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D5-7 Socio-economic study of impact of organic amendments on farmers' incomes

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Summary

This study aimed to identify the obstacles limiting the acceptance and development of strategies for valorizing date palm residues, producing organic amendments (OAs) from this waste, and encouraging their use by farmers in the studied regions. Additionally, it sought to evaluate the potential economic benefits of using these OAs for oasis farmers. This study was based on bibliography and interviews for farmers and compost and biochar producers. Due to the novelty of the subject, the limited availability of compost and biochar producers using date palm residues, and the low number of farmers using compost as an amendment in both countries, our study was conducted with a small sample of these stakeholders. This limitation have to be considered in the analysis and interpretation of the results.

Despite the availability of raw materials and technical feasibility, compost production from date palm residues remains underdeveloped, with only four units identified across Algeria and Tunisia. Producers were hesitant to disclose precise cost and profit data, citing confidentiality concerns, limiting the economic analysis of profitability.

Currently, the profitability of date palm compost is moderate due to rising production costs, especially in Algeria, where taxes and competition from established producers and imported compost challenge its market position. In Tunisia, compost remains competitively priced but would benefit from increased production and improved distribution. Key customers include wholesalers, seed merchants, and farmers, highlighting the need for robust distribution networks.

Promoting compost use requires better farmer awareness, increased production, product diversification, and cost reduction to ensure affordability. Survey findings indicate promising prospects for compost in agricultural applications, supported by appropriate policies and programs to drive adoption and growth.

Biochar production from date palm residues is nearly absent in Algeria and limited in Tunisia, with little data available on its long-term effects in oasis agro-ecosystems. Despite investments in large-capacity furnaces, production remains stable. Biochar is profitable for Tunisian producers due to low production and distribution costs and a lack of competition, giving them a market monopoly.

Farmers represent about 80% of biochar sales, with researchers and nurserymen accounting for smaller shares. Greater adoption of biochar could be achieved through awareness campaigns, communication efforts, and scientific studies highlighting its ecological and economic benefits. Supportive agricultural policies and programs could further accelerate its use, enabling significant growth in the coming years.

Concerning date palm compost use, farmers identified key obstacles, including insufficient equipment (50%), absence of demonstration plots (30%), lack of technical knowledge (20%), and limited availability of quality manure (10%). Despite these challenges, 90% perceive compost use as environmentally beneficial, while 70% report reduced production costs and half observe improved yields and crop quality. However, 50% have yet to see significant agronomic impacts.

To promote compost use, farmers recommend awareness campaigns (40%), pilot plots for training, subsidized collective grinders, and practical guides. Nearly all current users plan to continue using compost, and 60% of non-users intend to adopt it soon.

Barriers include the complexity of the composting process (40%), long maturation times, and the need for regular monitoring. Additionally, 20% of farmers highlight the high cost of production as a significant limitation. Training and financial support are essential to overcome these challenges and encourage widespread adoption.

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1 Introduction

In the ISFERALDA project, several organic amendments (OA) were studied in the laboratory and in the field. These are compost made with date palm residues and animal manure and biochar made from date palm residues. Mixtures of these OAs with each other or with other nutrient inputs were also tested. This study was performed in order to assess the socio-economic impact of the studied OA.

The main aims of this study were to identify the obstacles that hinder the acceptability and the development of the valorization of date palm residues, the production of OA from this waste and the use of these OA by farmers in the regions studied and to try to evaluate the potential economic gain from the use of these OAs for oasis farmers. For the second objective, the main problem was therefore to know if the gain in terms of agricultural yield compensate the costs incurred by the use of OAs and to compare with other fertilizers, particularly chemical fertilizers.

In order to be able to carry out this socio-economic study, different sub-objectives were defined notably based on the state of the art carried out in deliverable D4-1. We therefore sought i) to identify the obstacles to the development of the production and use of organic amendments such as date palm compost and biochar, ii) to know the strategies adopted by producers and farmers to address these obstacles, iii) to evaluate the economic performance of the production or use of compost based on date palm residues, and iv) to identify the actions and practices implemented to promote the production, the use and the acceptability of these OAs.

To achieve these objectives, a bibliographic research was carried out, a field survey work with OA producers and farmers was conducted in the study regions in Algeria and Tunisia and the data of the ISFERALDA project acquired in the laboratory and in the field were used. This report is divided in three parts according to the different socio-professional categories interviewed.

2 Method used

Based on the bibliography and preliminary interviews, 3 questionnaires were drafted for the 3 types of stakeholders (farmers, compost and biochar producers). These questionnaires are composed of several questions of different types, open and closed, quantitative and qualitative, technical and socio-economic related to the subject and objectives of the study. Questionnaires for compost producers and users in French are presented in Appendix 1.

The interviews were conducted with 2 compost producers, 1 biochar producer and 10 farmers using compost based on date palm waste in the two date palm growing regions studied in Algeria and Tunisia. These surveys were carried out directly with those concerned in the field in order to have direct exchanges; they allowed us to analyze all the responses to our questions in relation to the objectives of the study.

Given the originality of the nature of the subject, the small number and unavailability of many producers of compost and biochar based on date palm residues, and the small number of farmers using compost as an amendment in both countries, we were forced to work with a small sample of these actors, especially for producers. This small number will have to be taken into account in the analysis of the results.

3 Compost producers

Despite the date-producing vocation of Algeria and Tunisia since Antiquity, with a date-producing heritage of nearly 20 and 10 million palm trees in Algeria and Tunisia respectively, and although these palm groves produce a considerable amount of date and palm waste, the recovery of these agricultural

residues in compost to amend the soil remains low, both at the traditional level and on an industrial scale. This situation persists despite the availability of raw materials and technical feasibility. The number of compost production units from this waste is very low despite the need for fertilizers for agriculture. Indeed, to our knowledge, to date, the number of production units for the date palm compost is four, two in each country.

3.1 General information

The compost producers surveyed in both countries are between 37 and 60 years old. Although they have no specific agricultural training, they have a university degree. The producers interviewed are of oasis origin and work in the agricultural sector, particularly in date palm farming.

The production of compost from date palm residues is older in Tunisia, where it began in 2015, while in Algeria it only began in 2020. The production workshops are located on areas ranging from 0.43 to 1 ha. The type of production practiced is entirely industrial. They produce compost based on palm waste and manure, with the addition of some nitrogen, carbon or phosphorus additives and organic substances.

In terms of quality, the producers interviewed stated that their composts are of good quality, according to the results of analyses carried out in specialized laboratories. In Tunisia, the analyses carried out by the Food Quality laboratory revealed the following results: P_2O_5: 0.76%, MgO: 0.86%, NO: 54.42%, and a C:N ratio of 15.85. For Algerian producers, the analyses were carried out by the Messaoui laboratory in Biskra and the FATILAB laboratory in Oued Souf. The results obtained comply with the standards with a C:N ratio ranging from 15 to 30 and a nitrogen content ranging from 1 to 3%.

3.2 Compost production

According to our surveys, to produce 100 kg of compost, 1 m³ of water, 140 kg of palm and 70 kg of manure are needed. To obtain the raw materials needed to produce date palm compost, different procurement strategies can be implemented. Procurement can focus on using residues from their own and neighboring palm groves. The majority of this supply therefore comes from neighbouring palm groves or from palm groves of acquaintances from other regions obtained either for free or at a lower cost. The procurement strategy can also be based on the diversification of sources, in order to limit the risks of supply disruptions and mitigate the impact of a possible increase in the prices of essential raw materials.

Manure is generally purchased from livestock farmers on the markets.

Among the 2 producers interviewed in Algeria and in Tunisia, date palm compost production is increasing (Figure 1). The analysis shows that the Tunisian producer started his compost production longer ago, but the Algerian producer has a production that is growing faster. The recent period has seen an accelerated growth in production in both countries, with a particularly marked trend in Algeria.

In Tunisia, from 2015 to 2020, the production of date palm compost increased steadily from 32 tons in 2015 to 80 tons in 2020. This period shows a stable growth with an average annual increase of 9.6 tons. Between 2021 and 2023, a significant increase is observed, from 80 tons in 2020 to 190 tons in 2021, an increase of 137.5%.

In Algeria, from 2015 to 2019, compost production had not started, but from 2020, production starts with 25 tons produced, then increases rapidly to reach 100 tons in 2023.

Figure 1 shows that the current trend of date palm compost production among the 2 producers is increasing. It therefore seems that production has not yet reached its peak and demand is not yet fully satisfied.

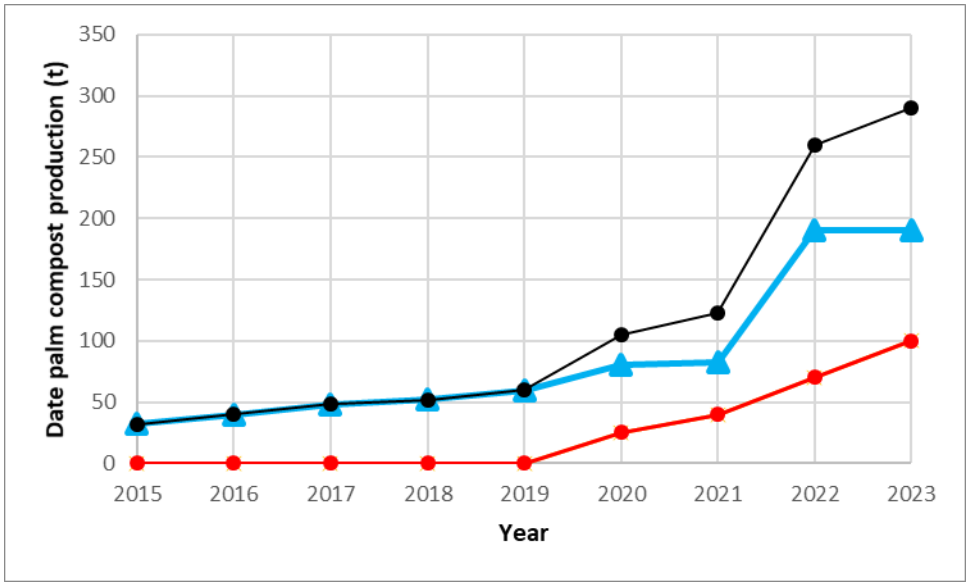

Figure 1 : Annual date palm compost production in Algeria and Tunisia

This increase in production responds to an increase in demand. In both countries, Algeria and Tunisia, the compost producers in our panel have noted an increase in market demand in recent years. The evolution of demand for date palm compost depends on several factors, including the quality of the product, the price level compared to other amendments, the improvement of farmers' perception of environmental protection, as well as awareness-raising actions carried out among them. However, even though it is increasing, this demand remains below the objectives expected by the compost producers interviewed, and this for several reasons: in Tunisia, the increase in prices limits access to the product, while in Algeria, the lack of awareness and marketing leads to a lack of knowledge among some farmers of the advantages and availability of this product on the markets.

3.3 Production cost and profitability

To introduce this part, it should be noted that the small number of producers interviewed meant that the producers preferred not to answer precisely the questions relating to the cost of production and the profits made. They considered that the data were not sufficiently anonymized and were afraid of disclosing industrial secrets. The data are therefore not sufficiently precise to carry out a precise economic study to know accurately the profitability of these installations.

Production of date palm compost requires water, date palm residues, animal manure and, on average, the intervention of two workers. Taking into account packaging and transport costs, the purchase and production costs of compost based on date palm residues in Tunisia is about 40 €.ton^{-1} (130 Tunisian dinars, TD), with a distribution cost of 120 €.ton^{-1} (400 TD). In Algeria, the purchase and production costs are 215€.ton^{-1} (30,000 Algerian dinars, AD), and the distribution cost, for a 20-ton truck, is about 3,600 € (500,000 AD) for a Biskra-Ouargla trip, or 180 €.ton^{-1}. For comparison, the distribution cost in Biskra is between €360 to €570 (50,000 to 80,000 AD) per 4-ton truck, or between €90 and €143 per ton.

The selling price of date palm compost varies from one country to another and from one type of compost to another. This price has undergone a significant evolution, according to the statements of the respondents in both countries between 2015 and 2024 (Table 1).

In Algeria, the price of compost based on sheep manure varies between 250 and 360 €/ton and this price can vary depending on the type of animal manure added.

In Tunisia, the price of compost has undergone a significant evolution of 100% between 2015 and 2023, going from 90 €/ton to 180 €/ton in 2024. This evolution of prices reflects the growing importance of compost in agriculture and the recovery of organic waste.

The price of date palm compost is moderately profitable for the producers in our panel in Algeria and Tunisia, due to the increase in production costs in recent years. However, it could become more profitable with an increase in the quantities produced and therefore sold. In Tunisia, this price remains competitive on the market. On the other hand, in Algeria, it is less competitive due to the increase in production costs and the increase in tax charges. This price is also less attractive compared to the oldest and well-established compost producers, who generally present their production in good packaging and benefit from a large loyal customer base. In addition, the prices of compost imported from Jordan are considered more competitive by the producers interviewed in Algeria.

Table 1 : Price of date palm compost for the 2 interviewed producers

Price (€.ton^{-1})	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Tunisian producer	90	90	105	120	120	120	120	120	180
Algerian producer	-	-	-	-	-	-	250	320	320

3.4 Marketing opportunities for producers

3.4.1 Commercial outlets

Marketing compost can be a complex activity for producers in both countries due to the difficulty of finding markets and the diversity of customers and distribution channels. In order of importance, the customers identified are:

- Wholesalers represent approximately 50% of sales. They purchase large quantities of compost to resell to retailers or other intermediaries. They play a crucial role as intermediaries in the supply chain.

- Seed merchants represent approximately 40% of sales. They sell seeds and other agricultural supplies and constitute a significant portion of compost producers' customers. They often integrate compost into their product offering to attract farmers and gardeners.

- Farmers represent 10% of sales. Although farmers are the end users of compost, they represent a small portion of direct sales. This may be due to the fact that they often purchase through intermediaries such as wholesalers and seed merchants.

This breakdown shows that compost producers need to focus on compost production, but also on building strong relationships with wholesalers and seed merchants to ensure efficient distribution of their products.

3.4.2 Geographic distribution of customers

Regarding the origin of customers and the extent of compost marketing, only 5% of production is sold locally, close to the place of production. The majority of production is marketed in different regions of the two countries: Tébessa, Ouargla, Batna in Algeria, and Gabes and Tozeur in Tunisia.

Several factors explain this distribution. The benefits of date palm compost are well known in regions far from the place of production. Farmers in these regions have recognized the added value of this compost compared to unprocessed palm grove waste. This knowledge promotes the adoption of the

product. In addition, producers of these composts have personal and professional relationships in these regions, which facilitates trade and acceptance of the product.

The low local demand is mainly explained by the lack of knowledge of the product. In addition, local farmers are not sufficiently informed about the benefits of producted compost compared to raw waste that is easily accessible because it is nearby.

In summary, commercialization of compost is widely promoted in non-local areas due to recognition of its benefits and producer networks, while local demand remains low due to lack of information and availability of unprocessed date palm residues.

3.5 Activity-related constraints and strategies implemented

3.5.1 Constraints

Many constraints hinder the smooth running of the activities of the producers of date palm compost interviewed in Algeria and Tunisia. These obstacles are diverse.

In terms of supply, the increase in the prices of certain raw materials and the insufficiency of financial resources to cover these purchasing costs pose a problem. In terms of production, respondents in both countries emphasize the increase in production and cost costs, which is reflected in the selling price, sometimes to the detriment of the competitiveness of the products. The most significant constraints in the area of marketing vary according to the country: in Tunisia, the lack of information given to farmers limits the demand for compost, and in Algeria, the main difficulty lies in the lack of outlets due to competition from other products, particularly imported ones. In addition, late payment by customers creates cash flow problems.

3.5.2 Strategies implemented

The strategy of the producers surveyed to improve the profitability of their production consists of increasing the supply by adapting their products to the needs of the market according to the expectations of farmers and the specificities of the different agricultural regions.

In terms of marketing, the compost producers surveyed rely on a promotion strategy focused on the constant search for new points of sale throughout the country. This marketing strategy is based on 2 methods: traveling to different regions to identify new outlets for their products, and creating a website and social media pages to promote the company's products to a wide audience.

To improve quality and reduce production costs, producers seek to modernize their equipment. They also participate in scientific research projects, in order to benefit of the results obtained as in the framework of the ISFERALDA project.

In order to transmit their knowledge on compost, particularly to technicians and farmers, the respondents organized numerous popularization and awareness-raising sessions. In Algeria, these activities took place mainly within the chamber of agriculture and with seed producers, while in Tunisia, they were conducted during awareness-raising workshops organized by specialized institutions. The producers interviewed in both countries also expressed the need to acquire additional knowledge and training on the use of composts on farms, in order to improve the technical, economic and environmental performance of their products and to meet market requirements with an economically profitable, technically viable, efficient and environmentally friendly product.

According to the respondents, the strategy to promote the use of compost in both countries should be based on several axes: i) strengthen communication with farmers so that they know the effects of compost on crops, ii) increase production in quantity and quality and iii) diversify the range of

products, with various types of packaging and weights. Finally, it is essential to reduce production costs in order to make sales prices accessible to all categories of farmers.

3.6 Impact of using compost

During our survey, we sought to gather producers' opinions on farmers' appreciation of the use of compost made from date and palm grove waste.

Although this does not concern most of the customers, all the compost producers surveyed in Algeria and Tunisia have received complaints from some customers regarding the compost sold. In Algeria, these complaints mainly concern the poor quality of the compost. In Tunisia, they concern both the quality and the high price of the product.

Despite these negative points, according to the compost producers surveyed, the use of compost as an amendment in the agricultural regions where they operate has a very positive impact on several levels. Their compost improves the quality and fertility of the soil. The producers emphasize that their customers have recorded an increase and improvement in yields and crop quality. Regarding the environmental impact, this date palm compost contributes, according to the producers, to the preservation of oasis ecosystems through the use of a natural and organic amendment, thus limiting the use of chemical fertilizers. On the social level, the impact is also appreciated particularly in Tunisia, because farmers feel integrated into the protection of the oasis system by using a natural and healthy organic amendment without pathogens as in manure.

3.7 Perspectives

The analysis of the surveys reveals positive prospects for the use of compost based on date palm waste in the amendment of palm groves and other crops in both countries. In Tunisia, a real evolution in the use of compost was observed according to the producers in our panel. In Algeria, the prospects would be even better with a reinforcement of awareness-raising actions, as well as appropriate support for agricultural policies and programs in this area. The evolution of agricultural practices and the promotion of this organic amendment could lead to a significant growth in its use in the years to come.

4 Biochar producers

The production of biochar from date palm residues is almost non-existent in Algeria and remains limited in Tunisia, with only two producers operating on a small scale despite the availability of the raw material. Indeed, biochar is a new amendment that is little known and very little used by farmers in the arid and semi-arid zones of Algeria and Tunisia. There is little data to date on its long-term effects in oasis agro-ecosystems.

4.1 Biochar production

Currently, companies producing biochar use the slow pyrolysis technique for tree pruning residues, but do not yet integrate palm grove waste into their process.

The production of biochar follows the following steps: the wood is first crushed, then pressed, before being subjected to a slow pyrolysis process up to a temperature of 450°C. Once pyrolysis is complete, the product is crushed a second time before being packaged.

The producers interviewed stated that the biochars produced comply with the standards recommended for this type of product. Analyses carried out in specialized laboratories have highlighted a high carbon content and a low nitrogen content.

The evolution of biochar production since 2015 has been almost stable. Indeed, production increased from 15 tonnes in 2015 to 16 tonnes in 2023. This near stability occurred despite significant investments, notably the purchase of new large-capacity furnaces intended to boost production.

Although increasing, the demand for biochar remains below the expectations of the biochar producers interviewed for several reasons. In Tunisia, the increase in prices limits access to the product, and the lack of awareness and communication actions lead to a general lack of knowledge of the properties of biochar as well as its availability on the market. The total absence of this type of action is mainly explained by the lack of personnel dedicated to these awareness-raising activities and the dissemination of information on practices and different agricultural products.

4.2 Production cost and profitability

According to the surveys, the production of 100 kg of biochar requires various costs: electricity and the intervention of two workers for two days. This brings the production cost to approximately 1.5 Tunisian dinar per kilogram (€0.45), rising to 3 TD per kilogram (€0.90) including packaging and distribution costs.

The selling price of biochar has seen a gradual and marked increase over the years. Between 2015 and 2024, it increased from 1 Tunisian dinar (€0.30) to 3 Tunisian dinars (€0.90) per kilogram.

Biochar remains a profitable product for the producers of our panel due to low production and distribution costs in recent years. In addition, the current lack of significant competition gives them a monopoly position in the Tunisian market, making them competitive. The increase in sales volume and therefore the decrease in production costs could further increase the profitability of this price.

4.3 Marketing opportunities for producers

The marketing of biochar in Tunisia is both an essential and complex activity for producers, due to the difficulties related to outlets and the diversity of customers and distribution channels. Farmers are the main market and represent approximately 80% of the volumes sold. This high proportion is explained by direct relationships between producers and farmers which avoid price increases due to intermediaries such as wholesalers and specialized distributors.

A significant but minority part of biochar sales is intended for researchers, who use it in their laboratories and experimental stations. This part illustrates the fact that research work is still underway to acquire data on these products. There is indeed no data on the long-term effects of biochar in soils.

As with compost, nurserymen provide an outlet for biochar producers.

The distribution of sales highlights the need for producers not to limit themselves to production, but to strengthen links with the agricultural sector in order to facilitate distribution and promote the use of biochar on the basis of reliable scientific data.

Regarding the geographical extent of marketing, about 30% of sales are made locally, while 20% are made at the regional level. Half of the stock is sold in various other regions of the country, indicating a limited but promising diffusion.

4.4 Activity-related constraints and strategies implemented

Unlike compost producers, biochar producers do not face major constraints in terms of supply, production or marketing. However, according to the producers interviewed, to effectively promote the use of biochar, it is necessary to implement specific strategies that should be structured around several axes. It is essential to organize regular meetings with farmers, in collaboration with agents and

technicians from specialized institutions, such as the CDDA (Sustainable Agriculture Development Center) and the chambers of agriculture. These meetings would aim to provide farmers with the necessary information on biochar so that they can make an informed choice. These initiatives should also include practical demonstrations and information sessions to build the confidence of potential users and provide them with information on the advantages and disadvantages of the products.

To improve the technical and economic performance of their activities, biochar producers in Tunisia adopt various strategies.

One of the main priorities is the supply of raw materials. This therefore consists of collecting large quantities of wood in order to constitute a sufficient and regular stock. The objective is to guarantee the continuity of production by avoiding supply disruptions that could lead to interruptions in the operation of production units and a loss of productivity. This proactive approach allows producers to secure their supply chain and reduce the risks associated with seasonal fluctuations or disruptions in the availability of raw materials. In addition, this efficient stock management helps to stabilize production costs, thus ensuring increased profitability and better competitiveness on the market.

To improve their production capacity, biochar producers in Tunisia adapt their offer according to market needs and demand. A major strategy is to plan the purchase and installation of a second large-capacity furnace to meet the growing demand and increase production.

In terms of marketing, Producers take advantage of the visibility offered by social media by creating pages on Facebook to ensure the dissemination of information and promote their products. They also rely on their customers to promote the products in order to develop their network and reach new customers.

To improve quality and reduce production costs, these producers are looking to modernize their equipment. The acquisition of more advanced technologies and more modern equipment makes it possible to increase productivity while optimizing the quality of the biochar produced. This approach helps to consolidate their position on the market and better meet customer expectations.

4.5 Impact of using biochar

In our survey, we sought to gather producers' opinions on the impact of biochar on farmers. The results show that farmers, in their majority, do not have a positive assessment of biochar, mainly because they rarely use it.

Nurserymen express more positive opinions. They use biochar in their nurseries and see significant results in terms of plant growth and quality.

This suggests that one of the main levers to promote the adoption of biochar in agricultural practices in general could lie in better awareness among farmers and the promotion of successful examples such as those of nurserymen.

According to the producers interviewed, the use of biochar as an organic amendment in the agricultural regions where they operate has very positive impacts on several levels:

- Economic impact: increased yields in quantity and quality. Biochar is more advantageous in terms of cost and efficiency than the use of peat alone, particularly for nurseries.
- Environmental impact: production allowing significant recovery of wood waste, thus contributing to the sustainable management of resources. The use of biochar allows the reuse of organic waste that is still little used to date.
- Social impact: waste recovery helping to keep collective spaces clean and improve the quality of life in rural areas.

- Agronomic impact: mixed with compost in a co-composting process, this combination considerably improves soil quality, and in particular soil water retention.

4.6 Perspective

The analysis of the results obtained from the answers to the questions relating to the future of biochar in Tunisia reveals optimistic prospects for its use as a soil amendment. Indeed, the producers in our panel noted a growing evolution in the use of biochar by Tunisian farmers.

The prospects for the use of biochar would be even more promising if awareness-raising and communication actions were implemented based on reliable scientific results. In addition, increased support from agricultural policies and dedicated programs would be a key factor in accelerating this development.

Finally, with more favorable agricultural policies and if the ecological and economic benefits of biochar are demonstrated by the results of scientific research, this agricultural practice could experience significant growth in the years to come.

5 Date palm compost users

5.1 Presentation of interviewed farmers

5.1.1 General information

The farmers interviewed in this study range in age from 36 to 64, with 40% of young producers aged 36 to 39. Although they do not have any specific agricultural training, 40% of them have a university degree, 30% have a secondary or intermediate level of education, while the rest have no formal qualifications. All of these producers are from oasis regions and are exclusively dedicated to agricultural activities, particularly date palm cultivation, a tradition passed down from generation to generation.

The average farm area is 3.22 ha, with a maximum of 11 ha in Algeria and a minimum of 0.25 ha in Tunisia. The largest areas are recorded in Algeria, while in Tunisia they remain modest, with a maximum of 3.5 ha.

All of the farmers interviewed cultivate date palms. Among them, 50% adopt a complete oasis farming system, combining the 3 cultivated floors: date palm, arboriculture and underlying crops. A smaller share associates the palm with herbaceous crops (20%), the rest of the farmers surveyed only cultivate the date palm (30%) (Figure 2).

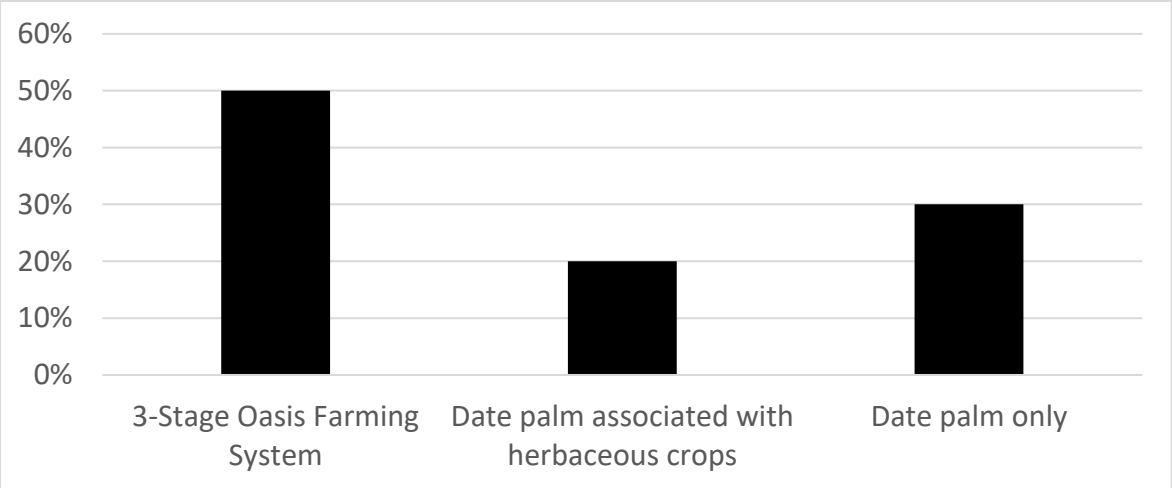

Figure 2 : Farming system of the farmers surveyed

5.1.2 Date palm residues use and constraints

The farmers surveyed produce waste related to date palm cultivation. The average quantities of date palm waste are 2.7 tons.ha^{-1}. It should be noted that nearly 80% of the farmers surveyed do not recycle this waste themselves. They incinerate or resell it. Among the farmers surveyed, some recycle the residues by producing their own compost (10%), others use them to create protective barriers around the farms.

The technique for making compost from palm grove waste consists of mixing manure with previously crushed waste. The main constraints that prevent producers from recovering waste into compost are numerous and of various natures. On the technical level, 90% of cases are affected by obstacles such as the lack of manure, the absence of suitable equipment such as crushers, as well as the lack of control over the compost production process. Furthermore, 50% of the farmers surveyed encounter, in addition to technical difficulties, economic obstacles, considering that the cost of producing compost is too high and difficult to bear due to their low financial capacity. Faced with these constraints, in particular the lack or absence of control over production techniques, all the farmers surveyed expressed the need to acquire knowledge and follow training on the production, on the one hand, and the use, on the other hand, of composts within their farms. These trainings would improve waste management and increase productivity while optimizing available resources.

According to the farmers interviewed, the main obstacle that hinders the production and use of date palm compost is the lack of necessary equipment, such as grinders (50%), the lack of demonstration plots to show the results obtained (30%), the lack of mastery of techniques (20%) and, finally, 10% of farmers mention the lack of manure, especially good quality manure from sheep.

None of the farmers interviewed used biochar in their agricultural plots. The use of biochar is unusual either in Algeria or in Tunisia. We did not find any farmer who use that product in his farm.

5.2 soil amendments use

5.2.1 Mineral amendment

The technical itinerary specific to date palm cultivation is complex and includes several stages, it can notably include the mineral amendment which is applied in their plots by 80% of the farmers questioned. In Tunisia, this amendment is exclusively carried out with sand inputs. On the other hand, in Algeria, in addition to the sand input, some farmers also use NPK type mineral fertilizers to enrich the soil.

5.2.2 Manure

All farmers surveyed in both countries apply organic amendments to their plots, but with varying sources and frequencies, depending on the crop type and the financial situation of the farmer. All respondents use organic amendments in the form of manure, of which 70% is sheep and 30% goat. Among users, 90% report that manure comes from local sources, such as neighbours or the market, while only 30% use their own domestic manure. The frequency of manure application differs: 20% of farmers apply an amendment every three years, 30% every two years, and 20% apply an amendment annually. The quantities of manure applied vary between 1 and 6 tonnes per hectare with an average of 3 tonnes per ha. The cost of a ton of manure is around €33 (100 Tunisian dinars) in Tunisia and €57 (8000 Algerian dinars) in Algeria.

Half of the farmers surveyed mentioned several risks associated with the use of manure. Indeed, unripe manure can have harmful consequences for the soil by becoming toxic, which harms the health of crops. In addition, this manure can contain seeds, pests or weeds, which become obstacles for farmers and affect soil quality.

5.2.3 Compost

About 60% of the farmers surveyed apply compost to their plots. During the first years, they are accompanied by their neighbors or by local compost producers, who are the main source of compost for these farmers.

The majority of respondents use improved industrial compost, only 10% use traditional compost. This compost is mainly composed of palm waste and sheep manure. However, the farmers surveyed do not know precisely the proportions of the different constituents of this compost.

The quantities of compost applied are on average 3.75 tons/ha per year in Algeria, and between 2 and 8 tons/ha each year in Tunisia. This quantity has not changed much since the introduction of compost on farms in both countries. It mainly depends on the type of crop and especially on the price of the compost. The purchase price by farmers is on average €340 per ton in Algeria and between €200 and €400 in Tunisia.

Regarding the prospects for using date palm compost, our survey revealed that farmers in both countries are showing a significant awareness. To this open question, farmers consider that this technique could become essential to ensure soil fertility in the future, that this compost is of major economic and environmental interest, and that this practice will allow optimized waste management and organic enrichment of the soil. Some farmers interviewed perceive this technique as a promising and effective solution for improving organic amendment.

5.3 Cost of using compost

The impacts of compost use on the production costs of the farms in our panel are profitable. In fact, 40% of farmers have observed a reduction in the production cost of their crops thanks to the reduction in the use of mineral amendments, which are often expensive, which helps to improve the competitiveness of their products on the market.

40% of the farmers surveyed state that the share of expenses related to the use of compost in relation to the production costs of their crops is between 15% and 20%. In relation to all the farm's expenses, this proportion is between 5 and 12% with an average of 9.25%. The majority of respondents do not know the exact proportion that these expenses represent in relation to the production costs of their crops or of their entire farm. This lack of knowledge is explained by the absence of recording and accounting systems within farms.

5.4 Compost use impacts

The impact observed by the respondents in our sample after using compost varies depending on the farmers. On the environmental level, nearly 90% of the farmers surveyed perceive a very positive impact. This effect is manifested in particular by the recovery of waste from palm groves, the reduction in the use of chemicals, the reduction of diseases, the preservation of biodiversity within palm groves and the reduction of groundwater pollution.

On the economic level, 70% of the respondents observed a favorable impact following the use of compost. These impacts include a reduction in production costs, an improvement in sales prices, and therefore in farm income and profitability. However, 10% of the farmers report a negative economic impact, often due to the high prices of compost. The rest of the farmers do not see any significant economic effect.

On the social level, only 20% of respondents mention positive effects, such as job creation and hiring of unemployed youth. On the other hand, 80% do not perceive any social impact to date.

Regarding the impact on the health of farmers and consumers, 30% believe that the use of compost has interesting benefits. They identify in particular the reduction in the use of chemicals, which leads to healthier products, while protecting the health of farmers by limiting their exposure to chemicals.

On the agronomic level, half of the farmers observe positive effects related to the use of compost. According to the respondents, this contribution leads to an increase in yield and an improvement in the quality of crops in the different levels of the oasis production system, such as date palm, herbaceous crops, fodder and arboriculture. The other half of the farmers have not noticed any significant change so far.

The impacts of using compost on the soil are numerous according to farmers practicing this type of organic amendment. Among the positive effects noted by 40% of the farmers surveyed are the improvement of soil quality and fertility.

5.5 Farmers' feelings on the use of compost

According to 20% of our sample, the type of compost considered most effective varies. For 10%, compost with a carbon/nitrogen (C/N) ratio between 20 and 30 is considered optimal, while the remaining 10% believe that compost composed of a mixture of palm waste and manure is the most effective for their crops.

For 30% of the farmers surveyed, date palm compost is beneficial for date palm, herbaceous and arboriculture crops, due to its ability to significantly improve soil fertility. About 10% of the farmers surveyed consider that compost is especially beneficial for crops with increased water requirements, as it promotes better water retention in the soil, which helps optimize irrigation.

Our survey reveals that all the farmers surveyed believe that the use of compost can sometimes be ineffective. For half, this is mainly due to a lack of awareness of the use of compost by farmers. To promote the use of compost, 40% of our sample suggest increasing awareness and supporting farmers in the use of compost. They also recommend training and experimental and demonstration actions on composting techniques.

Concerning the production of compost, 60% of respondents propose measures to encourage its production:

- setting up pilot plots and field training allowing direct evaluations,

- use of subsidized collective grinders to facilitate the production of raw materials,

- creation of practical and simple manuals to guide farmers in the use of compost.

For our sample, these measures are essential measures to encourage the widespread adoption of date palm compost.

Almost all of the farmers surveyed currently using date palm compost expressed the intention to continue using it in the future, but under conditions and for various reasons. For 10% of them, the use of compost will depend on the concrete results obtained in terms of agricultural yield. About 40% believe that the use of compost is conditioned by affordable prices. Only 10% cite environmental reasons, such as the recovery of waste and the use of raw materials available in palm groves.

For the 60% who do not yet use date palm compost, a majority plan to adopt it soon, but for various reasons. About 20% cite the increase in production as the main motivation. Among the 60% who do not use compost, 20% put forward the argument of the recovery and reduction of waste in oases, which also helps to reduce the sources of phytosanitary diseases in palm groves. Finally, the last 20%

condition their future use on obtaining sufficient training and knowledge on the techniques of manufacturing and using compost.

5.6 Advantages and disadvantages of using compost

The benefits of using compost vary considerably from one farmer to another. For 30% of them, the main benefit lies in the improvement of soil fertility. Similarly, the improvement of yields is the argument put forward by 20% of respondents. Furthermore, for 10% of our sample, the availability of raw materials needed to make compost, as well as its affordable price compared to that of manure, is a major advantage.

The disadvantages of using compost vary depending on the perspectives of the farmers. 40% of our respondents emphasize the difficulty of mastering the composting technique. They mention the complexity of the process, the relatively long time required for the manufacture and maturation of the compost, as well as the regular monitoring it involves. These elements make the practice unstable and less accessible to all. This justifies their request for training on the production of the compot. On the other hand, 20% of farmers mention the high cost of compost production as a major disadvantage, which can limit its adoption, particularly for farmers with more limited financial resources. This reflects a shared perception among producers, who encounter both technical and economic obstacles in the use of compost.

6 Conclusion

The study highlights the potential for valorizing date palm residues through the production of compost and biochar, two products with positive environmental, economic and agronomic impacts. However, several obstacles hinder their large-scale adoption.

From a technical point of view, the lack of suitable equipment, such as grinders, and the poor mastery of composting techniques are major obstacles. From an economic point of view, high production costs and low price competitiveness, particularly in Algeria, limit farmers' access to these organic amendments. In addition, insufficient awareness among producers and users contributes to a still timid local demand, despite the observed benefits, such as improved soil fertility and reduced production costs for some farmers.

However, the development prospects are encouraging. A strategy combining awareness, training, product diversification and reduced production costs could allow for wider adoption. Supporting agricultural policies, through subsidies and adapted infrastructure, as well as concrete actions such as the creation of pilot plots, would be crucial to accelerate this transition.

In short, with targeted and coordinated efforts, the valorization of date palm residues could not only contribute to more sustainable agriculture, but also offer significant economic gains to farmers in oasis regions.

APPENDIX 1

Questionnaire for compost producers (in French)

Projet ISFERALDA

Questionnaire pour l'étude des impacts socioéconomiques de l'utilisation du compost à base de déchets du palmier dattier (partie Fabricants de compost)

Nom et prénom du fabricant : …….

Age : Niveau d'instruction : Formation agricole :

Adresse :…… Tel :…… …… …..

Profession ou domaine d'activités :

Fabrication du compost

Capacité et moyens disponibles

Superficie de l'atelier (ha) : …….

Type de fabrication pratiquée : Traditionnel Industriel

Quels types de compost fabriquez-vous ?

À base de quoi fabriquez-vous le compost ?

Depuis quand fabriquez-vous le compost ?

Quelles sont les composantes essentielles du compost ?

Pour produire 100 kg de compost, il faut :

Compostant	**Quantité**	**Prix unitaire***	**Coût total**
Eau			
Electricité			
Gaz			
Main d'œuvre			
Palmes sèches			

Fumier Autres sources de carbone Autres sources d'azote Transport Stockage Emballage Autres intrants   Total

* En cas d'auto-approvisionnement, estimer le cout

Décrire brièvement la technique :

Qualité du compost

Avez-vous fait des analyses de compost produit ? Oui - Non

Laboratoire : ……

Principaux résultats d'analyse obtenus

Cout de production du compost

Combien coute 1 kg de compost (coût de production en Da/kg) ?

Quel est le coût de revient d'un kg de compost Da/kg ?

Quel est le coût de distribution ?

Quelle est l'évolution de la production du compost depuis 10 ans ou depuis que vous produisez du compost ?

Année	2015	2016	2017	2018	2019	2020	2021	2022	2023
Production en T									

Quel est le coût d'investissement (achat de matériels et équipements) ?

Vente du compost

Quels sont vos principaux clients ?

*Type (Pourcentage par type de client) :

Agriculteurs Exploitations agricoles Grossîtes Grainetiers Autres

*Origine : % *locale % *wilaya % *national…….%

Quel est le type de compost le plus demandé ? et pourquoi ?

Quelle est l'évolution du prix de vente du compost depuis 10 ans ou depuis que vous en produisez ?

Année	2015	2016	2017	2018	2019	2020	2021	2022	2023
Prix Da/qx									

Est-ce que ce prix est rentable pour votre entreprise ?

Pourquoi ?

……

<u>Est-ce que ce prix est compétitif sur le marché ?</u>

Pourquoi ?

……

<u>Est-ce qu'il y a une augmentation de la demande de compost sur le marché et pourquoi ?</u>

……

Recevez-vous des réclamations de la part de vos clients sur votre compost ? si oui

Sur la qualité ☐ Sur le prix ☐ Type d'emballage ☐ Autres ☐

Pensez-vous que l'évolution de la demande du compost dépend de :

*La qualité du produit !.....☐

*Le prix rentable /autres amendements : ….. ☐

*Amélioration du niveau de perception des producteurs envers l'environnement…..☐

*Des sensibilisations…….. ☐

*Autres ☐

Stratégie mise en place

Quelle est votre stratégie en matière de :

- D'approvisionnement

- De production

- De commercialisation

- Pour améliorer la qualité et diminuer le coût de production

Avez-vous de problème (et quel type) de :

*D'approvisionnement : ……

*De production : ……

*De commercialisation : ……

Selon vous, quelle stratégie devrait-on suivre pour promouvoir l'utilisation des composts ?

Ressenti par rapport à l'utilisation du compost

Quel est l'appréciation des agriculteurs sur l'utilisation du compost ?

……

Quel est (selon vous) l'impact de l'utilisation du compost comme amendement :

*Sur le plan technique :……

*Sur le plan économique :……

*Sur le plan environnemental :……

La demande est-elle croissante ?

Pourquoi ?

……

La faible demande s'explique pour vous par :

……

*Prix élevé ☐ *Méconnaissance ☐ *Qualité faible ☐ *Non rentable ☐ *Autres :

Organisez-vous des séances de vulgarisation auprès des agriculteurs ? .....

Si oui pourquoi et comment ?

Si non pourquoi ?

Avez-vous un besoin de connaissances/formations concernant l'utilisation des composts dans les exploitations ?

Selon vous, quels sont les obstacles qui pourraient freiner la bonne valorisation des déchets agricoles de la palmeraie ?

Selon vous, quels sont les obstacles qui pourraient freiner la bonne utilisation du compost dans la palmeraie ou l'exploitation ?

Selon vous, quelles sont les perspectives d'utilisation du compost à base des déchets des palmeraies dans l'amendement des palmeraies et des autres cultures ?

Impacts socioéconomiques et techniques :

Quels impacts vos clients (ou vous-même) ont constaté après l'utilisation du compost ?

- Sur le plan environnemental:……
- Sur le plan économique:……
- Sur le plan social:……
- Sur le plan technique:……

Y-a-t-il une augmentation :

- Des rendements des cultures pratiquées par les utilisateurs de compost ? Oui - Non
- De la production des cultures pratiquées par les utilisateurs de compost ? Oui - Non
- Une amélioration de la qualité pratiquée par les utilisateurs de compost ? Oui - Non

De quel ordre ? ……

Selon vous, quels sont les avantages d'utilisation du compost ?

……

Selon vous, quelles sont les inconvénients d'utilisation du compost ?

……

Selon vous, quelles sont les tendances d'utilisation du compost dans la région ?

……

Questionnaire for compost users (in French)

Projet ISFERALDA

Questionnaire pour l'étude des impacts socioéconomiques de l'utilisation du compost à base de déchets du palmier dattier (partie exploitations agricoles)

Nom et prénom de l'agriculteur : ……Date :

Age : Niveau d'instruction : Formation agricole :

Adresse :…… Tel :…… …… …..

Exploitation agricole

Région – zone - Palmeraie :……..

Superficie de l'exploitation (ha) : ……

Type de culture pratiquée :

Palmier dattier Arboriculture Cultures herbacées Autres

Production de déchets

- **Type de déchets produits ……Quantités produites/ an**…… .

Valorisez-vous vous-même ces déchets ? Oui ☐ Non ☐

Est-ce que vos sous-produits sont suffisants pour vos besoins ? Oui ☐ Non ☐

En cas de valorisation dans la production du compost, décrire brièvement la technique :

Quelles sont les contraintes de la valorisation des déchets ?

Techniques ?.....Economiques ?.....

Sociologiques ? .....

Avez-vous un besoin de connaissances/formations concernant l'utilisation des composts dans la palmeraie ou l'exploitation?

……

Selon vous, quels sont les obstacles qui pourraient freiner la bonne utilisation du compost dans la palmeraie ou l'exploitation ?

……

Selon vous, quelle stratégie devrait-on suivre pour promouvoir l'utilisation des composts ?

……

Selon vous, quelles sont les perspectives d'utilisation du compost à base des déchets de palmeraies dans l'amendement des palmerais et des autres cultures ?

……

Amendements

Type d'amendement pratiqué dans vos parcelles

- Amendement Minéral *:* Oui Non

Si oui, lequel : ……..

- **Amendement organique** : Oui Non

Si oui : le type d'amendement organique utilisé : Fumier Compost Biochar

- **Si fumier :**

- **Type : …… Source : ……. Fréquence d'application : ……**

Quantité par hectare : ……. Coût par hectare :…… ……

- **Si compost :**

Depuis quand vous utilisez le compost?

Qui vous a aidé à utiliser le compost?

Type de compost (bases : déchets agricoles, fumier animal…) : ……

Fréquence d'application ? ……..

Fabriqué localement au niveau de l'exploitation Oui Non

- **Si oui, quelles sont les proportions des constituants** :……..
- **Si non, Source du compost :**
  - Locale
  - Wilaya
  - Hors wilaya

Quel type de compost vous utilisez ?

Traditionnel industriel amélioré

Connaissez-vous les composants de base du compost utilisé ? Oui - Non

Avez-vous rencontré des difficultés pour fertiliser et amender le sol de votre exploitation ?

Oui Non Si oui, pourquoi :

Quantité apportée par hectare : ……

Coût par hectare : ……

- **Quelle est la quantité utilisée ?**

Au début **actuellement……**

<u>À quel prix achetez-vous le compost (prix par kg ou par sac, à préciser) ?</u>

Impacts socioéconomiques et techniques :

Quel impact constatez-vous après l'utilisation du compost ?

- Sur le plan environnemental (niveau de pollution par exemple ou autres...) :
- Sur le plan économique (niveau du coût de production, rentabilité ou autres...) :
- Sur le plan social :
- Sur le plan technique :

Y a-t-il une augmentation :

- **<u>Des rendements des cultures</u> que vous pratiquez ?** ☐
- **De la production des cultures que vous pratiquez ?** ☐
- Une amélioration de la qualité des cultures que vous pratiquez ? ☐

Comment ?

Avez-vous eu une augmentation de vos revenus après l'utilisation du compost : Oui / Non

Si oui combien ? .....

Quel est le prix de vente moyen de vos produits cultivés avec du compost ?

.....

Rendements

Effet de l'apport de l'utilisation de compost sur le rendement des cultures :

- Le rendement du palmier dattier (préciser l'unité) :

Avant l'utilisation de compost .....Après l'utilisation de compost .....

- Le rendement sur l'étage herbacé :

Avant l'utilisation de compost .....Après l'utilisation de compost .....

- Le rendement sur les cultures fourragères

Avant l'utilisation de compost .....Après l'utilisation de compost .....

- Le rendement sur l'arboriculture

Avant l'utilisation de compost .....Après l'utilisation de compost .....

- Le rendement sur autres cultures (orge en particulier)

Avant l'utilisation de compost .....Après l'utilisation de compost .....

En cas d'amendements organiques et/ou minéral, quels sont les bénéfices perçus (bénéfique, peu bénéfique, sans effet, néfastes) ?

- En terme de rendements : .....
- En terme de vigueur de la plante :.....
- En terme de besoins d'irrigation : .....

Couts de l'utilisation du compost

Quels sont les impacts de l'utilisation du compost sur le coût de production ?

Augmentation / Diminution

De quel ordre (en valeur, en %) ? .....

Quelles sont les charges en lien avec l'utilisation du compost ?

Que représentent ces charges dans la structure totale des charges de l'exploitation en moyenne ?

Que représente les charges de compost dans la structure totale des charges de la culture en moyenne ?

Ressenti sur l'utilisation du compost

Impact de l'utilisation de compost sur le sol : fertilité du sol, structure ou autres ?

……..

Quels impacts d'utilisation du compost sur la santé de l'exploitant ?

Quels impacts d'utilisation du compost sur la santé des consommateurs ?

Quelles sont vos suggestions pour promouvoir l'utilisation du compost?

Quelles sont vos suggestions pour promouvoir la production du compost ?

Selon vous quel type de compost est très efficace ?

Pour quel type de cultures ce compost est-ce très utile ?

Pourquoi?

Si vous pensez que ce compost n'est pas efficace, pourquoi?

Problèmes techniques économiques formation des utilisateurs

Si vous utilisez le compost, pensez-vous continuer à l'utiliser dans l'avenir

- Si oui, pourquoi ?

- Si non, pourquoi ?

Si vous n'utilisez pas le compost, pensez-vous l'utiliser prochainement ?

- Si oui, pourquoi ?

- Si non, pourquoi ?

Selon vous, quels sont les avantages d'utilisation du compost ?

Selon vous, quels sont les inconvénients d'utilisation du compost ?

Selon vous, quels sont les avantages d'utilisation de l'amendement minéral ?

Selon vous, quels sont les inconvénients d'utilisation l'amendement minéral ?

Selon vous quels sont les avantages d'utilisation de l'amendement organique ?

Selon vous quels sont les inconvénients d'utilisation l'amendement organique ?