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ANANABIO : A Project To Design Organic Pineapple Cropping Systems Through A Participative Approach Between Research And Producers.

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ABSTRACT

ANANABIO is a multi-partnership project (2016-2018) associating Research (CIRAD) with a technical institute (ARMEFLHOR) on Reunion Island (Indian Ocean) to design innovative practices for environmental-friendly organic pineapple cropping systems. Other partners of the project are the local administrative support to farmers (Agriculture Chamber and agricultural training school), professional organizations of farmers and independent farmers as well. Pineapple produced under the French Organic production specifications are marketed with the label 'Agriculture Biologique' (AB) of the French Ministry of Agriculture. The project proposes through a participatory approach to encourage farmers to co-design cropping systems with agronomists and to evaluate their performances. As far as cultural practices are concerned, ANANABIO focuses on the destruction of old crops and mechanized planting, organic fertilizer application, the pest and weeds management, and production of disease-free planting material. These cropping systems should also follow the Agroecology concept that promotes an agriculture that respects and protects man in his environment.

INTRODUCTION

Pineapple is the first diversification crop on Reunion Island with 16,000 tons produced on 360 ha, the main crop being sugar cane. Pineapple represents 75% of the fruits exported from the country towards the international markets. Pollution by pesticides and chemical fertilizers are critical issues in small insular territories. Thus, there is an increasing societal demand for better management of environmental risks and health protection in our country. Agroecology and more specifically organic production may provide the answer to this demand. Therefore, producers are looking for new ways to produce pineapple that are respectful of the environment and that could be better valorized economically. The evolution of the intensive cropping systems towards agroecological production and here towards organic production will be globally beneficial for a small country like the Reunion Island that is recognized as a hot spot of biodiversity and classified as a World Patrimony by UNESCO since 2010.

To obtain high quality agricultural products, farmers are forced to innovate their cropping systems with environmental-friendly and organic practices. These have to be re-designed to restore ecological processes and ecosystemic functions as for example the regulation of populations of soil microorganisms. Many functions provided by the agrosystems have been lost in the classical intensive monocultures. However, introduced biodiversity can restore some of these functions through rotation and/or association with selected plants. The characteristics of these plants may help to restore different services provided through the agrosystems: to reduce the impact of weeds, to reduce soil pathogen populations, to increase the populations of beneficial organisms (bacteria, mycorrhiza), to increase the natural regulations between beneficial organisms (auxiliaries) and pathogens, and as green manure to increase soil organic matter and fertility.

The project ANANABIO will develop cultural practices on four main issues: 1) Mechanization, particularly the destruction of the old plots after harvest but also mechanized planting, 2) organic fertilization, 3) weed management and 4) pest management. Agronomists, elaborating and evaluating innovative practices, will design new cropping systems. In addition, a participatory approach with farmers to evaluate the new cropping systems with their own indicators should enhance the adoptability by the industry. The project is divided into six specific work packages: management of the overall project, conception and implementation of the participatory approach, organic fertilization, mechanization, weed control, pest management, and finally transfer of the technical information to the industry.

PARTICIPATORY APPROACH, TECHNICAL EVALUATION AND SELF-EVALUATION OF THE CROPPING SYSTEMS BY THE FARMERS

This work package must develop different issues about the participatory approach to design and to evaluate the innovative cropping systems. These systems designed according to the agro-ecological concept will be evaluated with specific indicators of performance in three domains, agronomy, economy and environment.

For an agronomic evaluation, we selected different indicators: Rate of mineralization of different types of organic fertilizer; Efficiency of cover crops for weed management; Dynamics of nematode and symphylid populations under cover crops; Microorganisms activity in soil; Root system establishment and other classical indicators of pineapple growth (D leaf) and yield. Some of these indicators are not easy to measure at the experimental level so simulation tools and models have been used to select economically and environmentally beneficial cropping systems under a wide range of conditions (Sterk et al., 2007, Colbach, 2010). However, in most methodologies, the farmers play only a consultant role or are not consulted at all. Consequently, they rarely adopt the innovative cropping systems proposed by agronomists.

With the participatory approach proposed in this project, the hypothesis was that farmers have different contexts and objectives and so different ways to evaluate their systems with their own indicators. According to their economic and environmental objectives, farmers have to make compromises between their practices and their specific constraints to optimize performances and sustainability. Thus, pineapple producers with a wide range of contexts of production were previously surveyed to identify agroclimatic contexts and strategies of production and commercialization (Cambournac, 2013, Pissonnier, 2014) and to identify the strategies for the ecological transition of the farms (Dupré et al., 2017). Workshops were organized to identify the indicators that the farmers are using to self-evaluate their cropping systems. Thus, in order to ensure their adoption by farmers, a new organic pineapple cropping system must show efficient performance and be well adapted to the farmers' constraints.

Surprisingly, the farmers proposed many indicators on the agronomic, economic and environment domains of evaluation also proposed by the agronomists, although their methods and indicators were more empirical. This indicates that the farmers are fully part of the societal demand to reduce environmental problems and health risks. Finally, after aggregating and evaluating the different innovative practices, the organic cropping systems will be designed taking into account the agronomic expertise of farmers and agronomists.

The recently developed SIMPIÑA model for 'Queen' (Dorey et al., 2015, Dorey, 2014) will be used to match cropping practices to the various environments of pineapple farms in Reunion. Pineapple is grown in most areas in la Réunion at elevations from 50 m to 900 m resulting in a wide range of climatic conditions. Large farms can be found on low and relatively flat lands in the southern, western and northern parts of la Réunion. Most of the smaller farms with different management practices are established on sloping lands (300 to 700 m elevation) in eastern and northern areas with sometimes very steep slopes. There is a high diversity of soils on which pineapple farms are established. The soils are mostly more or less weathered andic soils (East, South and higher areas in the West) including black soils (Mid elevation in the West). In the drier western area of the island, some pineapple farms are established on very difficult black clayey soils. The eldest soils are ferrallitic (mainly in the North East of the island).

ORGANIC FERTILIZATION

Most of the fertilizers used in conventional systems of production comply with the requirements of the organic production except for nitrogen (N). Natural sources of K and P are authorized for organic production. Therefore, the work package on organic fertilization has first to identify known or possible local sources of organic N that could supply the quantity of N required for a pineapple crop in Reunion, about 350 $kg.ha^{-1}$ (pineapple residue, blood & bone meal, legume cover crops, composts, etc). Then, with the available sources of N, controlled and field experiments would determine if the N needed for pineapple growth and production is theoretically and actually available to meet that requirement with the appropriate timing during the cycle.

Possible sources of Nitrogen in la Réunion:

The pineapple residue after harvest may provide a large amount of N as the amount of fresh organic matter after harvest in pineapple may reach up to 200 tons fresh $weight.ha^{-1}$ on varieties like Smooth Cayenne (Py et al., 1987). In la Réunion, the mother plants and the remaining suckers are picked out and placed in windrows either to be destroyed with a slasher or to push them away on the edges of the plots, especially if they are highly contaminated by parasites, or when the plots are too stony for a mechanized destruction. In the experimental plots of the project, the mother plants are slashed into very tiny pieces (see hereafter the section Mechanization). Thus, we could evaluate amounts of residue ranging from 20 to 40 tons of dry matter per ha in different fields of conventional producers, being a potential source of nitrogen ranging from 170 to 320 $kg.ha^{-1}$. But the quick mineralization of the pineapple leaves cannot meet the requirement of growing plants during the 9 or 10 months of the pineapple vegetative growth. Part of this organic matter will contribute to restore the soil organic statute and will contribute to the growth of the cover crops that can be used in rotation systems with pineapple.

The cover crops as green manure are also investigated as an optional N source. Different cover crops and their biomass produced will be evaluated in the project without forgetting that some of these plants are also used for weed management (see section Weed Management) and to reduce soil borne pathogens (see section on Pest Management). The first plants selected for these experiments were crotalaria species, *C. juncea* and *C. spectabilis* (but others as *C. ochroleuca* will be studied), and mix planting of Crotalaria and Pearl Millet as well. The first results observed in our conditions showed large variations of biomasses produced between crotalaria species but also according to the date of sowing (warm or cool season). Preliminary results showed relatively low biomass productions during the warm season in la Réunion (10 tons DM ha^{-1}) when compared with Martinique (40 tons DM ha^{-1}) corresponding respectively to ~300 kg $N.ha^{-1}$ vs ~1200 kg $N.ha^{-1}$ incorporated into the soil with *C. juncea* as a green manure.

There are not many commercially available organic plant nutrient sources that comply with the organic production requirements. The only one available is a blood and bone meal from slaughterhouses, with a high content in N (~14%) and a fast mineralization. However, mixed incorporations of blood and bone meal and *Crotalaria* spp biomass before planting are also under evaluation.

Another solution is Ramial Chipped Wood (RCW; chipped branches <7.0 cm in diameter) but in the project it was used first for a different purpose. The RCW was used as a dead mulch to cover the soil and to control weeds. Nevertheless, this fresh material is also a source of nitrogen and was developed first in Canada, however, it is now a wide spread technique around the world, including for small private horticulture gardens. Unfortunately in our case, it also induces a strong proliferation of ant nests and mealybugs. Moreover, the main source for this material (roadside maintenance) is not appropriate for organic production, thus the use of RCW has not been investigated more deeply in this project as a Nitrogen source. Composts would have also been an interesting solution to be explored. They have been used in Ghana in large Organic farms for example self-produced composts from banana and pineapple residue of the farm mixed with large amounts of aquatic grasses collected from the Volta River (Soler, 2007). In la Réunion, the composts locally produced do not meet the specifications for organic production.

Experimental evaluation of different sources of Nitrogen:

The selection of organic compounds or cover crops will rely on analyses based on previous published works on methods to evaluate the mineral forms of N (NH_4^+, NO_3^-) and CO_2 released by the natural mineralization process and the carbon-to-nitrogen ratio C/N ratio. The C/N is an indicator to evaluate the ability of organic matter to decompose more (low C/N ratio) or less (high C/N ratio) rapidly in the soil

These researches intended to establish predictions of mineralization characteristics for C and N for exogenous organic matters (including industrial sludges, composts, animal wastes, mulches, cover crops used as green manure and fertilizers) incorporated into the soil from their biochemical characteristics in controlled systems but also in experimental fields (Lashermes et al., 2009, Lashermes et al., 2010, Fernandes et al., 2010).

In addition, the amount of nitrates lost by leaching at field level as well as the CO_2 and the ammoniacal N released will be measured. The data will allow calculating the equivalent amounts of organic fertilizer to replace the chemical ones. Then fertilizing procedures should be proposed to the farmers. Nevertheless, a strong challenge appears for N fertilization as most of the farmers are using classical plastic or organic mulch. So, to elaborate a schedule of applications of organic N during vegetative growth will be complicated as most of the N, available in solid form, would be applied before planting by the incorporation of the cover crops biomass, mixed or not, with other organic compounds. The contribution of organic matter, including green manure with cover crops, to soil fertility is well known (Jama et al., 2000, Pieri, 1989, Pichot, 1975). The mineralization characteristics of the cover crops may play an important role by releasing N slowly enough to maintain an equilibrated access for K and N to the pineapple plants throughout the vegetative growth period. In addition, in Reunion Island, there is no industry that produces organic composts or fertilizers and to import such fertilizers will not be economically sustainable.

. Similarly the C/N ratio of plants or different organic matter sources may help in evaluating the impact of soil C/N and the speed of their mineralization when incorporated into the soil (Giroux and Audesse, 2004). It is considered that in a soil with a C/N <15 there is a strong production of nitrogen, maximized at a C/N ~10, and the rate of decomposition increases as the C/N decreases. *C. juncea* has a C/N ratio of about 16.7, as is the case for many other Fabaceae. Due to their nitrogen-fixing capabilities they contain more N ~3% vs C ~50% than Poaceae spp, N ~0.8% vs C ~49% (Van Soest et al., 1991). Nevertheless, there is a large variability of the C/N in plants and organic matter in soils and the speed of the mineralization does not depend only on this ratio as for example the availability of nutrients for bacterial populations in the soil. The experiments in this project will help in evaluating not only the total amount of N actually available for the plants, but also the timing of release during the cycle for the blood and bone meal, the crotalaria and a mix of both sources.

MECHANIZATION

The work package 'Mechanization' has two objectives, the planting and the destruction of the old plants into very tiny pieces.

The mechanization of planting is a critical issue because of the high cost of labor in European territories and both organic and conventional productions are concerned. To determine the needs of the farmers is a complex task because of the high diversity of contexts (Cambournac, 2013). Most farms are mechanized to some extent as the cost of labour is very high in French territories, but the biggest equipment, for example a planting machine, must be shared through the cooperatives. In the project, the next step will be to design, build and test the equipment while relying on the direct participation of the farmers in technical workshops and field tests.

To shred old plants and particularly the stems into very tiny pieces, the project needs to identify and test commercially available equipment. The objective is to limit further development of small shoots from large pieces of stems as they could interfere with field operations in the planted crop and maintain populations of soil borne parasites and mealybugs, jeopardizing the establishment of the new pineapple crop. This practice is part of the integrated pest management but it also accelerates the mineralization of the organic matter. The most efficient tools identified to obtain the desired particle size belong to two categories: First, modified "wood chippers" normally used to destroy tree branches; Second, modified "rotary slashers" with heavy chains as the crushing system. The first ones are commercially available machines that need only slight adaptations. Rotary slashers need deeper modifications that for safety reasons can only be done by specialized companies. The first option is under evaluation in the project and the first results are good in terms of destruction but, as expected, relatively time consuming when compared to the classical pineapple slashers with articulated hammers rotating at high velocity.

WEED MANAGEMENT

In the work package on 'Weed management', different options are under investigation The weed control should be done using several techniques that will not interfere with pineapple growth, with pest management or other proposed practices. A diagnostic survey identified the agronomic and economic constraints linked to weed management. Thus, a specific frame of constraints was designed before selecting the plants and the farmers could aggregate their point of view to the frame of constraints. One of the main constraints is the cost of weed control, as chemicals are not allowed anymore. Another strong constraint is the omnipresence of weeds vegetatively multiplied by a mechanical destruction and that frequently damages the plastic mulch growing through it, as for example *Cyperus species* (*C. rotondus* in lower areas and *C. esculentus* above 500 m). Other weeds vegetatively multiplied are *Phalaris arundinacea* and *Raphanus raphanistrum* (both in higher lands), and *Oxalis* sp. (Perret and Dorel, 1999). A more exhaustive floristic survey must be done to identify the main weeds present in pineapple fields in la Réunion and the possible evolution of the flora using cover crops for weed management.

The weed control should not consist in a simple elimination of the weeds by hoeing or using only mechanized systems because it may result in strong erosion problems. The andic soils are particularly fragile in some areas of production subjected to heavy rains but there is also a tendency to over-mechanize some of these practices enhancing the deleterious consequences on the soil integrity. Finally, the optional techniques under investigation include mechanized weeding of inter-rows for some areas, natural mulch, dead (wood chips) or live mulches (cover crops that need to be cut or rolled down before they compete for light with pineapple). Nevertheless, as the soil borne parasites on pineapple are not hosted by pineapple only, the selection of the plants must take into account the pest management that is also partly based on the use of the same plants.

The project will assess different techniques mentioned above in experimental fields in organic farms. Beside the impact of the techniques on weed control, different parameters must be evaluated at the same time as the populations of soil borne parasites. We also decided to introduce *Crotalaria* before pineapple as it should induce a selection among the weeds and reduce the amount of seeds in the soil.

As far as cover crops are concerned, some specific constraints appeared including the commercial availability of seeds, certification for organic production, or taking into account the risk of introduction of invading species severely controlled by local authorities.

PRODUCTION OF DISEASE-FREE PLANTING MATERIAL AND PEST MANAGEMENT WITH ROTATION CROPS

The work package on pest management focuses on the production of disease-free planting material and on the selection of cover crops (also called in this case servicing plants (Table 1, Soler et al., 2016)) that have the potential to reduce the inocula of soil borne parasites. It is also expected that these servicing plants help to restore some natural regulations between beneficial and pathogenic microbial populations. Doing so, they contribute to establish stronger below– aboveground interactions for the crops. These interactions are believed to be a driving force for a healthy growth and which account for better yields in environmentally friendly agrosystems (Laksmanan et al., 2014, Orrell and Bennett, 2013). Other ecosystemic services can be provided by the agrosystems when servicing plants are used in a rotation and/or association with pineapple. They can improve the organic matter content of the soil, contribute to improvement of soil structure, contribute to the weed management (see previous section), and improve the quantitative and dynamic bioavailability of nutrients through their redistribution from deeper to upper layers of the soil. The table 1 summarizes expected ecosystemic services provided by the agrosystems with the corresponding plant traits that may help to restore the services.

Table 1 Expected ecosystemic services provided by the agrosystems and related traits of cover crops integrated in rotation or association with pineapple.

Expected ecosystemic services	Related cover crop traits
Clearing the soil of nematodes and symphylans before pineapple is planted	Host unfavorable to pathogens, Allelopathy, Biofumigation after incorporation
Cleansing the soil to the depth at which symphylans can be found	The root system should be capable of exploring the soil profile beyond the depth usually explored by the pineapple root system (30-40 cm).
Enhancing the suppressive effect of soil on pests (balance between microflora and microfauna communities, increased mycorhization potential)	Plant capable of mycorhization, Satisfactory biomass production, Quality of organic matter
Controlling weeds (many plants host soil borne parasites)	Cover crop, Allelopathy
Improving the soil structure and organic matter content	Appropriate root system, Satisfactory biomass production
Improving the quantitative and dynamic bioavailability of nutrients	Satisfactory biomass production, Quality of organic matter, Ability to fix nitrogen, Appropriate root system
Control of aerial parasites of pineapple or associated cash crops	Attraction of auxiliaries Repulsive effect on aerial parasites

A preliminary diagnostic survey in the different areas of production showed the presence of several pathogenic nematodes including *R reniformis, P brachyurus* and *Meloidogynae spp*, but also of symphylans and strong development of wilt disease with the associated mealybugs. A more exhaustive survey will be undertaken.

Production of planting material "free of diseases"

In Reunion Island, farmers harvest all the suckers in one shot, 4 to 6 months after fruit harvest by pulling the whole plant out of the soil. Then, they select few suckers with the correct size from the numerous ones produced by Victoria ('Queen'). This practice tends to give contaminated suckers, especially by mealybugs but also by symphylans and nematodes, if the suckers are not correctly prepared by removing old dry leaves and remaining roots. The frequent exchanges of planting material between farms is a common practice responsible for a rapid extension of contaminated areas (no possibility of disinfection).

The production of disease-free material through tissue-cultured techniques is well-known but it is not economically feasible as a regular source of plants in Reunion. For this project, the plan is to establish a supply of 'second generation' plants after the production of a reduced number of tissue-cultured plants. After acclimation, the tissue-cultured plants will be multiplied using 2 classical methods, first at field, level castration of the plant after forcing, and second in greenhouse, early destruction of the apex of young tissue culture plantlet (Soler and Dole, 2006) and distributed to growers when sufficient supplies are available. Economical sustainability is expected in both cases because of the high rate of production of suckers by the Victoria ('Queen'). They normally should replace the classical production of suckers after fruit harvest, at least until the populations of parasites decrease to reasonable levels.

Selection and evaluation of cover crops to sanitize the system

The preliminary diagnostic survey showed the diversity of pathogenic nematodes on pineapple that the servicing plants should help to control in addition of the symphylans. The diversity of the conditions of production (soil, rain and temperature), requires a more exhaustive diagnostic taking into account the seasonal impact on the growth of parasites populations.

The servicing plants are selected among the germplasm available in Reunion Island. The main criteria in this case is that the plants should not allow the increase of soil borne parasites. Nevertheless, as indicated in Table 1, other services are expected from the characteristic of these plants (fertility and organic status of the soil, natural regulation with the increase of beneficial population of microorganisms, weed control, and more).

First, we need to determine which of the plants are unfavorable hosts of pineapple parasites. This will be done under controlled conditions with inoculations of monospecific populations of local parasites. Other characteristics will be evaluated in experimental plots (particularly the biomass produced in different areas of production at different seasons, the potential of mineralization and the improvement of several soil characteristics). Then, the plants will be integrated and evaluated in pineapple cropping systems as rotation crops and/or cover crops as well. The evaluation will encompass agronomic, economic and environmental efficiency from both the perspectives of farmers and scientists.

The first plants tested in experimental fields are *Crotalaria* species (*C. juncea and C. spectabilis*) because of the practical experience already acquired in Martinique for *R. reniformis* (main pathogenic nematode on pineapple in Martinique) and previous publications on the topic (Wang et al., 2003, Wang et al., 2002). These plant species are already present in la Réunion but several issues must be investigated. First, the *Crotalaria* sp. are short-day plants flowering after 1 or 2 months during winter period. Therefore, the plants need to be incorporated into the soil after 4 months, meanwhile during the warm season the plants can be maintained up 6-7 months before destruction. The nodulation has been shown to be a critical point for production of toxic alkaloids by the *Crotalaria* sp. (Irmer et al., 2015) and although the nodulation occurs early after germination even in the cold season, the length of the cycle may have an impact for the production of the toxic pyrrolizidines and the management of soil borne parasites. The second point to be investigated for *Crotalaria* sp. is their impact on the different pathogenic nematodes. We need to verify if the local strain of *R. reniformis* is efficiently controlled by the *Crotalaria* sp. Then, the nematode *Pratylenchus brachyurus* has been also identified as one of the aggressive pathogenic nematodes for pineapple in la Réunion, meanwhile they are not in Martinique. Wang et al. (2002) have indicated that *Crotalaria juncea* does not control the *Pratylenchus* sp. Nevertheless, Machado et al. (2007) showed that *C. spectabilis* and *C. breviflora* can efficiently control the nematode *Pratylenchus brachyurus*. So, another alternative that is tested on experimental fields is to mix Crotalaria species (*C juncea* and *C. spectabilis*) and *C. juncea* with Pearl Millet as the latter plant may also control some species of *Pratylenchus*. Finally, *Crotalaria* sp. have their own pathogens very aggressive, in Martinique, it is the *Utetheisa ornathrix* caterpillar but in la Réunion, it is a bug from Miridae family. Both of them may require a management as they reduce considerably the growth of the plants.

ADDITIONAL ISSUES DEVELOPED FOR THE ORGANIC PRODUCTION

Forcing technique for organic pineapple:

The traditional forcing techniques (application of ethylene or ethephon in water) are not acceptable under the French organic production standards. Nevertheless, a technique using dry activated charcoal charged with small amounts of ethylene exists already (Soler et al., 2006), the project is looking for an administrative authorization to use it for pineapple because in French territories the use of ethylene is not authorized in open air.

Analysis of existing distribution channels for pineapple organically produced:

The objective here was to acquire a global vision of the different distribution channels of organic fruits and vegetables in Reunion Island. Organic farming is still not very widespread (170 producers in 2015 grow fruit and vegetables on 316 ha) and supply does not meet demand. Although, 9 different distribution channels were identified for organic fruits and vegetables, the majority of producers prefer direct or short-sale marketing. The long circuits cover professional organizations and cooperatives as well as export sales. The different channels are described as follows: Direct sale, short or long channels, then farms profiles and their economic strategies, importance of fruits and vegetables in the channels, advantages and disadvantages of the channel for the producer, media for marketing and success factors.

Transfer of the technical information

The objective of the last work package is to design training tools and technical sheets to transfer the techniques developed by the project to agricultural schools, to the farmers and to the technicians of the professional organizations. This technical information includes many prophylactic measures already known but very often abandoned by the farmers because of the efficiency and easy use of the pesticides. The prophylactic measures sometimes require much labor and close monitoring of the pest and disease development.

CONCLUSION

The objective of the ANANABIO project in Reunion Island is to propose to the pineapple producers cropping systems that comply with the French organic production specifications. The farms will be certified and fruit marketed under the label ‘Agriculture Biologique’ (AB) of the French Ministry of Agriculture. A complete review of the conventional and intensive systems of production is necessary. To do so, the project brings together the resources from research and technical institutes, professional organizations and farmers. The new cropping systems must follow the concept of Agroecology for health and environment protection. Practices including the destruction of old crops, fertilizer applications, pest and weed management, and the production of disease-free planting material, and forcing, are the focus for the technical innovations. Many of the technologies will be useful for conventional production as well. The participatory approach developed in this project with farmers from the conception to the evaluation of new practices and cropping systems should facilitate their adoption by the industry.

Project organization: ARMEFLHOR: Financial management, CIRAD: Scientific & technical management. Work packages & Team leaders: Cell management of the project, [2]Soler A. and [1]Nurbel T., Participatory approach and integrative actions: [2]Dorey E. & [2]Darnaudery M. assisted by[2] Lebellec F, [2]Michels T. & [2]Danflous J.P., Organic fertilization: [2]Thuries L., Mechanization: [1]Hoarau I., Weed management: [1]Tisserand G., Production of disease-free planting material and Pest management with rotation crops: [2]Soler A., Forcing: [1]Graindorge R., Transfer of the technical information (Chambre d’Agriculture, EPLEFPA).

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Other partners : AROPFL, Chambre d’agriculture, EPLEFPA (Agricultural school).

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