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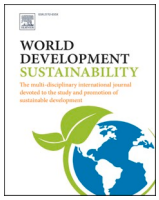

Environmental agricultural practices in the Ziban palm groves: Should we choose between yield and sustainability?

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ABSTRACT

Since antiquity, with transhumant breeding, the cultivation of the date palm has been the main agricultural vector around which social and economic activities are articulated in oasis regions. The conduct of this culture is guided by a specific and complex technical itinerary. The objective of the present study aims to identify and characterize the main sustainable agricultural practices within the palm groves of the Ziban in south–eastern Algeria and the sensitivity of date palm farmers to environmental practices as well as their degree of adaptation. Our study is based on face-to-face surveys conducted among 50 producers among 10 date palm areas in the region. It brings to light that despite the production developments, date palm farming in this region remains dominated by extensive and traditional agriculture, either due to a lack of means, knowledge, or environmental commitment. As a result, several sustainable practices remain widely shared in the majority of palm groves. Similarly, it appears that several larger and newly established producers are committed to these new practices which have various objectives in particular, to protect the environment, and to sustain the culture and the quality of the products.

1. Introduction and research context

For over 50 years, in order to cope with heightened competitiveness between countries on the international market, and the increase in demand for quantity, most actors and agricultural policies of the countries have supported the growth of yields [1].To meet quality requirements, enhancement strategies using geographical signs, labels and brands have been put in place. As a result, a lot of technical progress has been made in the upstream and downstream agricultural sector. Overall, this has led to an intensification of agricultural activity, a concentration of actors by increasing critical sizes and increased use of chemical inputs. However, climatic constraints and new societal expectations in terms of quality, health safety, and agriculture sustainability are challenging the dominant agroindustrial model.

In Algeria, the agricultural sector has seen significant development, and has so far experienced a movement of intensification, encouraged by the implementation of significant public support. Recently, Algeria opted for the promotion of Saharan agriculture, including date palm cultivation, through the creation of a dedicated public office, financial support, land concessions, the development of strategic crops in the southern perimeters (cereals, potatoes), and support programs for irrigation, inputs, and access to energy [2].

With regard to date palm cultivation, attempts at intensification aimed at increasing agricultural yields have often been accompanied by an unreasonable use of natural resources as well as overexploitation of groundwater and chemical inputs. This change in practices is not without consequences on the environment and production, with deterioration in quality, as well as pollution of water and soil [1–3]. These new intensive practices threaten the sustainability of this crop, particularly in an area regarded as vulnerable, and where agriculture is faced with many constraints: the fragility of the natural environment, poor soil, rising groundwater, salinity, and the need for irrigation water.

Regarding this situation, a number of empirical studies have demonstrated the persistence of certain sustainable practices [4,5]. Farmers in these areas are becoming increasingly aware of the effects of changes in technical itineraries with respect to product quality in order to cope with the fragility of the oasis system which is marked by high evapotranspiration rates, significant salinization of water and soil, and water scarcity. Two trends—the arrival of "investor" growers and agricultural intensification—stand in contrast to two other recent trends. The first trend concerns the use of traditional practices such as organic fertilization, water-saving techniques and ancestral cultivation practices

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to combat the palm's enemies. The second trend which is more recent and less well-received, concerns the "return" of large-scale farms, often to save production costs, to more sustainable practices including the use of natural fertilizers, adaptation of technical itineraries, and mobilization of old irrigation techniques, etc. This raises the question of trade-offs between yields and sustainability, both for small farms and for larger, more recent ones.

These large, intensive farms often stand side by side with smaller ones, with significant differences in practices and yields. The arrival of certain external players backed by substantial funding poses further problems. Their installation seems to come up against the desire of some local farmers to maintain sustainable agricultural practices and production methods that respect the area in which they are based [6], despite numerous constraints linked to farming activities, product valorization, or financing. In this context, our research focuses on the place of these practices in the technical itinerary specific to the crop in the Ziban palm groves.

More explicitly, we ask the question of yield gains versus losses when adopting sustainable practices, is it agronomically profitable for Ziban date palm farmers to adopt sustainable practices? We maintain that the establishment of good, proper cultural management for this region constitutes a sustainable alternative for the maintenance of a climatic balance between the development of the palm tree, the production of dates, and the protection of the environment in the face of threats such as salinization, low soil fertility, and excessive use of phytosanitary products. We also argue that this adoption of sustainable practices is based on distinct motivations and is not only related to environmental sensitivity, but also concerns cost savings, mastery of practices, and a desire to maintain old practices. To this end, we maintain that the search for yields and sustainable practices are not opposing, including the economic level stricto sensu.

Beyond the examination of the existence of such a trade-off between yield gains and the sustainability of the oasis ecosystem, we focus on the identification and analysis of the adaptations implemented by phoeniciculture farmers to more sustainable farming practices. Our research is based on field surveys of approximately 50 date-growers in the Ziban region, with the aim to identify the sustainable practices of date-growers, assessing their awareness of environmental issues and their adaptation to new constraints of competitiveness and product enhancement. We begin by describing the dates sector in Algeria and sustainable practices, before turning to the results of our surveys and outlining recommendations for the main players in the sector.

2. The dates sector in Algeria and sustainable agricultural practices

2.1. Presentation of the date sector in Algeria and the challenges of sustainability

The date sector in Algeria is significant with a date heritage of nearly 20 million palm trees, a production of more than 1.2 million tons and an export of more than 50 thousand tons (4 %). Algerian dates position on the world market and their role in the national economy has been continuously strengthened [7]. Several public support programs for the sector have been put in place and the Deglet Nour variety (literally "light date") has been listed among the products with high potential for regional development. Although the cultivation of date palms is spread over 27 wilayas (administrative regions), most of it is concentrated in Algeria's south-eastern wilayas which has more than 50 % of the national phoenicicole heritage.

Characterized by the coexistence of these two extensive and semi-intensive cropping systems, the date industry in Biskra is of great economic and social importance. The wilaya has great potential for this culture both upstream and downstream. According to the Directorate of Agricultural Services [8], the number of palm trees is 4.5 million palm trees (nearly a quarter of the national potential) with a production of more than 4.2 million quintals, and records the highest yield nationwide 70 kg/palm. The palm groves of Biskra also have a hundred autochthonous cultivars, including the Deglet Nour, with high market value and the most requested on the market. In terms of water resources, the wilaya counted nearly 12,000 boreholes in 2016, that is, the irrigation of 120,000 ha. In terms of logistics, the wilaya records the presence of several packaging companies and 250 cold room storage capacities [8].

These socio-economic factors have certainly favored the production of Deglet Nour dates as a local product. But it seems that agro- pedological and climatic conditions as well as local indigenous know-how have oriented new farms towards this cultivar at the expense of other cultivars and date palm regions. In addition, several studies have illustrated the dysfunction of this date sector in Biskra and in Algeria following the combination of several technical, socioeconomic, and political constraints [9]. Despite the various risks that limit date production and agricultural practices by threatening the sustainability of the oasis system, Ziban date palm farmers have developed several sustainable agricultural practices to increase phoenicicole production, while limiting pressure on natural resources and biodiversity.

2.2. Panorama of sustainable practices in the oasis environment and the date sector in Algeria

The date palm is a demanding tree that requires a variety of agricultural practices and ongoing maintenance to produce quality dates, following the technical itinerary of specialized institutions such as ITDAS (The technical institute of Saharan agriculture development) and INRAA (*Algerian National Institute of Agricultural Research)*. According to Benziouche and Chehat [10] the practices and level of application of agricultural operations specific to this crop vary greatly regarding the profile of farmers, and from one operation to another depending on the need, specificity, and importance of these operations and the financial means of the date growers.

In order to understand the sustainable practices in date palm cultivation, it is necessary to present the technical itinerary of this culture which remains similar in the palm groves of most date palm countries, particularly the Maghreb and Mediterranean countries. Farming practices include: The main purpose of tilling the soil the preparation of the irrigation network such as the installation of seguias and the channeling of water, as well as the production of planting beds around the palm trees. This practice also results in plowing and loosening the soil. Soil fertilization is generally done using fertilizers that are organic and/or mineral origin. It contributes to increasing the palm tree productivity and improving the quality of the date [11]. This operation is dependent on soil texture, irrigation techniques, age of palm trees, and farming systems at the level of an oasis [12]. Grooming and cleaning palm groves is an operation that is carried out manually. It involves collecting pruning and harvesting debris, weaning young dead offshoots and weak offshoots at the foot of the mother palm [12]. The waste is destroyed by burning to reduce the foci of parasites and the enemies of palm trees.

Pollination is an important operation. It is carried out manually or semi-mechanically by attaching the spikelets of the male feet (Dokkar) with the inflorescences of the female feet (Nakhla). This operation is carried out over a period which extends from March to the end of April. The duration of reception of pollen grains by female gamettes for the main varieties (Deglet- nour,Gharesse, Mech degla) is 8 to 12 days. It takes place in calm and dry weather. Rains occurring during pollination [13,14] could lead to the leaching of pollen to produce partenocarpic dates [12–15]. For phytosanitary treatment, it makes it possible to deal with several diseases and phytosanitary problems [10]. Weeds, insects and mites threaten production and cause damage. To mitigate this damage, the use of phytosanitary products (PPS) with precautions in the use of doses during the treatment period are essential [15,16]. However, a schedule of protection practices and sustainable control are popularized by specialized institutions, through the use of biological physical techniques, chemical and integrated control.

Finally, date palm watermanagement need is the last aspect of the most important agricultural practices for preserving the sustainability of oasis systems. According to Djerbi [16], the production of one kilogram of dates consumes 2400 liters (i.e. 240 m^3 for a production of 100 kg of dates). According to Benziouche and Chehat [10–17] the doses of water applied depend on the climate, the nature of the soil and the quality of the irrigation water. Currently, the doses of water applied vary according to the seasons, where the most frequent irrigation systems are arranged, by basin, by board, and localised irrigation. In summer, during the fruiting phase, the interval between two irrigations is between 7 and 10 days; However in winter, irrigation could occur every 15 days. Rainfall could space out irrigations by 3 to 4 weeks [17].

Previous research emphasizes that sustainable practices relate to the entire technical itinerary and coincide with environmental objectives of preserving natural resources. Table 1 below shows a summary of the sustainable practices of date farmers in the date sector. Overall, previous research and empirical observations demonstrate that sustainable practices relate to five main components: soil, water, palm and relevant diseases, fertilization and the choice of autochthonous varieties. These practices encountered in other Phoenicicole regions in Algeria, are based on three complementary components: cost reduction, preservation of resources, and preservation of indigenous know-how. The second component is directly linked to the environmental dimension, while the other two relate to economic and socio-cultural issues. Although the practices have been informed by previous research, the issues are rarely addressed and challenge researchers. What are the objectives behind the adoption of these practices: to reduce the impact of high-intensity system versus the agroecological intensification of traditional systems? How can the effects of these practices be measured: through economic indicators relating to farms or local agricultural systems? How and with whom these practices should be disseminated: small traditional farms or large intensive structures?

The aim of our empirical application is to test out the existence of such practices in our study region, to investigate their motivations (environmental sensitivity, economics, local adaptation, etc.) and to assess the extent of their dissemination and the constraints on their adoption in the palm groves of the Ziban.

The questions this work aims to answer are clearly defined:

- What practices are considered sustainable in the Ziban palm groves, as well as their degree of diffusion?
- What is the level of adoption of these practices by farmers?
- What are the technical-economic and environmental motivations and causes for adopting these sustainable practices?
- What are the constraints limiting the implementation of these practices?

Table 1
Synthesis of environmental practices of date palmer production.

Sustainable practices	Details
Irrigation and management of water needs	• Drip system • Night irrigation • Installation of seguias and water channeling • Optimal use of resources and arbitration of other crops
Fertilization	• Organic inputs, compliance with treatment doses and dates and savings in the use of phytosanitary products • Adaptation of uses to soil analyzes and palm needs
Ground work	• Bring earth if exhaustion. • Soil preparation
Luttes contre les maladies et traitement du dattier	• Incineration of infected bunches, application of lime to repel insects, bagging of bunches and protective nets, • Regular grooming of palm trees, • Manual mowing of weeds, uprooting of weeds,
Choice of varieties	• Preservation of autochthonous varieties- • New plantings and renewal

Source: Elaborated by the authors based on the results of previous empirical research.

3. Materials and methods

3.1. Context and presentation of the study region

Biskra named "the capital of the Ziban," extends over an area of 21671 km^2 and is 425 km southeast of the capital (Fig. 1). According to [18] the relief of Biskra is made up of four morphological units, mountains, foothills, plains, and depressions. Compared to the whole country, Biskra is one of the richest wilayas in water resources. Aquifers (groundwater, limestone, sand, Albian) represent water capital [18,19]. These are the most exploited aquifers. Currently, the deepest aquifers (sand and artesian aquifers) constitute an alternative for satisfying the need for water in extension [20]. Also, irrigation is based on the exploitation of the two existing dams. Salty, gypseous and sandy soils, and alluvial soils are the most encountered in the Ziban oases. These are soils characterized by low physical and biological chemical fertility [21].

At present, production is threatened by soil salinity, water availability, the rise of a surface water table and soil hydro morph, and also depends on farming practices and soil fertility [22]. The region has an arid climate with low rainfall (average annual rainfall of 140 mm) and very high temperatures (average 21.5 °C, maximum 42 °C). Rainfall is irregular and can be torrential.

3.2. Data collection

This study is based ourselves first on a series of specialized documentation in this field (we exploited the various previous research studies on the date-growing sector in Biskra and Algeria), on our knowledge, and particularly on field work based on surveys with a sample of 50 local farmers of date palm. The latter was conducted in 2020 in the Ziban region among producers in 10 potentially date-producing communes (Fig. 1) in the central and western zones of Biskra. This represents a quarter of all the communes in the wilaya, with an average of 4 to 5 farms surveyed per commune.

In order to identify the farms to be surveyed, several selection criteria were used: the educational level and know-how, the importance of the date palm growing area, the level of environmental awareness, the level of exploitation of water resources, fertilisers, PPS, the use of sustainable farming techniques and the availability of native varieties. In addition, and in order to ensure the representativeness of the sample, we included quotas according to the size of the farms (measured by the number of palm trees) because of the nature of the subject and the vocation of the region. As a result, we divided our panel into 3 types of farms: small, with fewer than 100, medium, with between 100 and 200, and large, with more than 200 palm trees per farm (Table 2).

The sample was selected by randomly drawing two hundred producers from a list provided by the agricultural services department. Out of these, 50 producers agreed to participate in the survey; This represents 25 % of the list of producers available to us.

This survey of farming practices was carried out during the winter period (February) by individual and semi-structured interview through face-to-face with 50 producers. The interviews lasted an average of one hour. The interview guides contained a dozen questions direct and indirect, quantitative and qualitative questions in relation to the research problem; on the characterization of the farm, and in connection with agricultural practices around the various themes identified previously. The interviews were conducted at farm, to obtain direct feedback in the field. In terms of the characteristics of the farms in our sample, described in the table above, we find out that the average ownership per farm is around 240 palm trees.

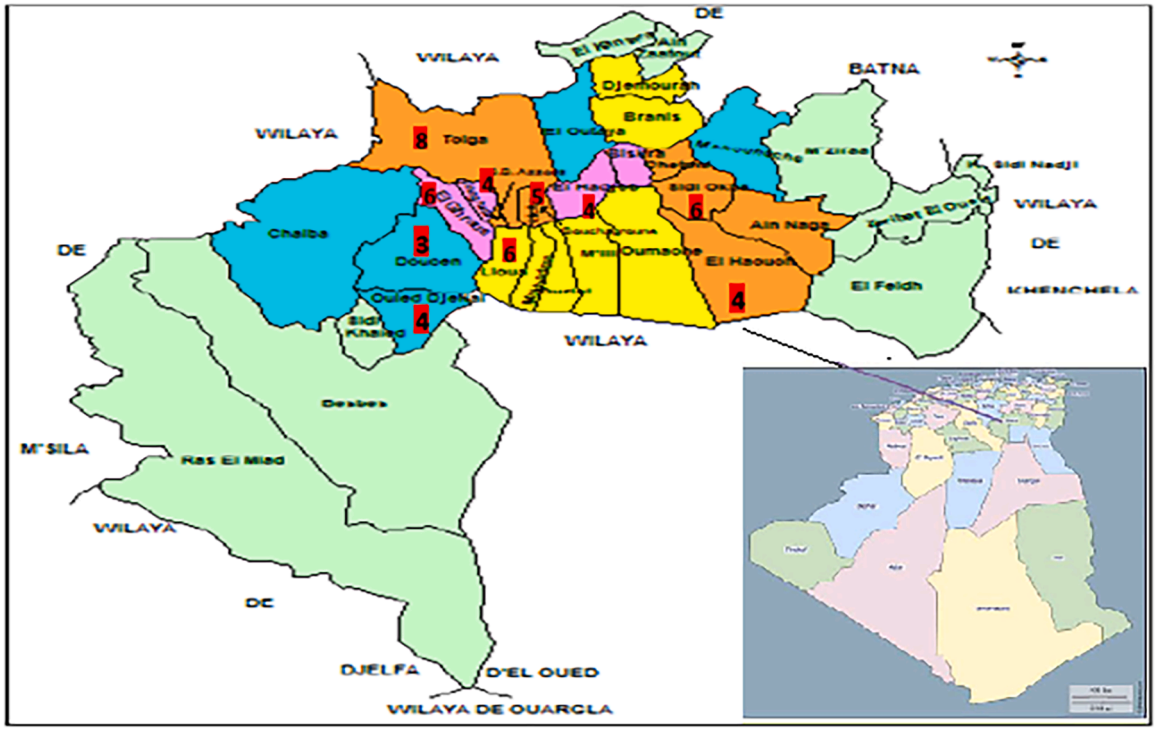

Fig. 1. Geographical location of the date producer study and survey area.
Number of date palm growers surveyed by municipality: Tolga (8), Sidi Okba (6), El Hadjeb (4), Ouled Djelal (4), Daoucen (3), Loua (6), El-Greous (6), Foughala (4)), Elhaouch (4), Bouchagroune (5).

Table 2
Description of farms surveyed (sample $n = 50$).

Characteristics	Average
Farm size (area in ha)	2
Number of palm trees/farm	240
Production (in tonnes)	16.8
Production start date (year—average)	1998
Age of farmer (years—average)	54

Source: Elaborated by the authors based on survey data.

Also, this work is consolidated by other direct interviews with actors and institutions having relationships with the subject.

After completing the survey, the questionnaires were analyzed and answers were obtained for each question raised; which are subsequently structured in tables, and finally an analysis and discussion are carried out based on the targeted problem. We have indicated the main sections covered by the questionnaire

4. Results and discussion

This research allowed us to examine two themes: sustainable practices in the Ziban palm groves on the one hand, and the link between these practices and other issues: yield, innovation, social role in the oasis environment, and intergenerational transmission, on the other.

4.1. What sustainable agricultural practices in the Ziban palm groves?

According to specialized institutions, the calendar of date palm cultivation includes several operations deemed necessary for production in quantity and quality [23,24]. In this study, we analyze the sustainability of these good practices based on the results of previous research, as well as empirical observations of farms and responses collected through our interviews with date producers in Biskra.

4.1.1. Working and amending the soil with earth and sand

Tillage practices are considered essential by farmers. These operations are carried out; in particular, in palm groves threatened by the rise in the water table, on average, every 2 or 3 years. In fact, nearly 96 % of date palm growers prepare the soil for palm groves. However, only the owners of recent plantations, where the market value of dates is relatively high, carry out this practice correctly. This practice involves preparing the seguias for irrigation and the planting beds." Mowing weeds constitutes 50 % of tillage. Only 20 % of farmers resort to mechanization (tractor, plows, rotary and graders) for deep plowing and maintenance of basins, while the rest of date palm farms use both methods at the same time. Finally, soil amendment by adding soil is another good agricultural practice carried out by 28 % of respondents in the Ziban palm groves, threatened by the surface water table.

4.1.2. The organic amendment

Another sustainable farming practice recorded in the Ziban palm groves is organic amendment by spreading manure. This practice is carried out by all (100 %) of the farms in the region, every 2 to 3 years, usually in winter. Farmers argue that it is necessary to maintain yields, especially on large and medium-sized farms. Yet, the amount of manure used sometimes falls short of the 100 kg per palm tree recommended by ITDAS. In the palm groves surveyed, the amount of manure applied was 33 kg. Over 70 % of producers use sheep manure, 35 % cattle manure and only 20 % poultry manure. In the future, 90 % of date growers plan to use organic manure, despite financial constraints. They believe that these organic inputs have a significant impact on the environment, soil, water, and date production, enhancing both the quality, quantity and yields of date production.

4.1.3. Controlling date palm diseases and pests

Boufaroua is one of the most common parasites in the oases of the region. It attacks semi-soft varieties, in particular the Deglet Nour date [23–25]. The presence rate of this mite exceeds 80 % of all farms due to unfavorable climatic conditions, particularly drought [13]. To limit the

damage of Boufaroua, and to reduce the use of acaricides (Vertimec Masai, Zoro), 40 %of producers opt for the elimination and incineration of infected bunches. Other good sustainable practices have been observed in some palm groves, such as the use of bagging to protect date bunches against climatic hazards, Boufaroua attacks, and to maintain adequate hygrometry and temperature of bunches.

All farmers questioned said that ongoing maintenance of the palm grove and the burning of organic waste avoided the use of chemical products. For example, 72 % of respondents plan to mow weeds by hand, uproot weeds, groom palm trees properly, and collect and incinerate date palm waste. Lastly, 10 % of respondents use lime (CaO) around the palm tree to limit the rise of insects, particularly red ants and locusts in the crown of the palm. To deal with other phytosanitary problems, many growers sometimes resort to certain sustainable practices that are not harmful to the environment. These include mowing weeds by hand (72 %), uprooting weeds, grooming palms properly, and collecting and incinerating waste. To combat insects, 10 % of respondents use environmental and traditional practices, such as smearing lime (CaO) around the palm tree at a height of one meter above the ground to limit the rise of insects.

4.1.4. Water-saving techniques and irrigation practices

Several studies illustrate that irrigation is the major constraint preventing good productivity of date palm farmers [9–17]. According to our survey, the most used irrigation technique in the Ziban palm groves is that of the basin (24 %) or the row (14 %). This traditional irrigation network contributes to saving water, but it nevertheless remains poorly laid out and poorly maintained in almost all date palm farms, leading to a very high rate of water loss. This has also led to support from the public authorities, either in the form of localized irrigation systems under the PNDA, or through the installation of new date producers who are aware of the environmental aspect and the need to maintain sustainable resources, or in the form of induced investment. Indeed, nearly 62 % of the producers surveyed use the localized or drip irrigation system.

Nearly 50 % of those surveyed believed they had adequate access to irrigation water, with minimal waste resulting from using this system. For these farmers, implementing drip irrigation is a key aspect of rational water management in the region, helping to conserve water, time, and labor.It is a reasoned, localized and homogeneous form of irrigation. It ensures that moisture is maintained in the rhizosphere layer. Lastly, 40 % of those surveyed suggested that drip irrigation leads to the reasoned application of periodic doses, accompanied by a remarkable reduction in weeds, particularly quackgrass. In addition to drip irrigation, 32 % of date growers consider that night irrigation, good management of irrigation frequencies (by spacing out water applications between 10 and 20 days depending on the season, the needs of the palm tree, and the climatic and soil conditions), reducing the volume of pits and slices used for planting palms, applying a rational planting density (7 m × 7 m and 8 m × 8 m), and using organic fertilizers are alternatives for saving water and sustainable managing.

4.1.5. Preservation of autochthonous varieties

A large number of cultivars have been inventoried in Algerian oases. Indeed, 940 cultivars were inventoried in Algeria [17], including 130 cultivars found in the Ziban oases. Nevertheless, our survey demonstrates significant genetic erosion of local cultivars, particularly in the palm groves of the western zone, where 99 % of Deglet Nour is grown as a single variety, leading to the disappearance of several native cultivars. This genetic erosion threatens the oasis balance and biodiversity as a result of the concentration on cultivars of high economic interest. This has been particularly conspicuous in large farms. According to those surveyed, genetic erosion is exacerbated by several factors, such as the ageing of native cultivars and attacks by diseases and pests on old palm trees.

To demonstrate the existing level of perception and awareness of producers on this issue, initiatives to protect these ancestral varieties and biodiversity within the Ziban palm groves are conducted locally by 48 % of those surveyed and supported by institutions such as ITDAS, INRA, DSA, CRSTA and the Department of Agronomic Sciences at the University of Biskra in order to spread the negative effects of the monovariety. The multiplication of young offshoots in palm groves (16 %), the purchase of offoffshoots even at high prices, the exchange of offoffshoots between growers and the collection of young offoffshoots were, according to our surveys, the major actions for the protection of local varieties threatened by extinction (Table 3).

4.2. Sustainability or yield: an irrelevant arbitration

These initial descriptive empirical results lead us to make observations and to discuss them in light of previous empirical studies conducted in the Algerian context or in other countries. Firstly, there is evidence of a high frequency of environmental practices on phoenicicole farms, although the rates differ according to the farm practices and characteristics. Our results illustrate that soil preparation, organic fertilizers, and saving water by adopting drip irrigation systems are the most common practices. Conversely, practices involving the adaptation of fertilizer doses and water quantities after resorting to analyses, or night irrigation and the planting of autochthonous varieties, are not yet widespread.

Next, It should also be noted that the interviews revealed that the primary drivers for adopting these practices are not solely environmental sensitivity but are more closely related to performance and profitability considerations, including among large farms . It is therefore a matter of identifying inexpensive alternatives to the use of expensive technical solutions (such as chemical fertilizers). Date palm productors did not “understand” our questions about the possible trade-offs between sustainability and yield, since a large majority of them considered that the adoption of environmental practices was essentially done for economic reasons in order to improve existing yields and the quality of products. In addition, a number of farmers also told us about other innovations, particularly in the fight against palm diseases and pests or even pollination, which constitute real technical advances. For example, the use of a protective net for each diet can significantly reduce infection rates, similarly, the tests of autochthonous varieties constitute future solutions for the renewal of palm groves.

Another point concerns the distinction of the frequency of practices according to farm profiles. We had as a priori, the adoption of these

Table 3
Frequency of environmental practices of date palmer production.

Category	Practices observed	Frequency in %
Water management/ irrigation	– Adoption of the drip system.	62
	– Night-time irrigation to avoid ETP.	32
Preservation of autochthonous varieties	– Preservation of endangered varieties Tantbouchet, Zograi, Litima and others.	48
	– Vegetative propagation against genetic erosion by new plantations of autochthonous varieties.	16
Soil tillage and amendment	– Organic supply fertilizers of ovine, bovine and poultry origin as an alternative to chemical fertilizers.	100
	– Soil preparation.	96
	– Add soil if soil exhaustion.	28
Disease control	– Disposal of infected bunches by incineration.	40
	– Manual mowing of weeds,Uprooting of weeds, regular grooming of palm trees.	72
Compliance with standards	– Compliance with treatment doses and dates.	40
	– Adaptation of uses to soil and water analyzes.	20

Source: Elaborated by the authors based on survey data.

practices by default, in particular for cost reasons by small farms and a low frequency in larger farms. Observations in the field enabled us to qualify this, as many large, recently created farms were adopting environmental practices in large numbers, particularly in terms of irrigation and tillage, or compliance with doses and efforts to save inputs (Table 4). These farms also rely on the availability of skilled labor to carry out manual grooming of the palms. For their part, small farms adopt traditional techniques for irrigation (seguias), soil preparation, amendment, and disease control (lime, nets). These farmers play a key role in conserving autochthonous varieties, giving them priority when renewing their groves.

Nevertheless, the development of these new farms coupled with the very significant growth of market gardening activity in greenhouses in the wilaya of Biskra acutely raise questions about the depletion of water resources and conflict situations in water governance. (illegal drilling, conflicts between farmers, competition in uses, etc.) [26]. These issues have also been observed in other contexts. Mekki et al. [27] had reported the limits of the extension of palm groves generated by issues related to the exploitation of water resources in the Kébili region of Tunisia.

Finally, our survey has lead us to identify other advantages to the dissemination of these environmental practices in the date palm farms of Biskra. The first concerns the preservation of know-how and the intergenerational transmission of practices. These transfers are based on processes for selecting good practices and adapting them to the local environment before their "institutionalization" and dissemination. The second relates to coordination with other local sectors. Thus, exchanges with breeders for organic matter correspond to better valorization of date palm by-products as animal feed. This has been the work of both small and large farms. The third advantage revealed concerns the preservation of the agricultural system with a view to oasis agrotourism and better promotion of products. Thus, we were able to identify several initiatives (sometimes collective) for the implementation of agrotourism actions related to the sustainability of the oasis environment. Similarly, some date palm growers were engaged in labeling processes (organic farming for export, or geographical indication for the Algerian market) in order to enhance selling prices and to diversify outlets [6].

Table 4
Exploitations size and environmental practices of date palmer production.

Category	Less than 100 palms	Between 100 and 200 palm trees	More than 200 palm trees
Water management/ irrigation	++++ Night irrigation	+++	++
Preservation of autochthonous varieties	++++ autochthonous varieties	+	±
Soil tillage and amendment	++++ Soil input if exhaustion	++++	++++ Organic inputs
Disease control	+++ palm tree grooming		
Dose compliance	−−	±	++ Dose compliance

Authors' Assessment according to the survey results (+ strong, −weak).
Source: Elaborated by the authors based on survey data.

5. Conclusion and outlook

The aim of our study was to take stock of environmental practices on phoeniciculture farms in the oases of south-eastern Algeria. Analysis of empirical research data from around fifty palm growers in the Ziban region of Biskra showed that certain practices were widespread, particularly those relating to soil preparation, organic fertilizers, palm tree maintenance and the adoption of water-saving irrigation systems. Other practices linked to the preservation of native varieties or the adoption of agricultural innovations were present, but were shared in different ways depending on the size of the farms. We showed that the idea that small farms are more sustainable than large ones needs to be qualified. Finally, our field observations show the emergence of numerous 'frugal' innovations (bagging, protective nets, use of lime) and the integration of specific features of the local environment (arbitration in water management, organic amendment from oasis livestock farming, etc.).

In order to answer the initial question, the adoption of these environmental practices does not respond to sustainability versus performance arbitrations. Quite the contrary, Sustainability objectives are not seen as a source of cost, but rather of savings and consistency with local practices. Farmers adopt these practices for reasons of yield and product quality. Other factors contribute to their diffusion: the efforts of institutions in terms of agricultural extension, the desire of farmers to protect and transmit indigenous know-how, the preservation of the agricultural environment and the inclusion of these practices in agro-environmental territorial approaches.

The present findings are in line with previous studies on agricultural practices in oasis environments [17–26]. Among other things, they point out the importance of issues related to water management, the dissemination of environmental practices, and the role of institutions (support, extension, collective innovation, etc.). Also, our results show the adaptation and appropriation capacities of the actors of agricultural innovations and their efforts to preserve existing practices. Finally, they underline the irrelevance of theoretical frameworks based on simplistic visions of trade-offs between environmental practices and productivity.

The present results suggest that agricultural organizations step up their efforts to disseminate these practices and encourage local growers to adopt them. This could also contribute to the creation of a local frame of reference, to which new arrivals and those among the growers who would like to settle in this region could adhere. Such an integrated approach would contribute to better preservation of resources and the transmission of indigenous knowledge and local practices.

Despite the limitations due to the sample size and the qualitative nature of the approach, the present work helps to identify a number of perspectives in relation to agricultural innovations and environmental practices. It will first be a matter of comparing these initial results with those from other regions in Algeria and other countries. Then, it is necessary to examine the reasons why environmental practices are not adopted, since costs do not seem to be a major obstacle. Finally, further investigations would enable these agricultural practices to be considered from a broader socio-economic perspective of the oasis environment, for example, links with other activities, and effects on social and territorial organizations.

CRediT authorship contribution statement

Salah Eddine Benziouche: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Salim Khechai:** Writing – review & editing, Writing – original draft, Project administration, Investigation, Formal analysis, Data curation. **Foued Cheriet:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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