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D4-1 Inventory of the existing local composting and pyrolysis processes

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Summary

The purposes of this report are i) to know the feelings of local farmers with respect to organic amendments such as compost and biochar and ii) to carry out an inventory of existing composting and pyrolysis processes in the regions studied.

In Tunisia or in Algeria, compost based on date palm residues are little known and little used by the farmers who prefer using organic amendments like the animal manure. Even if some of the date palm producers recycle date palm agricultural residues, they never mention composting to recycle these residues.

Whatever the country, there are few structures allowing the production of compost based on date palm residues. Nevertheless, almost 2/3 of the interviewed farmers in the palm groves agreed with the use of compost made from date palm residues provided that the product is available in quantity, in quality, in a permanent way and with reasonable prices on the local markets. Farmers also ask for demonstrations and reliable results.

The strategy for promoting the recycling of date palm agricultural waste for the production of compost must be based i) on making producers aware of the use of this type of amendment with the presentation of reliable results, ii) on the reinforcement the training of technicians and producers on the techniques of making and using compost, iii) on encouraging the financing of the installation of production units of good quality compost, iv) on the development of scientific research projects in collaboration with local farmers to define the best compost formulas, and v) on the presentation of the advantages of compost for farmers.

In Algeria and in Tunisia, biochar is not produced or used on a large scale. It is mainly used for research purposes. The ISFERALDA project aim at developing the research on that amendment so that biochar is better known and well accepted by producers.

This report shows the importance of the ISFERALDA project to improve the acceptability of the organic amendments studied among farmers. Field trials and visits to experimental farms fall squarely within this framework.

Table of contents

Summary 2
1 Introduction 5
2 Tunisia 5
2.1 In the whole country 5
2.1.1 Annual organic manure production 5
2.1.2 Existing composting structures 6
2.1.3 Production and use of biochar 7
2.2 In the palm groves of Nefzaoua 7
2.2.1 Characteristics of the oasis of Nefzaoua 7
2.2.2 Farmers profile 8
2.2.3 Use of organic amendments 8
3 Algeria 10
3.1 Age and level of education of farmers 10
3.2 Use of organic or mineral amendments 10
3.3 Date palm waste 10
3.4 Composting 11
3.5 Constraints to waste recovery in the study areas 12
3.6 Prospects for the development of compost production 13
3.7 Production and use of biochar 13
4 Conclusion 14

List of tables

Table 1: Global organic matter balance in Tunisia in 2004 (Grissa, 2017) 5
Table 2: Evolution of the quantity of total compostable organic waste per governorate 6
Table 3: Amendments applied by farmers 8

List of figures

Figure 1: Distribution of respondents according to their age and literacy level 8
Figure 2 : Effect of soil amendment in improvement of date palm production 9
Figure 3: Valorization of date palm waste in the studied regions 11
Figure 4: Results of agricultural surveys on the possibility and conditions of purchase and use of compost available on the market 12
Figure 5: Breakdown of producers according to constraints on compost recovery 13

1 Introduction

This inventory was based on surveys conducted both in Tunisia by researchers from the Institute of Arid Regions of Medenine (IRA) and in Algeria by researchers from the National Institute of Agronomic Research of Touggourt (INRA), the Institute of Technology in Saharan Agriculture (ITDAS) and the University of Biskra (UMKB). We also used socio-economic and technical reports from the UMKB and the synthesis report of the DS-SLM Project on decision support for the integration and extension of sustainable land management (Grissa, 2017). The lack of some recent statistics in this report reflects the lack of integrated country-level studies on this topic.

The purpose of this report is to know the feelings of local farmers with respect to organic amendments such as compost and biochar and to carry out an inventory of existing composting and pyrolysis processes in the regions studied.

2 Tunisia

2.1 In the whole country

2.1.1 Annual organic manure production

The production of manure, dry poultry droppings and compost in 2004, on a national scale, was estimated at $2{,}874.10^3$ tons. This only covers 15% of the country's overall needs. Even taking into account all the organic waste that could be mobilised, only 21% of the needs would be covered.

In the southern regions, where almost all oases are located, despite significant needs for organic amendments, compost production in 2004 was very low or even zero (Grissa, 2017, Table 1).

Table 1: Global organic matter balance in Tunisia in 2004 (Grissa, 2017)

Governorates	***Needs in organic matter (tons)***	***Production of cattle manure (tons)***	***Production of dry poultry droppings (tons)***	***Current compost production (tons)***	***Potential compost production from mobilisable waste (tons)***	***Overall balance (tons)***
Gafsa	517 784	58 453	2 336	0	40 236	-416 759
Gabès	247 303	55 552	5 586	0	69 780	-116 385
Médenine	93 157	47 417	653	0	9 823	-35 264
Tozeur	495 313	60 741	1 926	0	28 275	-404 371
Kébili	406 776	12 665	2 698	0	9 535	-381 878
Tataouine	776 047	29 667	64	0	9 000	-737 316

The quantities of waste used have been estimated in 2014 and 2019 in these regions (Table 2). They are far from the available potential. However, there is an increase in the proportion of waste used between 2014 and 2019. Indeed, these proportions vary from 18.8% to 40.9% in

2014 and from 24.7% to 49.8% in 2019. Since 2004, the general policy towards a more sustainable agriculture through the valorisation of these wastes has been felt through the creation of several associations and SMEs in these regions such as the Association for the Safeguard of the Oasis of Chenini (ASOC). However, production remains low compared to the existing potential.

It is important to specify that the available data do not allow us to know the quantities of organic waste directly from the date palm.

Table 2: Evolution of the quantity of total compostable organic waste per governorate

gouvernorat	***2014***			***2019***		
	Waste used	***Total waste***	***% waste used***	***Waste used***	***Total waste***	***% waste used***
	10^6 kg/year	***10^6 kg/year***		***10^6 kg/year***	***10^6 kg/year***	
Gafsa	56.6	205.0	27,6%	92.2	264.3	34,9%
Gabès	80.5	228.3	35,3%	127.6	299.2	42,6%
Médenine	139.6	399.4	35,0%	215.5	517.0	41,7%
Tozeur	19.1	46.7	40,9%	31.6	63.5	49,8%
Kébili	18.0	71.9	25,0%	30.3	93.0	32,6%
Tataouine	19.7	104.9	18,8%	32.5	131.4	24,7%

2.1.2 Existing composting structures

2.1.2.1 Municipal composting stations

In 2017, the composting experiments of the pilot stations of Sousse and Sfax started within the framework of the Euro-Mediterranean strategic platform project of adapted waste management MED-3R (Recycle, Reduce and Reuse) financed at 90% by the European Union.
The other Tunisian municipalities will then be able to take advantage of the experience of these two municipalities to create their own organic waste composting stations. However, the composting technique is often neglected and sometimes even non-existent in several governorates.

2.1.2.2 On-farm composting stations

Grissa (2017) precised that, in Tunisia, some farmers produce their own composts on their farms, especially organic farmers. Most of the composts produced are the result of co-composting. Woody agricultural wastes are indeed used by farmers because they have a strong structuring power for the composting of agricultural manures. Windrow or pile composting is the most common method on the farm. The size of the windrow depends on the size of the equipment used to turn the compost. Most on-farm composting is done by hand or with a tractor-shovel. Only a few farmers use a windrow turner or forced aeration tunnel system.
These farmers benefit from technical assistance and support from the CTAB (Technical Center for Organic Agriculture) and a subsidy for the purchase of equipment necessary for compost production. In addition, the organic agriculture directorates in most CRDAs (Regional

Commissariat for Agricultural Development) provide farmers with a crusher for agricultural waste.

The majority of farmers recognize the word compost but they cannot associate it with a concrete material as they have never seen it and often compare compost to manure. Even if they don't use compost, some farmers are able to list some of its benefits. Farmers need information and training to make compost. Farmers make compost to increase the organic matter content of their soil and maximize crop yields. They adopt this practice when they realize the positive effects of it through their experiences, observations and discoveries in the field during visits to the units of specialized organizations (CTAB, ...) or to farmers during awareness days.

Thus, the collaboration between agricultural professionals and farmers can play an important role in the acceptance of the composting technique. Farmers' decision making is influenced by profitability and by different factors such as available resources, mobilizable means, economic situation of the farm, technical assistance or training. The availability of various organic materials (especially manure and green waste) encourages farmers to make their composts, but the lack of farm machinery (especially the shredder) can slow down the implementation of the composting technique, especially in the oasis regions.

2.1.2.3 Private composting stations

In connection with the environmental policy, there is a boom in composting to transform green waste into organic amendment. The structures are presented in the form of companies or associations. In private composting stations, Grissa (2017) precised that quality of the compost is excellent. However, it is sold with some difficulty. Composting companies or associations often struggle to develop their compost marketing and distribution programs at the beginning of their operations due to poor planning and a lack of expertise in demonstrating and popularizing the benefits and features of the product.

2.1.3 Production and use of biochar

Biochar is not produced or used on a large scale in Tunisia. No farms have been identified as using biochar. It is mainly used for research purposes.

2.2 In the palm groves of Nefzaoua

The study was conducted in the oasis of Nefzaoua. Nearly 280 farmers, or 42% of farmers, were interviewed. The study was conducted by researchers from the Institute of Arid Regions of Medenine

2.2.1 Characteristics of the oasis of Nefzaoua

The cropping system in the oasis consists mainly of date palm plantations. 96% of the farmers interviewed own more than 100 palm trees each. In parallel, alongside date palms, farmers grow fodder for domestic animals or for trade. Due to the availability of irrigation water, some farmers also grow vegetables for household consumption.

2.2.2 Farmers profile

The demographic information of the interviewed farmers is presented in Figure 1. It shows that 49.5% of the farmers involved in the farming work are old and illiterate, 38.7% of the farmers are middle-aged and possessed basic primary and middle education levels. The young farmers represent only 11.8% of the farmers who work in the oasis. They have had more school education than the older farmers.

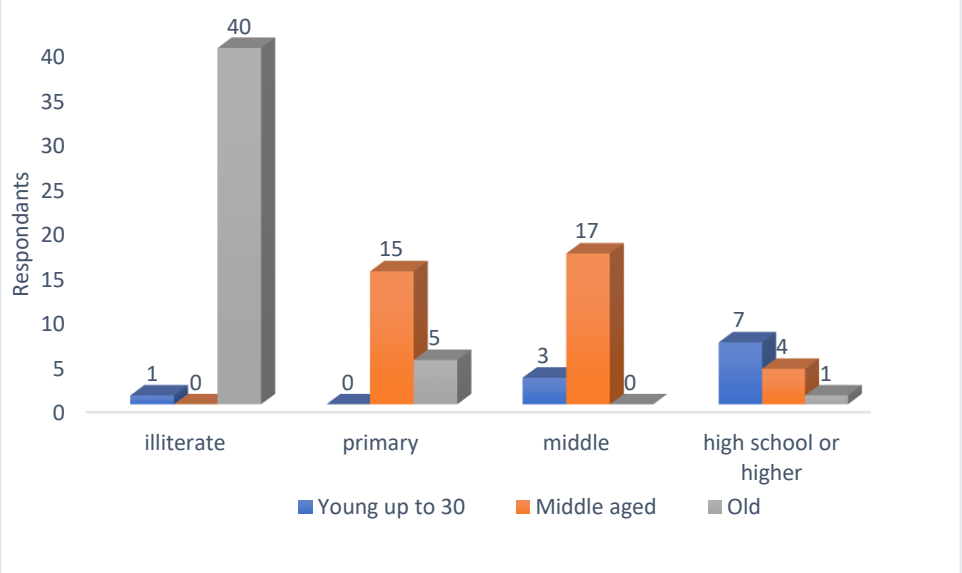

Figure 1: Distribution of respondents according to their age and literacy level

2.2.3 Use of organic amendments

A large majority of the interviewed farmers said that they have some sustainable farming practices to fight soil degradation (96.8%, Table 3). According to the farmers, the soil conservation measures they use help to limit soil erosion and mitigate the effects of soil salinity and hydromorphy. Most farmers (90.3%) apply sand mixed with animal manure to improve soil fertility. Few farmers (6.5%) apply windbreaks near their fields to avoid soil erosion and breakage of palm branches by strong winds.

Farmers believe that the fight against oasis degradation is complicated, that it is beyond their capacities and that the applied agricultural practices do not present a long-term and radical solution to limit the general degradation of oases but rather help to mitigate the local effects of this degradation.

The results of the interviews revealed that most farmers (84.9%) acquired their knowledge of land management from other farmers (farmer-to-farmer knowledge).

Table 3: Amendments applied by farmers

Farmer's response to	Frequency	Percent (%)
Farming practices combating oasis degradation		
Yes	275	96,8
No	3	3,2

Sustainable practices adopted		
Use of sand and organic matter amendments	264	90,3
Wind breakers to avoid wind erosion	6	6,5
No adopted practices	8	3,2
Source of knowledge		
Ancestors	14	7,5
Farmer to farmer knowledge	259	84,9
state rules and regulations	2	2,2
Agricultural extension services	5	5,4

According to the results of the survey, in the Nefzaoua oasis, the average quantity of dune sand supplied is 491 ± 92 m^3 per hectare of cultivated area. For manure, the average quantity supplied is 31 ± 7 tonnes per hectare of cultivated area.

All the farmers interviewed who use mineral and organic soil amendments say that in the year of application of the soil amendment, there is little or no improvement in the yield of the date palm. According to the farmers' explanations, after tilling the soil and applying the amendment, the tree regenerates its roots. Thus, several farmers visited observed that the amendment applied will have a positive effect on the morphology of the palm tree and will increase the number of palms on the palm tree. It is after the first year of application of the amendment that the yield of the date palm is improved for 48% of the farmers concerned (Figure 2). This improvement is observed in the second year after the application of the amendment for 35% of the farmers. This improvement is observed by 17% of the farmers in the third year after the amendment. It is generally at the end of this period, 3 years, that the farmer renews the amendment in his cultivated plot.

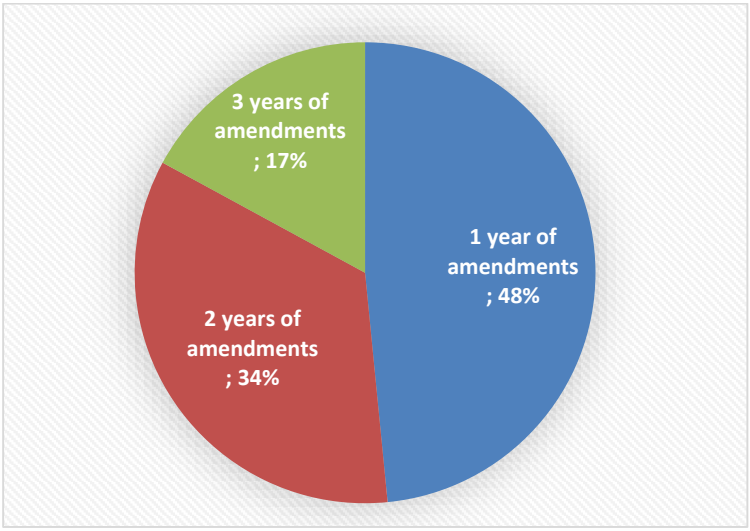

Figure 2 : Effect of soil amendment in improvement of date palm production

Surveys of farmers have shown that there is no use of date palm biochar in particular or even biochar in general in the oasis of Nefzaoua.

3 Algeria

The use of compost and biochar was studied in the palm groves of the three Algerian study regions: the Oued Righ valley, the Zibans and the Ouargla region.

These surveys aim to identify the level of recycling of date palm waste mainly in the form of compost and biochar as an organic amendment in the framework of a circular economy to i) meet the needs of sustainable oasis agriculture and ii) improve the physico-chemical characteristics of soils.

The surveys were conducted in the Ziban region (around the Biskra site) where more than 40 farmers were interviewed. The investigated communes are Djammourah, Chetma, Ain Naga, Biskra, Foughala. The interviews with the farmers were conducted directly on their farms. The choice of farmers was random for a better representativeness of the results. In the region of Oued Righ, about fifteen farms were visited along the valley. The communes concerned are Timbesbest, Ourir Temacine, Nazla. In the region of Ouargla, the commune concerned is Hassi Ben Abdallah. The exact number of farmers interviewed was not specified.

3.1 Age and level of education of farmers

The age of the farmers on the farms varies, with the majority of farmers being between 45 and 55 years old. They have a primary to secondary school level, 12% of them have a university education. Few have had any formal agricultural training (2%). Most have inherited the know-how.

3.2 Use of organic or mineral amendments

Fertilization and soil amendment in the oases of the regions studied are sometimes weak. If they exist, they are only practiced in the largest farms.

Mineral inputs are rarely used in the Oued Righ region, unlike in the Ziban (Beziouche, 2000).

Organic amendments are used in the three regions studied and are constantly increasing. The main use of organic matter is in the form of manure, especially sheep manure. More than 90% of producers in the Ziban region use organic matter, although the quantities applied are low and below the doses recommended by ITDAS (80 kg of manure/tree/year applied against 150 kg recommended).

3.3 Date palm waste

Producers from the areas concerned declare that, each year, significant quantities of date palm waste are produced during the different agricultural works of the technical itinerary: grooming, pruning, harvesting and packaging. The quantities obtained are between 4 and 15 quintals depending on the producers, the regions and the cultivation system.

Approximately 30% of producers value its date palm waste in the regions of Oued Righ and Ouargla (Figure 3). The proportion is lower in the Zibans. Several types of recovery are indicated:
- use of the palms as windbreaks or fences;
- use of certain parts of the palm such as carnaf or lif as an amendment to their date palm;
- use as livestock feed;
- sale of the palms to handicraft producers.
Composting, on the other hand, is never mentioned for the valorization of date palm agricultural residues.

The rest, 70% of the farmers, incinerate this agricultural waste.

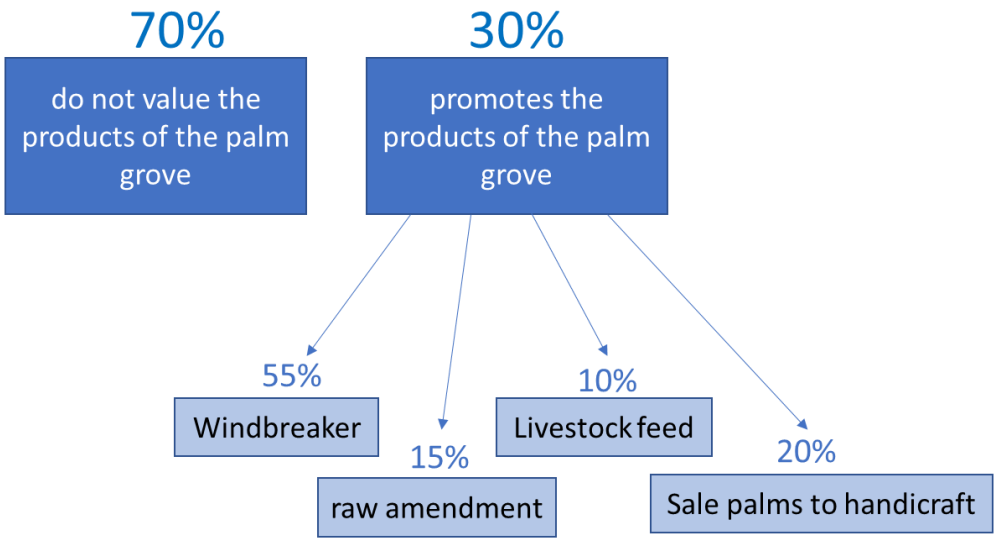

Figure 3: Valorization of date palm waste in the studied regions

3.4 Composting

Apart from the ITDAS farm as an experiment and the existence of a compost manufacturing unit recently installed in the wilaya of Biskra, Palm Compost, our project partner, waste composting is very little used.

60% of the farmers interviewed know or have already heard of the usefulness of compost as an alternative to mineral amendments to improve soil fertility and contribute to improving production in quantity and quality. Some farmers are aware of environmental issues and the role of compost in sustainable agriculture. However, the level of technical knowledge of compost production is very low among producers according to our survey, except for the shredding operation. Indeed, a category of producers express their needs in knowledge on the preparation and use of product.

When asked about the purchase and use of this type of compost if it were available on the market, 68% of the producers agreed with the use of compost made from date palm residues in the different crops grown on the farm, particularly in date palm, but under certain technical and

economic conditions (Figure 4). In particular, these producers insist on the availability of the product in quantity, in quality, in a permanent way and with reasonable prices on the local markets. Other producers put forward the condition of availability of information and of adequate and necessary popularization of the techniques of use by the specialized institutions. Others ask for demonstrations and reliable results, because they tried but the results were disappointing.

Producers who refuse the purchase and use of compost in their agricultural activities, put forward as arguments the ignorance of the advantage of compost, the financial difficulties or the non-need for this product at present. However, they declare the possibility of reconsidering their decision if the compost gives good results.

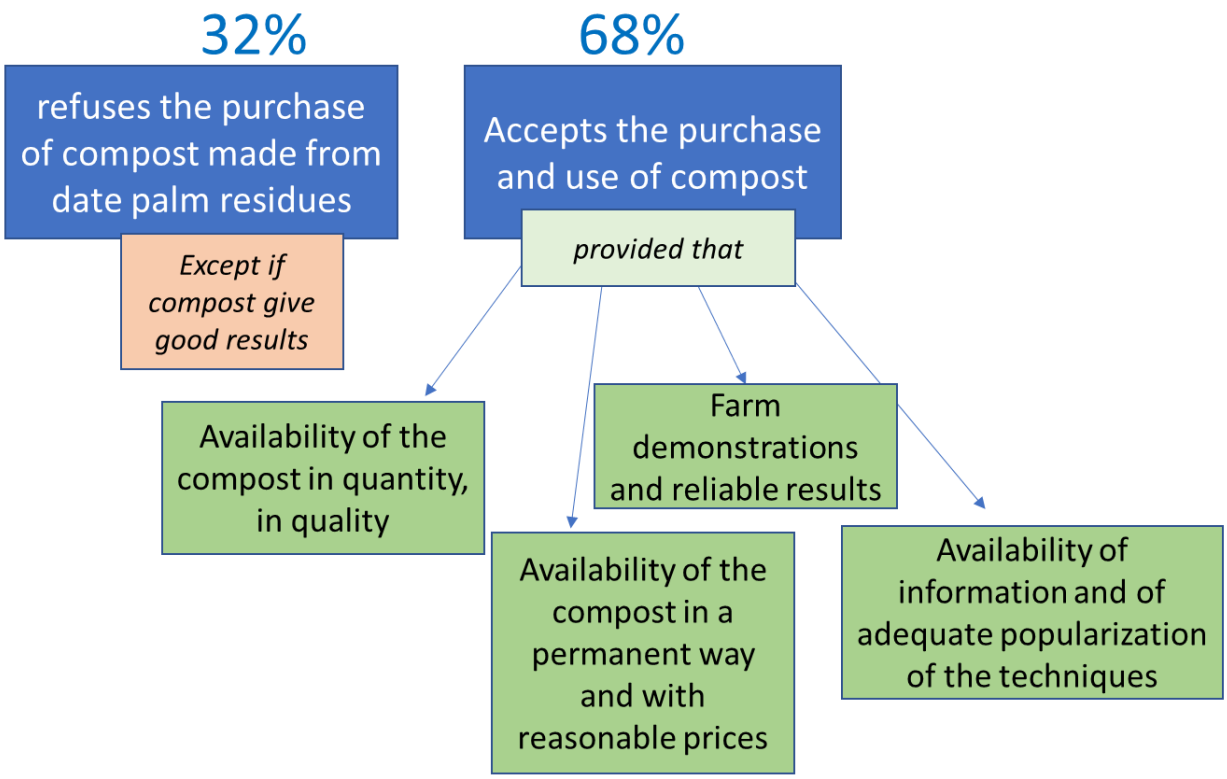

Figure 4: Results of agricultural surveys on the possibility and conditions of purchase and use of compost available on the market

3.5 Constraints to waste recovery in the study areas

According to data from agricultural surveys and our experiences in the field, several constraints hinder the recovery of date palm residues in the form of compost in the regions studied. These constraints are technical, sociological and economic (Figure 5).

Technically, the quantities of the raw material are currently insufficient and there is a lack of knowledge of composting technology by farmers.

Sociologically, the lack of knowledge of manufacturing techniques, the lack of popularization and awareness by specialists and institutions such as ITDAS, INRAA and others, and the absence of qualified labor hinder the development of composting.

Finally, the virtual absence of the installation of compost manufacturing units in the regions studied, the lack of funding, the absence of studies of the economic profitability of the activity and the lack of demand for the product represent the constraints economic.

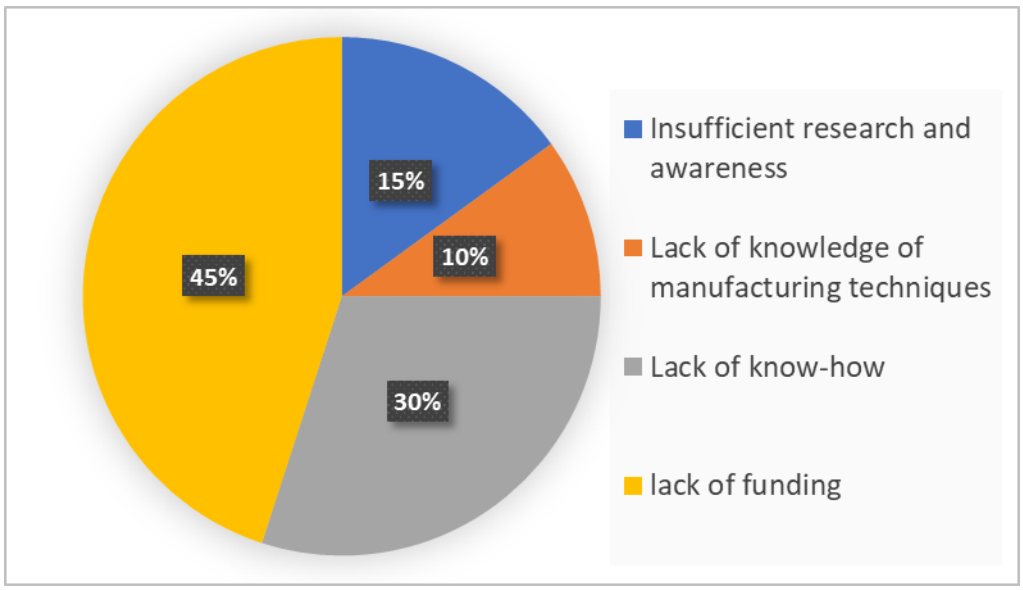

Figure 5: Breakdown of producers according to constraints on compost recovery

3.6 Prospects for the development of compost production

The prospects for using compost made from date palm waste in palm groves are favorable on the one hand because of the willingness of producers, certain stakeholders and the public authorities, and on the other hand, because of the good perception and level of awareness of producers on environmental issues and sustainable agriculture.
Therefore, the strategy to be followed to promote the recycling of agricultural waste from date palm for the production of compost must be based on:

- Sensitization of producers to use this type of amendment with the presentation of reliable results in the field;
- Reinforcing the training of technicians and producers on the techniques of making and using compost;
- The encouragement of investments in this context by financing projects for the installation of small units for the production of better-quality compost;
- The development of scientific research for the establishment with producers of the best compost formulas with a minimum of cost and high efficiency;
- Prepare and organize an extension campaign on compost management for farmers, on the positive effects on soil fertility and structure, water retention and the effect of temperature.

3.7 Production and use of biochar

Biochar is not produced or used on a large scale in the studied regions. No farms have been identified as using biochar. It is mainly used for research purposes.

4 Conclusion

Composting seems to be more developed in Tunisia than in Algeria. Indeed, private and public structures have developed in Tunisia and have led to a significant production of compost.

However, in Tunisia or in Algeria, compost based on date palm residues are little known and little used by the farmers who prefer using organic amendments like the animal manure. Even if some of the date palm producers recycle date palm agricultural residues, they never mention composting to recycle these residues.

Whatever the country, there are few structures allowing the production of compost based on date palm residues. Nevertheless, almost 2/3 of the interviewed farmers agreed with the use of compost made from date palm residues provided that the product is available in quantity, in quality, in a permanent way and with reasonable prices on the local markets. Farmers also ask for demonstrations and reliable results.

The strategy for promoting the recycling of date palm agricultural waste for the production of compost must be based i) on making producers aware of the use of this type of amendment with the presentation of reliable results in the field, ii) on the reinforcement the training of technicians and producers on the techniques of making and using compost, iii) on encouraging the financing of the installation of small production units of better quality compost, iv) on the development of scientific research projects in collaboration with local farmers to define the best compost formulas with minimum cost and high efficiency, and v) on the presentation of the advantages of compost for farmers, in particular the positive effects on soil fertility and the water retention.

In Algeria and in Tunisia, biochar is not produced or used on a large scale. It is mainly used for research purposes. The ISFERALDA project aim at developing the research on that amendment so that biochar is better known and well accepted by producers.

This report shows the importance of the ISFERALDA project to improve the acceptability of the organic amendments studied among farmers. Field trials and visits to experimental farms fall squarely within this framework.

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