Semis Direct de Madagascar renamed as GSDM, *Professionnels de l'Agroécologie*



3. RESULTS AND DISCUSSIONS

The results, best practices and lessons learnt presented in this article are those most relevant in terms of restoring degraded soils,

combating pests and diseases and contributing to the food security and nutrition of agricultural households. For the most part,

these are the results of small farms of .5 ha to 5 ha with or without crop-livestock integration.

The Reference site of Ivory as a training site and exchange between stakeholders

The Ivory site, is located 100 km west of Antsirabe on the plateaus of the central zone of the Middle West at an altitude of 1000 m on red ferralsols derived from basalt. This site was created in 1998 and has made it possible to have

references over several years of the systems preferred by farmers to solve the major problems of the Middle West of Madagascar and many part of the Country, including *Striga asiatica*. Several conservation agriculture systems

have been tested by researchers on the Ivory site since its creation, allowing them to identify the systems most adopted by farmers. Results from the last 8 years reviewed are presented here.

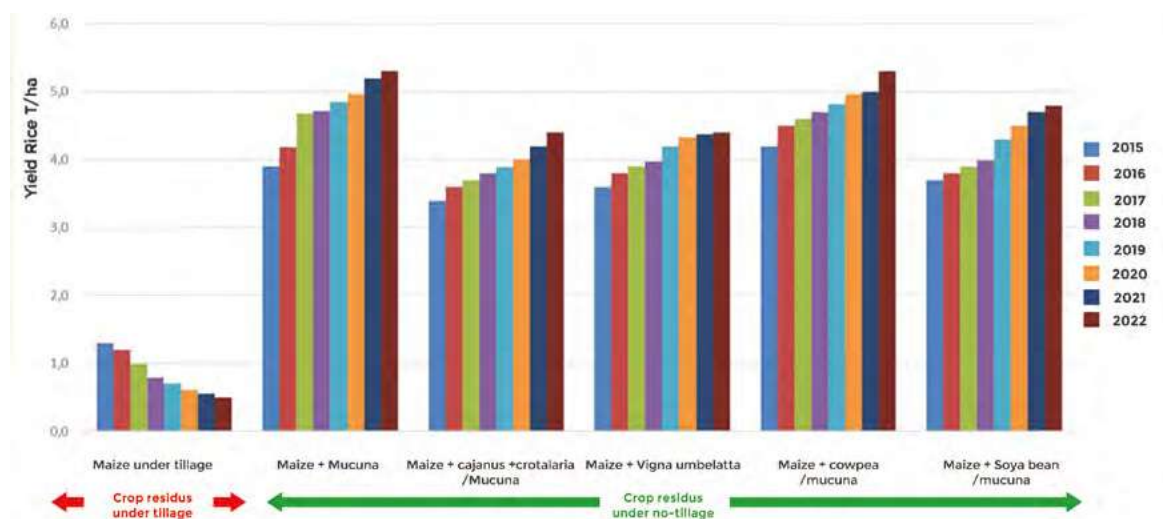


Figure 1 : Yields over 8 years of rice on maize residues associated with legumes with cattle manure under tillage compared to no tillage (GSDM, 2022)

Of these results, the greatest difference is observed between tilled and no tilled plots (no tillage since 1998). No-till systems yield on average 3 times more than tilled systems, and the yields of the tilled plots even with cover crops decrease each year between 2015 and 2021 while the no tilled plots with cover crops are more stable over time.

These results confirm the decline of soil carbon in the plowed plots even in the presence of cover crops because plowing accelerates

the mineralization of soil organic matter.

Of all the legumes tested, the mucuna-based systems are consistently the best. The current flagship system is now “maize associated with mucuna”, followed by the following year of “upland rice intercropped with *Cajanus cajan*” (Fig.2°). Maize and Cajanus are very lignified legumes that can remain throughout the dry season (6 to 7 months). Indeed, the greatest erosion is observed at the beginning of the rains in

November and December when the soil must always be covered (ANDRIANAVALONA H.M. *et al*, 2008).

This biannual rotation system based on mucuna and maize is on the way for scaling up in the Malagasy Highlands, but its limit lies in the availability of seeds of legumes used as cover crops. Indeed, legumes are heavily attacked by caterpillars of the *Helicoverpa armigera* type at the flowering period (GSDM, 2022).

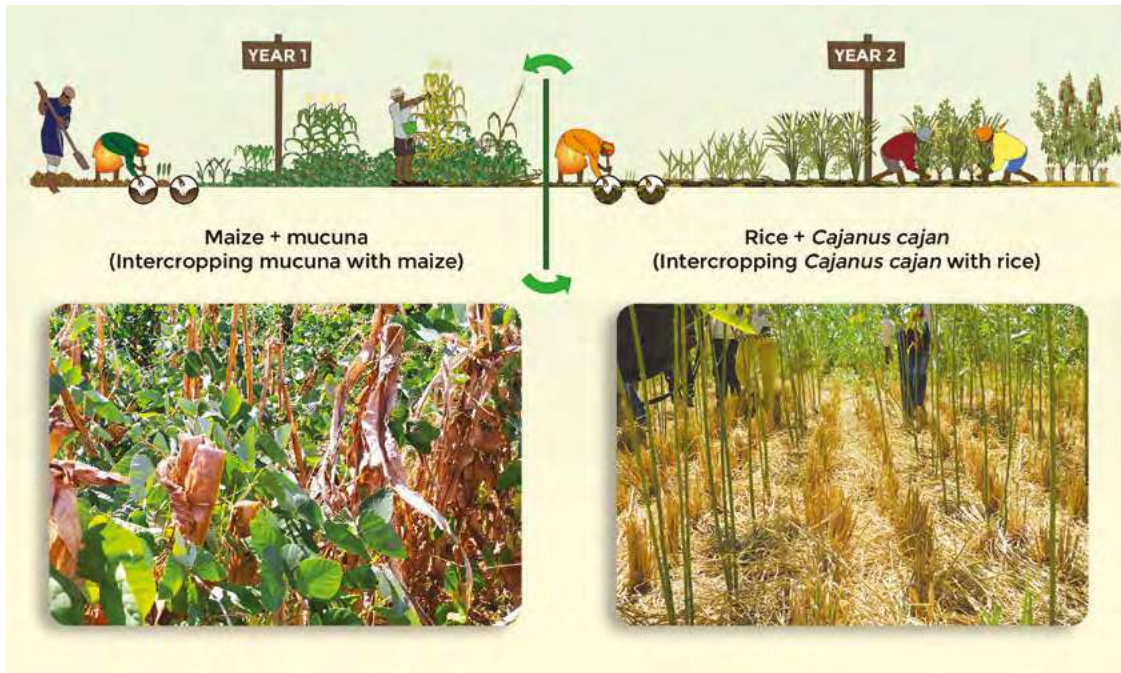
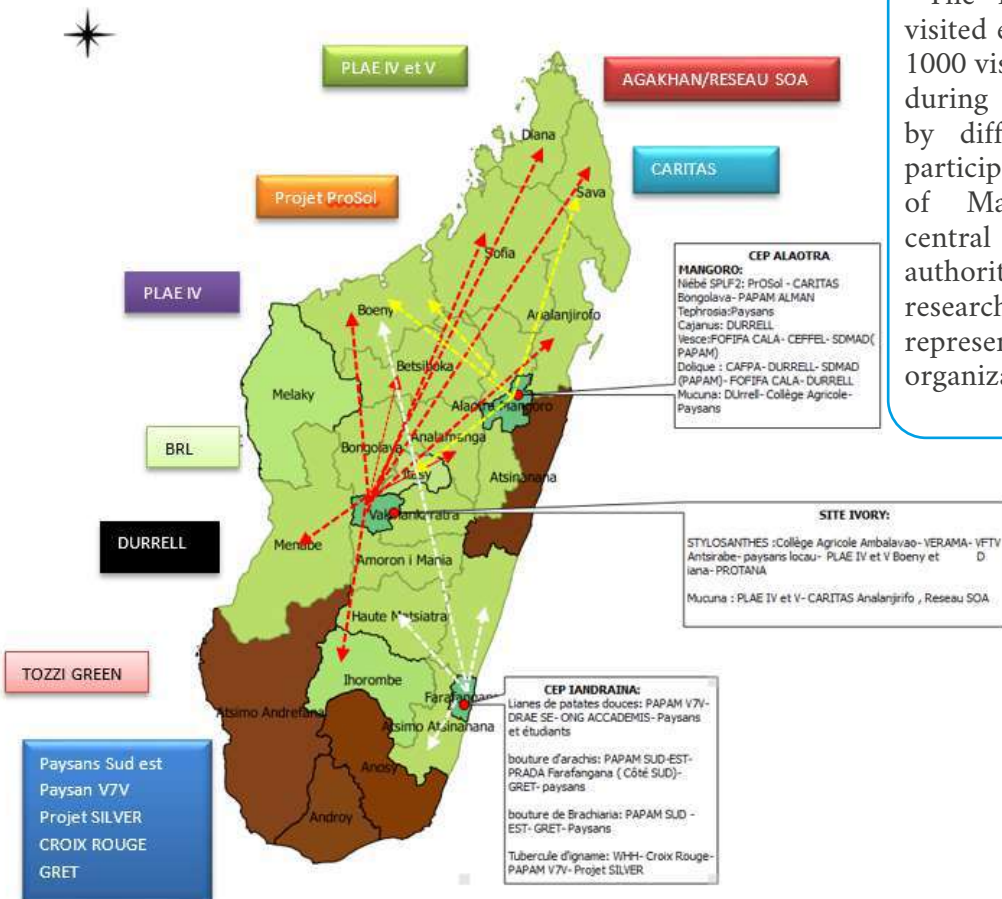


Figure 2 : The flagship extension training flyer in mucuna-based system Conservation Agriculture (GSDM, 2022)



The Ivory site is very visited each year (on average 1000 visitors per year, except during COVID period) by different categories of participants from all regions of Madagascar including central and regional authorities, decision-makers, researchers, students, representatives of Farmers organizations (fig.3).

Figure 3 : Dissemination of plant material in the Country from the Ivory site



A capitalization of service plants used in Madagascar for twenty years has been published by GSDM in the Journal of Agroecology and shows the predominance of

mucuna-based systems both for the restoration of soil fertility and the control of bio-aggressors (RAKOTONDRAMANANA *et al*, 2022). These results confirms also

the strong extension of mucuna-based systems for upland rice (GSDM, 2022).

Lessons learnt from the extension service and farm level surveys

Among the various cropping systems designed for the conditions of the middle-West of Madagascar where the soil is highly degraded, several cropping systems actually control *Striga asiatica* but the best control is obtained with perennial *Arachis* (*A. pintoï* or *A. repens*) or *Stylosanthes guianensis* (HUSSON *et al*, 2011). *Stylosanthes* is the best species to restore the fertility of degraded soils and to control *Striga* but it is not widely adopted by small producers because of the need for one fallow year to obtain enough biomass (GSDM, 2021). Besides that, it is a species that covers the soil well during the long dry season of 6 to 7 months, but it needs a special tool, an animal traction roller, to lay down the biomass and to crush it before sowing.

The use of farmyard manure is generally a common practice on farms in the Highlands of Madagascar where the soils are generally acidic (ferralsols soils derived from granite, migmatite or gneiss) but these manures are generally of poor quality and often mixed with soil. In a COMESA-funded project (MANITATRA project), GSDM supported the improvement of cowsheds to produce better quality manure and subsequently be able to make good compost (7-day compost, 45-day compost, liquid compost, vermicompost). Training on compost production has been intensified given the very high

cost of fertilizers. In particular, training on vermicompost with the introduction of composting worms, *Eisenia foetida*, was of great interest to producers, resulting in a rapid dissemination of this technique, particularly among medium-sized producers (RAHARISON T. *et al*, 2022). Vermicompost is in great demand by market gardeners, rainfed rice producers and organic export producers (vanilla, cloves, essential oils, etc.) But for rainfed rice, vermicompost is used mixed with manure at the rate of 20% giving satisfying yields (GSDM, 2022). We can see there a prospect of organic rainfed rice in the near future. Organic products represent an export market of 110 million dollars in Madagascar in 2020 (LIAGRE L., 2020). Involvement of GSDM in this area as part of the KCOA-KHEA⁴ project may help boosting this organic farming. In Madagascar, the sector of organic farming is in full expansion for 20 years marked by growth regular product export with strong typicity (cocoa, spices, vanilla, fruits and vegetables, honey, oils essentials, etc.) with a number turnover estimated at €110 million in 2020 compared to €22.6 million in 2009, in connection with the steady increase in cultivated areas and the number of certified farmers and operators (LIAGRE L., 2020).

The rice husk-based biochar has been tested by the CEFFEL center as an alternative to the use of chemical fertilizers. Biochar is

a charcoal substance made from the pyrolysis of plant waste. It is known for its ability to increase yields, water holding capacity, to reduce soil acidity and to increase nutrient availability. Tested on tomato, rice husk-based biochar significantly increases yield (RASAMIMANANA A. *et al*, 2021). However, this technique is not yet widespread in the main production areas and specially around big cities where market gardening is expanding with the high demand from the cities.

The *Ady gasy* developed by the CEFFEL Center uses liquid compost to which biocidal plants such as *Tithonia sp*, *Tephrosia sp*, sisal, neem, etc. are added. *Ady gasy*, while being a liquid fertilizer, protects crops preventively but not curatively. The most spectacular result was obtained on tomatoes against the tomato leaf miner, *Tuta absoluta*, which is very destructive in the Betafo area (RAVONIALIMANANA, L. *et al*, 2020). This technology is on the way of being widely used on market gardening. *Ady gasy* is not yet effective enough to protect all crops against bio aggressors: in particular the pods of legumes (cowpea, *Cajanus cajan*, mucuna, *Tephrosia*, etc.) are strongly attacked by caterpillars at the time of flowering. This poses a big problem for seed production for these service plant used in Conservation Agriculture.

⁴ KCOA – KHEA: Knowledge Center for Organic Agriculture – Knowledge Hub for Organic Agriculture in East Africa



Fall Army worms (*Spodoptera frugiperda* S.) first appeared in the South West region of Madagascar in 2017 and caused considerable damage to maize. Damage counts on farmers plots have shown that mucuna combined with maize considerably reduces damage (RAKOTONDRAMANANA *et al*, 2018). Other research has confirmed these results (RANAIVOSON A. *et al*, 2020). Now fall Army worm's damage has decreased over time but the technology exists for use anytime.



Lessons learnt on Best Practices targeting food insecurity and nutrition

Food insecurity and malnutrition is omnipresent in several regions of Madagascar, particularly in the Southern regions of Androy, Anosy and the South East regions (Fig.5 and 6). Some central regions of the Country, in addition to the high population density, are also food insecure and malnourished, hence the need to work more on food security and nutrition of the population, targeting in particular young children and women of childbearing age. Among the most widespread actions to deal with food insecurity and malnutrition carried out by almost all the projects are the dissemination of orange-fleshed sweet potato varieties (Photo 1), red bean and yam varieties. The most spectacular results have been obtained with the orange-fleshed sweet potato developed by the International Potato Center (CIP) and multiplied and distributed by the FIFAMANOR Research Center in Madagascar. These varieties are rich in beta-carotene and constitute a fortified food for malnourished children in particular. These are varieties with short cycles (90 - 110 days) and which have adapted to all regions of Madagascar (RALISON N., 2020).

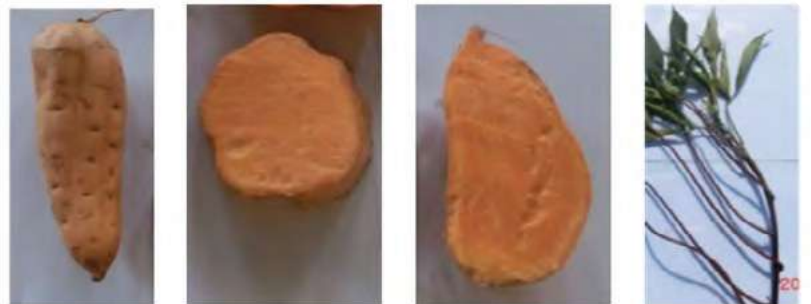


Photo 1 : Orange-fleshed sweet potato varieties

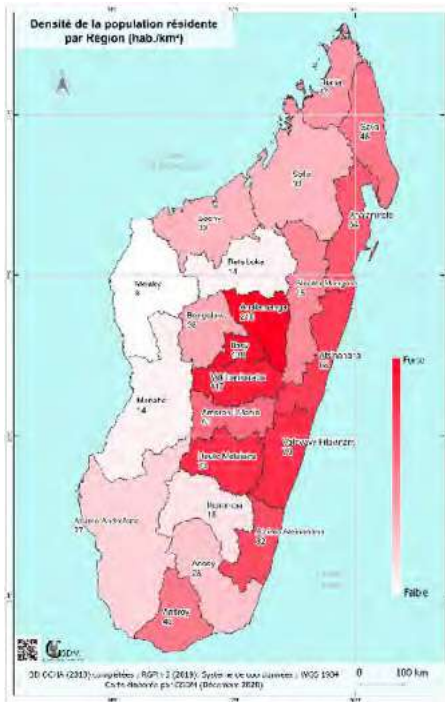


Figure 4: Resident population density by region (inhab./km²)



Figure 5: Incidence of extreme poverty by region (%)

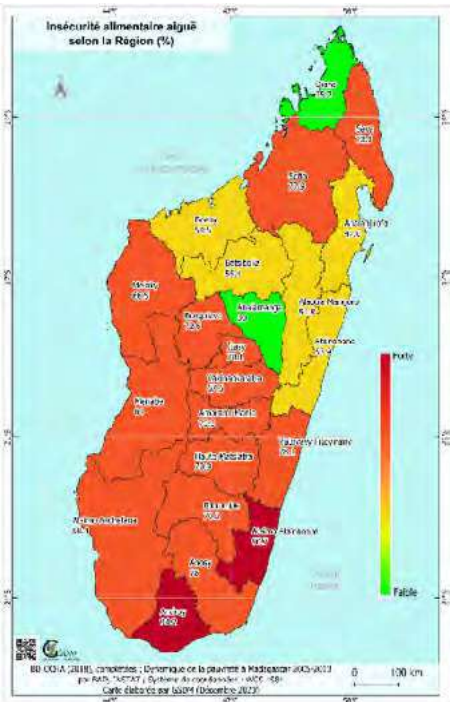


Figure 6: Acute Food Insecurity by Region (%)

The “Basket Compost” technique consists of alternating biomass with a layer of organic matter and then planting a tuber plant such as cassava or yam. By improving the substrate in this way, cassava yield can reach 2 to 3 times the traditional production system. From the harvest of a compost basket hole, we can feed a family of 6 people during the day. In addition to cassava production, a perennial plant such as coffee, cloves or vanilla can be planted later in the same hole. A legume cover crop *Arachis sp* can be planted to cover the soil giving nitrogen to the cash crop and getting rid of weeds.

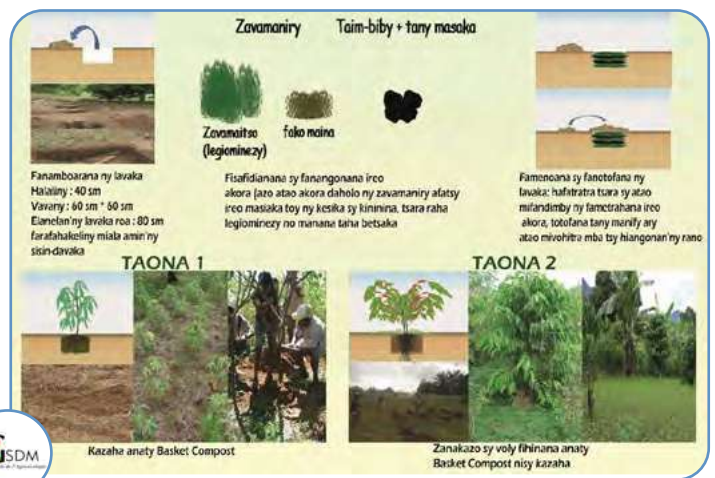


Photo 3 : From cassava on basket compost to perennial cash crops



Photo 2 : From the harvest of a compost basket hole, it is possible to feed 6 persons during the day





In addition to the dissemination of Agroecology through the classic channel of dissemination using technicians, lead farmers, and farmers field schools, GSDM has experimented with the Ministry of National Education the training of students in Agroecology by training the trainers first (teachers) and by setting up practice plots in schools for training purposes. These trainings used different tools such as fun booklets, 3D films but also exchange visits between schools and parent training. These activities had surprising results because the students were able to convince their parents to adopt the new techniques: this is what we call "reverse education" (GSDM, 2022).



Photo 4 : Vermicompost achieved by the students, CEG Mariarano



Photo 5 : Practical training of students, Vakinankaratra (left), Mahajanga (right)



Photo 6 : Broadcast of GSDM's 3D film on Agroecology, Mahajanga

4. CONCLUSIONS

Due to the predominance of small producers in the agricultural sector and the exorbitant prices of fertilizers and chemicals, good agricultural practices and the use of biopesticides have prospects for small farmers.

Given the experiences acquired over time by GSDM, its members and its partners, agroecological techniques are currently available and are already applied by farmers in restoring soil fertility and in

the fight against bio aggressors without the use of chemical fertilizers or chemicals. Currently in the Vakinankaratra farmers are embarking on the production of rainfed rice on *tanety*⁶ with only farmyard manure added with 20% vermicompost with acceptable results. Tomato growers use liquid compost with the addition of biocidal plants.

The cassava crops on basket compost are scaled all over the

humid zones with a cover of arachis to later receive a cash crop.

Capitalized technologies can offer enormous prospects in the development of territories with biological vocation not only for export but also for the local market, currently at the embryo stage. The inclusion of GSDM and SYMABIO⁷ in the KCOA-KHEA project opens up prospects in this direction.

⁶ *Tanety* : hillsides as opposed to the lowland traditional paddy fields

⁷ SYMABIO : Syndicat Malgache de l'Agriculture Biologique



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