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D4-2 Report on technological processes adopted fort the preparation of organic amendments

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Summary

This deliverable describes the technological processes and improvements adopted for the preparation of the compost by the company Palm Compost company, partner of ISFERALDA project in Algeria, and by the association for the safeguard of the Chenini oasis in Tunisia (ASOC). It also describes the technological processes for the production of biochar in Algeria and Tunisia.

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1 Context

1.1 Presentation of oasis agriculture in Algeria and Tunisia

In Algeria, palm groves are mainly located in the south-eastern part of the country. They cover an area of 128,800 ha with around 14.6 million palm trees, of which 2/3, or around 9.6 million, constitute the production potential (Feliachi, 2005). Date production in the Algerian Sahara can be subdivided into seven date-producing regions: Zibans, Oued-Righ, Oued Souf, Ouargla, M'zab, Saoura, Touat and Tidikelt [2]. The Oued-Righ and Oued Souf regions cover an area of 24,000 and 6,000 hectares respectively for a total number of palm trees of around 2.6 and 1.1 million respectively. The wilayas of Biskra and El-Oued have the largest areas, both totalling 53.5 thousand hectares, more than half of Algeria's total.

Tunisia's oases cover a total area of 41,000 ha, of which 23,000 ha are in the Kébili region, home to around 10% of the country's total population. There are a total of 5.4 million date palms, including 3 million in Kébili. Date palm residues are little used and often burnt.

Intensive cultivation leads to a decline in soil fertility, with a reduction in stable organic matter content and increased plant susceptibility to nutritional imbalances and disease. To remedy this, the permanent use of organic amendments such as manure is necessary. In these regions, manure is not only scarce and expensive, but also of variable and sometimes mediocre quality. In the oases, large quantities of organic by-products, such as my leaves, are available. Appropriate reuse of these products is needed to minimize their destruction and improve the fertility of degraded oasis soils, in line with a circular economy integrated into the agro-ecological concept.

1.2 Introduction to the compost industry

In Algeria, the unavailability of general statistics on the use of composting at farm level in the oases means that we have to rely on the results of surveys carried out as part of the ISFERALDA project in the two Algerian regions of Oued Righ and Zibans. It turns out that, due to the withdrawal of the public authorities in terms of extension and training in composting techniques, the use of organic soil improvers such as farmyard manure and mineral fertilizers is for the moment the only option. At present, given the economic circumstances reflected by the ever-increasing cost of these products, farmers are showing a particular interest in composting, starting timidly with public institutions which are carrying out awareness-raising campaigns in this direction. It should be noted, however, that unless there is a targeted strategy of public support to develop this sector in an integrated way, its future will be in vain.

In Tunisia, composting is attracting more and more interest due to the large quantities of agricultural waste and the demand for organic matter for soil fertilization.

In Chenini, the association for the safeguarding of the oases in Chenini Gabes in Tunisia (ASOC) aims at the rehabilitation of the oasis by supporting and mobilizing the local population, and exchanging their experiences with other oases. The current market of the association are farmers, private gardens, town halls and schools in the region.

1.3 Presentation of the biochar industry

Biochar is a complex product whose properties depend on the initial biomass and pyrolysis conditions, including temperature, pyrolysis duration and atmospheric conditions (oxygen content). Its use and the way in which it is applied could have an influence on agricultural yields, soil quality and the environment in general. There are several techniques that are used for the pyrolysis of wood or agricultural residues. They differ in their principle, their performance and their impact on the environment. Traditional techniques, called partial combustion, emit large quantities of greenhouse gases, unlike more modern techniques. These generally industrial techniques require very large investments and quantities of biomass to be treated. Carbonization ovens that allow the elimination of greenhouse gases and offer a carbonization efficiency greater than 30% are rare.

In Algeria, the production of biochar is almost non-existent because it requires a more complex and expensive manufacturing device than that of compost. The production of biochar is in the experimental stage and the biochar is currently being used for scientific research purposes.

In Tunisia, biochar is not specifically mentioned in any national legislation, unlike organic amendments such as compost or manure. The company BIOFIRE located in Tébourba in the north of Tunisia produces biochar as an amendment for agricultural soils. The unit can process 10 tonnes of biomass per day, mainly wood (olive/fruit tree pruning wood, Eucalyptus wood), but it is open to carrying out tests on other materials.

2 Compost production

The optimization of production processes takes place more specifically in Algeria where the industrial partner of the ISFERALDA project, Palm Compost, is located.

2.1 In Tunisia

The compost used in the ISFERALDA project is produced by ASOC and is made up of 1/3 manure (usually goat manure) and 2/3 shredded plant material consisting of date palm leaves (Figure 1). Raw material collection is carried out by ASOC staff. Composting lasts 6 to 7 months. During the composting period, irrigation is carried out by well water if necessary, according to the observations of the technical agent. In 2022 the production of compost reached 115 tons, and the forecasts are on the rise for the years to come.

Figure 1: Composting process in ASOC, Tunisia

2.2 In Algeria

2.2.1 Current production

In Algeria, the compost is produced by Palm Compost, partner of the ISFERALDA project. Palm Compost is a company that produces compost from palm tree residue; three months are required for composting and maturation. The composting process follows several stages to obtain a finished product ready for marketing.

Composting is a natural accelerated process of decomposition of organic matter. When piled up, these materials naturally decompose and turn into a rich material, which easily integrates into the soil. This process is facilitated by the interaction of several factors such as humidity, aeration and a diverse group of microorganisms (bacteria, fungi and other meso- and microfauna). Applying compost helps improve soil fertility, water retention and plant health.

The production of compost in Palm Compost company is detailed in the deliverable 4-4.

2.2.2 Improvement of production processes

One of the objectives of the ISFERALDA project is to optimize the composting of date palm residue by reducing composting time and improving the quality of the compost. As part of a doctoral thesis project by Ms. Houda Boutalbi, supervised by Prof. Kamel Guimeur (University Mohamed Khider of Biskra, UMKB) and Mahtali Sbih (University Hadj Lakhdar of Batna, UHLB) several composting experiments with these agricultural residues was set up in order to meet these objectives.

2.2.2.1 Experimental protocol

Firstly, the palm residues are finely ground then soaked in water until saturated for 5 to 10 hours. Subsequently, the residues are suspended to ensure drainage up to 80% of the saturated water content (Figure 2).

Figure 2: Grounding, soaking and drainage of the date palm residues

Once drained, the date palm residue is mixed with different products to facilitate the composting process. The products tested are:

- sheep manure at different doses,
- poultry droppings in different doses,
- sludge from domestic wastewater treatment plants,
- leachates from technical landfills for their high loads of microorganisms. In order to avoid poisoning that heavy metals (Cd, Pb and Hg) can cause, we took their content into consideration to determine the safe quantity of leachate to add.

The composter is a 50 liter drum with a perforated PVC tube which allows air ventilation (Figure 3). The drums are pierced to allow the release of CO_2 and the drainage of excess water if necessary. In the composting process, parameters such as humidity and aeration are maintained at their optimum in order to have ideal conditions for the activity of microorganisms (Figure 4).

Figure 3: 50L drum, lid with PVC tube passage, PVC tube fixed on the lid

Figure 4: Different modalities, arrangement of barrels, aeration of barrels

Physicochemical parameters such as electrical conductivity, pH, fulvic acids/humic acids ratio, C/N ratio and weight loss of residues are measured during this experiment.

Due to the delay in funding of the Algerian partners, this experiment started in June 2023 and is still in progress

3 Biochar production

3.1 In Tunisia

In Tunisia, the pyrolysis of date palm residues was carried out within the BIOFIRE industrial unit.

The date palm residue was first crushed and sieved to 5cm. The crushed waste was dehydrated under the effect of a hermetically sealed hot air blower, supplied by a biomass combustion chamber, then compressed under the effect of a very high temperature (350°C) in the form of 'a hollow briquette inside. This form of the product facilitates the combustion of woody green waste.

The pyrolysis was carried out in a horned metal furnace at a temperature of 460°C. The combustion time is 9 hours, while the cooling time is 48 hours. The carbonization yield is 25%: 500 kg of biochar produced for 2 tons at the start. The pyrolysis also produced 70 kg of tar.

3.2 In Algeria

In Algeria, to our knowledge, there are no industries allowing the production of biochar from agricultural soils. ISFERALDA project partners from UMKB and UHLB are in contact with brickyards to assess the feasibility of the process in the factories. Therefore, biochar was manufactured using homemade pyrolyzers built at UMKB.

In the tests carried out during the ISFERALDA project, the objective was to establish an effective, relatively simple, and inexpensive procedure for farmers for obtaining biochar from palm tree residues.

The biochar production method is a so-called conventional slow pyrolysis carried out from palm grove residues. It is made using the traditional pit or millstone carbonization process, but modified with a 200 liter barrel (Figure 5, Figure 6) . With this type of process, carbonization temperatures range between 300°C and 500°C. The biochar manufacturing time varies from 2 to 3 hours depending on the weight of the initial biomass. The production yield of biochar compared to the initial biomass is affected by the temperature as well as the size of the palm grove residues, it can vary from 33 to 42%, depending on the pyrolysis temperature (FAO, 1983).

Figure 5: Construction of the homemade pyrolyzer

The size of the residue to be pyrolyzed can have an effect on the duration and quality of the pyrolysis, we proceeded to shred the dried palm fronds to three sizes: fine, medium and coarse. These tests show that finely ground residues do not pyrolyze completely and in some cases not at all. The medium and coarse size of the palm residues pyrolyze homogeneously at temperatures varying from 300 to 400 °C in a time interval between 2.5 hours and 3.5 hours. The yields obtained vary between 39 and 45%.

Figure 6: starting the home-made pyrolyzer

Reference

FAO (1983) Simple Technologies for Charcoal Making. FAO Forestry Paper 41, Rome, ISBN 92-5-101328-1.

HISTORY OF CHANGES		
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1.0	15/09/2023	▪ First version
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