

FROM OASIS ARCHIPELAGO TO PIONEERING ELDORADO IN ALGERIA'S SAHARA[†]F. AMICHI^{1,2,3,5*}, S. BOUARFA⁴, M. KUPER⁵  AND P. CARON⁵¹AgroParisTech-Engref - Centre de Montpellier, Montpellier, France²Gestion de l'eau acteurs et usages, Montpellier, France³Institut Agronomique et Veterinaire Hassan II, Rabat, Morocco⁴IRSTEA - UMR G-eau, Montpellier, France⁵CIRAD Occitanie-Montpellier, Montpellier, Languedoc-Roussillon, France

ABSTRACT

Since the 1980s, the Biskra region in Algeria's Sahara has undergone rapid agricultural change leading to territorial transformation. Horticultural production under greenhouses, associated with a rapid expansion of date palm plantations, has led to a tangible agricultural boom that is constantly pushing the boundaries of agricultural production and constitutes a true pioneering fringe. To understand the pioneering logics at work, we propose to study the pioneer fringe through three fronts, namely land, water and infrastructure. First, we analyse each front separately in order to understand its logic. In a second step, through three illustrations, we show how these fronts interpenetrate, accelerate one another or, on the contrary, constrain the pioneer fringe. The analysis of the advance of the pioneering fringe has shown that it results from the interweaving of the three main fronts and each of these combines both the actions of the state and private initiative. © 2018 John Wiley & Sons, Ltd.

KEY WORDS: pioneer front; pioneer fringe; territorial transformation; groundwater; state action; private initiative; Biskra; Sahara; Algeria

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RÉSUMÉ

Depuis les années 1980, la région de Biskra dans le Sahara Algérien a connu de fortes mutations agricoles entraînant des dynamiques de transformation territoriale. En effet, sous l'effet du développement de la production maraîchère, associée à l'expansion rapide des plantations de palmiers dattiers, on assiste à un véritable boom agricole qui ne cesse de repousser les frontières de la production agricole et constitue une véritable frange pionnière. Dans le but de comprendre les logiques pionnières à l'œuvre, nous proposons d'étudier la frange pionnière à travers trois fronts à savoir: le foncier, l'eau et les infrastructures. Dans un premier temps, nous analysons chaque entrée séparément afin d'en comprendre les logiques. Dans un second temps, à travers trois illustrations, nous montrons comment ces fronts s'interpénètrent, s'accélèrent les uns les autres ou au contraire se contraignent. L'analyse de l'avancée de la frange pionnière nous a montré qu'elle résulte de l'imbrication des trois principaux fronts et chacun de ces fronts conjugue à la fois l'action de l'État et l'initiative privée. © 2018 John Wiley & Sons, Ltd.

MOTS CLÉS: front pionnier; frange pionnière; transformation territoriale; eaux souterraines; action étatique; initiative privée; Biskra; Sahara; Algérie

INTRODUCTION

Numerous studies have examined mankind's colonization of new territories. These studies attempted to understand the factors that motivate the expansion of human activities into

so-called 'virgin' areas; to evaluate the impact of such activities on renewable resources; and to analyse the conditions that make them sustainable. The term 'frontier' of settlement was coined to describe the integration of new land. The historian and sociologist Turner (1893) elaborated this concept in a series of articles between 1893 and 1918, explaining the influence of the 'frontier' on American national identity (Slatta, 1997). Turner's research, in common with subsequent studies that draw on it, emphasizes the role of private initiative in the advance of pioneer fronts: cowboys in the

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[†]De l'archipel oasien à l'eldorado pionnier au Sahara Algérien.

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Far West, in this particular case, and more generally the 'land-tilling pioneer' (Bowman, 1931). Other studies place greater stress on the state's role in pioneer-front territorial expansion, in particular through the construction of road and railway systems.

The notion of 'front' denotes a uniform and linear form of territorial expansion. Yet, this notion often minimizes the way various factors overlap, interact and contribute to the development of new spaces. Bowman used the term 'pioneer fringe' for the first time in 1931 in a deliberate challenge to Turner's formulation. Monbeig (1966) stated in the same sense: 'We should talk about "pioneer fringe" rather than "front", since sudden breaks are rare: we usually move from organised spaces to spaces that will become so via a relatively swift progression.' This statement draws attention to the fact that agrarian colonization generally underestimates or even deliberately ignores the existence of earlier organized spaces. Such earlier organized spaces related in North Africa's Sahara, for instance, to the pastoral rangeland exploited by nomads and which declined due to the sedentarization of nomadic populations and the regression of transhumant pastoralism (Bisson, 1991). Following Kopytoff's seminal work (1987), more recent studies, therefore, refer to an 'ever-renewed process of colonisation of "internal" or "interstitial" frontiers, operating on the margins of already established socio-political entities' (Chauveau *et al.*, 2004). Caron (1998) makes a further distinction between pioneer fronts and pioneer spaces in order to distinguish between what happens at the front and the process of appropriation that takes place within the spaces. Accordingly, the concept of pioneer fringe incorporates the complex nature of the interactions between different protagonists involved with agricultural dynamics on an internal frontier.

This type of pioneering process has been under way in the arid Biskra region in the Algerian Sahara for almost three decades, thanks to a significant increase in irrigated horticultural greenhouse production, linked to a rapid expansion of date palm plantations. The boom is based on colonizing new spaces and pushing back the frontiers of agricultural spaces. As a result, the conventional vision of oasis agriculture as an archipelago of ancient oases surrounded by vast spaces with extensive livestock farming is being replaced by an 'Eldorado' vision of intensive Saharan agriculture (Côte, 2002). This renewal of Saharan agriculture has come about following the disappointing results of state-driven large-scale cereal development using pivot irrigation (Otmane and Kouzmine, 2013). We argue in this article that such state initiatives have opened up spaces for the current agricultural boom. In fact, a new Saharan agricultural model is emerging, based on private initiative of farmers from across Algeria investing in the access to groundwater by drilling boreholes; in land by converting rangeland or spate

irrigation systems (Hamamouche *et al.*, 2018); and in greenhouses for cultivating horticulture (Amichi *et al.*, 2015). The region's favourable natural conditions enhance this intensive form of agriculture: the abundant groundwater reserves and high direct sunlight mean that horticultural produce can be brought to market at an early date (the so-called *primeurs*). At first sight, the state does not seem to play a part in this new territorial dynamic. However, agricultural subsidies and expansion of the electricity network, road system and commercial infrastructure for the flow of products, and even the social infrastructure supporting social services including schooling and health, all contribute to the region's agricultural vitality.

This article aims to analyse the development of irrigated agriculture in and around Biskra in the form of a pioneer fringe. We will show how this concept can be used to characterize the region's territorial transformation. And, on this basis, we will formulate the hypothesis that the fringe is moulded by a combination of private and public actions.

Our article will briefly trace the recent history of changes in agricultural policy in Algeria's Sahara, shifting from state interventionism in the 1960s to 1980s to a liberal approach that is supported—and often subsidized—by the state. This survey is followed by an analysis of the development of the pioneer fringe around the El Ghrouss oasis, which is examined in the form of three main overlapping fronts: (i) land—there are lively markets for large tracts of land that was previously pastoral, with access now facilitated by recent land policies; (ii) groundwater—the development of deep boreholes, combined with the proliferation of informal arrangements for accessing water, means that groundwater is available to a growing number of stakeholders; (iii) public infrastructure (roads, electrification, etc.)—creating an environment that fosters territorial transformation.

DESCRIPTION OF THE CASE STUDY AND METHODOLOGY

The new groundwater-based Saharan agriculture

The Algerian state has focused on expanding agriculture in the Sahara as part of a strategy to diversify the country's economic activity beyond the exploitation of hydrocarbons. During the 1970s, a model based on large cereal farms was promoted as a way to reduce Algeria's dependence on cereal production and imports. These extensive farms were irrigated by large pivots, using pumped groundwater, according to the American model. Following mixed results, particularly in terms of agricultural yields, this model was progressively abandoned. It was a model largely shaped by state action, its top-down design excluding any involvement of local actors (Otmane and Kouzmine, 2013).

The 1980s heralded the beginning of economic liberalism in Algeria. Against this background, agricultural policy in the south of the country was defined by a 1983 land reform programme. This freed up land in the public domain and *arch* land (tribal land collectively owned) for private—and increasingly individual—use. The land reforms marked the start of a series of incentives designed to promote private agricultural investment; unlike the earlier model, this involved local actors. Newly accessible land was now irrigated by boreholes constructed by state-owned firms, in contrast to the archipelago of ancient oases, which were irrigated by artesian water sources or flooding. Access to the confined aquifers through boreholes, initiated by the state, was then taken over massively by private actors, some of whom received subsidies but most of whom implemented these boreholes informally, particularly from the 1990s onwards. The state devised a number of infrastructure projects in support of this emerging agricultural dynamic, as well as unblocking substantial financial resources for farmers. These different initiatives, both state and private, often overlap, and have helped build three fronts—land, water and infrastructure—that lie behind the region's current territorial expansion.

The El Ghrouss pioneer fringe

Our investigations focused on an area around the El Ghrouss oasis in the *wilaya* (department) of Biskra, approximately 400 km south-east of Algiers. This area has witnessed sharp changes in agricultural practices over the last three decades, driven by a boom in greenhouse horticulture and a renewal and expansion of the century-old date palm plantations (Dubost and Larbi-Youcef, 1998; Khiari, 2002; Amichi *et al.*, 2015). In El Ghrouss, the surface area under greenhouses, introduced in the early 1990s, increased rapidly in the early stages: 535 ha in 2000, according to Khiari (2002). The increase in the surface area of palm groves was even more impressive, going up from 600 ha in 1980 to about 3465 ha in 2000 (Khiari, 2002).

For this study, surveys were carried out between 2013 and 2015, the primary objective being to identify the various actors working in the pioneer fringe in the El Ghrouss territory. The second objective was to explain the role of each actor in the dynamics of the pioneer fringe.

The surveys pinpointed three main categories of actors. First, the farmers, who were divided into four groups: (i) landowners who install the boreholes and rent out the land along with access to groundwater; (ii) lessees who will rent the land and purchase greenhouses and agricultural inputs; (iii) sharecroppers who constitute the skilled workforce of this sector; (iv) seasonal workers (Amichi *et al.*, 2015). Second, professionals in the agricultural sector: drillers of boreholes, seed and input suppliers, and market actors, in particular the traders responsible for the flow of agricultural

commodities. These two categories are not entirely distinct, since some farmers may also be involved in marketing or work as borehole operators, etc. Third, actors in the various local administrations in the municipality of El Ghrouss and regional administration of Biskra: the services responsible for water supplies, the agricultural authorities, energy supply, town hall, technical and research institutes, and the university.

The pioneer fringe in the El Ghrouss area includes two distinct and complementary farming systems. The first is greenhouse market gardening (tomatoes, sweet and hot peppers, melons and watermelon), an activity that was introduced into the region three decades ago (Khiari, 2002). The second is based on setting up new monocropped *deglet nour* farms, a date variety with a high market value. Unlike greenhouse market gardening, there is a long history of date palm cultivation in the Sahara in stratified oases (date palms, fruit trees and annual crops): in fact, it is the very essence of oasis life. Although horticulture was practised in the past in the ancient oases (intercropped with palm trees), it was mainly meant for self-consumption. By contrast, horticulture in the pioneer fringe has been developed under greenhouses; high amounts of inputs are used, and the produce mainly supplies the markets in northern Algeria. Greenhouse horticulture is characterized by high added value per hectare and a short production cycle, and it attracts all types of farmers, with or without land.

Greenhouse market gardening is often the precursor to planting palm trees. 'Virgin' plots are colonized and cultivated under horticulture in order to fund the planting of palm trees and to secure a cash flow until date production begins. Figure 1 shows three landscapes that illustrate the different stages in the growth of the pioneer fringe: (i) an area of agricultural development, occupied exclusively by greenhouse horticulture; (ii) a mixed area combining new date palm plantations that are not yet productive and greenhouse horticulture; (iii) an area composed exclusively of date palms.

The complementary nature of the two farming systems rests on interconnected individual and collective initiatives, including a variety of mechanisms for pooling the resources required for agricultural production (Amichi *et al.*, 2015). These arrangements cover access to land, groundwater, capital, the market, technical knowledge and workforce, as well as the possible use of state support. The dynamism of this imbricated system is based on a synergy between actors with different needs and production means. This includes landowners (or those having land-use rights under a concession granted by the state), who rent out part or all of their land to sharecroppers or lessees so that it can be developed. These sharecroppers and lessees can perhaps be likened to Kopytoff's frontier entrepreneurs (1987), as they bring in the know-how, the capital and the workforce to bring the



Figure 1. Three types of landscape illustrating the different stages in the development of the pioneer fringe [Colour figure can be viewed at wileyonlinelibrary.com]

land under production. Before the parcels are rented out, they are laid out in small plots that correspond to the greenhouse sites, which are fed by irrigation water from one or more boreholes that the landowner has already drilled. There is a specific model that is becoming increasingly widespread in the region: owners start off by using their plots for intensive horticulture through sharecropping or by leasing them for a minimum of 3 years before considering planting palm trees on the spot where the first greenhouses were erected. The nature of the soil in the region, combined with the intensive character of market gardening, obliges such lessees or sharecroppers to move the greenhouses after 3 years so the soil can regenerate and so they can find more fertile land nearby. The landowner then generally reverts his land to palm tree plantations, explaining the mosaic in the landscape of the mixed system of Figure 1.

Below we describe the dynamics of each of the three fronts: land, water and infrastructure. Three examples are then used to analyse the interconnections between the fronts and their impact on territorial extension before we end with our conclusion.

A PIONEER FRINGE ON SEVERAL FRONTS

Lively land markets

The vibrant land markets found in Algeria's Sahara today are rooted in the 1983 Access to Agricultural Land Property law, promoting landownership through agricultural development, part of a policy of liberalizing the agricultural sector. The aim of the law was to free up access to land in the state's private domain, i.e. all land where there were no formalized rights, essentially tribal or *arch* lands, where tribes have ancestral but no formal rights.

The Algerian state proceeded in two different ways. First, it operated as a developer on some of the land organized in irrigation development schemes by drilling deep boreholes and introducing electrification for agricultural purposes. This land was then distributed to beneficiaries for cultivation, with additional access to individual landownership

after 5 years of activity. The beneficiaries were either family members who had been exploiting the land prior to its development by the state, family members from neighbouring *archs* or local notables, usually veterans of the colonial war or local government officials (Daoudi and Colin, 2017).

However, given the popularity of access to landownership via agricultural development, the state also opened the door to private initiatives for developing the land lying outside these collective irrigation schemes. In some cases, the state formalized the practice of illicit expansion that was already under way. The beneficiaries assumed responsibility for accessing the land and the bulk of the expenses, ranging from drilling deep boreholes to costs associated with cultivation. Owing to the initial capital required for developing this land, the latter option often involved domestic investors with capital, mainly from the Biskra region but sometimes from across Algeria. In any event, this second form of land access has become much more widespread than the former, where the state plays the role of developer.

The popularity of accessing land through development has given rise to a property market for buying, selling and renting land in and around El Ghrouss (Daoudi and Colin, 2017). These deals provide for the transfer of some of the land newly acquired by owners not just to new purchasers but also to lessees and sharecroppers. Nevertheless, the deals are still profoundly marked by diverse, complex social relations, and are not governed exclusively by economic and legal considerations.

The newly acquired land can then be cultivated as owners, tenants and sharecroppers join forces using a variety of agrarian agreements to pool heterogeneous productive resources (land, water, capital, work, etc.). This land dynamic has encouraged farmers to invest increasingly in new rangelands, where the land is still cheap, and push back the previous frontiers, including in areas without electrification or agricultural tracks. As an indication, the price of land ranged from Algerian dinar DZD 40 000 (about €200) ha⁻¹ in the new areas to DZD 1 million (€5000) ha⁻¹ in the most productive date-growing zones. Access to land and the construction of boreholes are intimately linked in the region,

where the availability of water is one of the main factors in developing land.

Water: the ever-increasing number of boreholes

The old oases were always located around water springs and along the wadis. Access to groundwater via boreholes has made it possible to significantly increase the irrigated areas, and push back the water front. Farmers are no longer restricted to particular areas where water appears on the surface and is easily accessible. This horizontal expansion of the water front is gaining pace with the emergence of new pumping facilities. In addition to the growing number of these boreholes, new and less costly techniques for drilling boreholes mean it is possible to drill deeper and deeper, up to 600 m, to repel the vertical water front.

There are two formal procedures for obtaining a permit for drilling a borehole or for rehabilitating an old borehole based on checking the existence and non-functioning of an old borehole. These two measures, which were laid down by the authorities in 2008, are strict and complex (Executive Decree 08–148 of May 25, 2008 J.ON° 26, Art. 2). The ability to circumvent these rules is of major importance. For example, the authorities in the municipality of El Ghrouss estimate that there are 200 licensed boreholes. However, based on the invoices issued by the national electricity company, 1320 boreholes could be identified during this study, i.e. only 15% of the boreholes throughout the municipality have been formally authorized (Massuel *et al.*, 2017).

The cost of drilling a borehole is about DZD 10 000 (€50) per linear metre, which includes the cost of the workforce (paid to the driller) and the equipment that the farmer obtains directly (cement, drilling pipes, suction and discharge pipes for the pump, and electric cables). The price may rise by DZD 7000 (€35) per linear metre to cover risks associated with a possible control in cases where drilling is not allowed. Although institutional and financial constraints act as barriers to accessing groundwater, the number of boreholes continues to grow and push back the boundaries of Saharan agriculture.

The situation in El Ghrouss is characterized by a lack of reliable information about groundwater use through boreholes. Since most of the boreholes are connected to the electricity grid, they are listed by the public electricity company and are read periodically for billing purposes. In 2015, the 1320 boreholes connected to the network were used to irrigate 470 ha of greenhouses and 4800 ha of palm plantations, according to our investigations. Massuel *et al.* (2017) attempted to calculate the quantity of water extracted on the basis of an estimated 630 m³ of water consumed per greenhouse (with a surface area of 400 m²) per year on average (approximately 15 700 m³ ha⁻¹) and a range of 11 000–19 000 m³ ha⁻¹ for palm trees depending on their

maturity. This led to an estimation of groundwater use in the region ranging between 60 and 100 hm³ yr⁻¹.

Proactive infrastructure development

The proactive public policies introduced by the Algerian government since independence highlight the importance of improving access to new territories in the Sahara. Land development is accompanied by the gradual organization of marketing channels, in particular for transporting hydrocarbons. Transport networks are continuously developed to connect the region, as can be seen in the expansion of the road and air networks and the future prospect of developing the railway (Kouzmine, 2008). The infrastructure includes several items that play a major role in the agricultural dynamics and territorial development: (i) tracks or roads for organizing production (boreholes, transporting equipment, inputs and labour, etc.) and finding market opportunities for products; (ii) electricity grid for facilitating and reducing the cost of groundwater use; (iii) hydraulic equipment (boreholes, irrigation canals) by setting up public irrigation schemes in recent decades; (iv) social services, schools, dispensaries, shops, etc., without which it would be very difficult to mobilize the workforce.

Energy is an essential element that needs to be taken into account when considering access to groundwater. Algeria is noted for the high quality of its electricity grid (Akrich, 1989), and water resources at great depth (up to 600–700 m) can be pumped efficiently. In areas that have already been developed and urbanized, a specific grid called the 'agricultural line' serves the boreholes. This grid benefits from a heavily subsidized tariff that is lower than for the domestic network (especially outside the peak period between 5 pm and 9 pm). In zones not served by agricultural lines—but which are situated in the immediate vicinity of areas that are connected—farmers apply for a new line to be set up with the national electricity and gas company (Société Nationale d'Electricité et de Gaz; Sonelgaz). This operator is responsible for generating, transporting and distributing electricity as well as transporting and distributing gas. The application is generally made collectively so that the investment costs for farmers may be pooled. Some farmers with large projects, however, may also apply individually. The investment does not cover the total cost, which is covered in part by the state. At present, Sonelgaz does not check the legal status of boreholes for connection requests (i.e. whether they are legal or not): this explains why the number of boreholes in the operator's database is far higher than those officially listed by the water management services that record authorized boreholes. Based on our previous estimates of groundwater use of boreholes, the total electricity consumption amounted to about 10⁸ kWh yr⁻¹. The energy used to pump water is equivalent to the average annual

electricity consumption of 80 000 inhabitants in Algeria (based on 1277 kWh yr⁻¹ per inhabitant in 2013; World Bank, 2013).

Setting up public collective irrigation schemes is also an opportunity for expanding the pioneer fringe, even though these schemes have often failed in terms of agricultural development. Installing an electrical network, opening up the tracks and roads that go with establishing such schemes, as well as hard evidence that there is water, are all opportunities for expanding agriculture in areas that are peripheral to the concession. Farmers who are not direct 'beneficiaries' of these perimeters rely on this infrastructure, including for possibly extending the electricity grid to their own boreholes. The risks normally associated with drilling boreholes, i.e. the chance to find water, are limited since the boreholes of the public schemes have already demonstrated that there is a very real chance that farmers can access the groundwater resources nearby.

Access to electricity and transport via tracks does not always precede the acquisition of land and borehole construction. Farmers may purchase land in advance of the pioneer fringe, setting up boreholes before public infrastructure arrives. They build rough tracks in the transition period and

use diesel energy. The infrastructure then follows via state intervention when the density of the water supply or the number of producers justifies it. Accordingly, the state may intervene ahead of a new agricultural dynamic (which is the case for public irrigation schemes) or after, when it follows and supports the dynamic.

PIONEER EXPANSION: THREE INTERACTING FRONTS AND THREE CONTRASTING EXAMPLES

Below we analyse the agricultural development of three particular areas in the study zone as a way of furthering our understanding of how the three fronts interact. These examples provide a good illustration of the methods and effects of the progress of the various fronts for the local agricultural dynamic.

Three interacting fronts in El Merhoum

The three pioneer fronts interact simultaneously in the El Merhoum area in the north-west of the oasis (Zone 1 in Figure 2). This area is considered the most dynamic in the

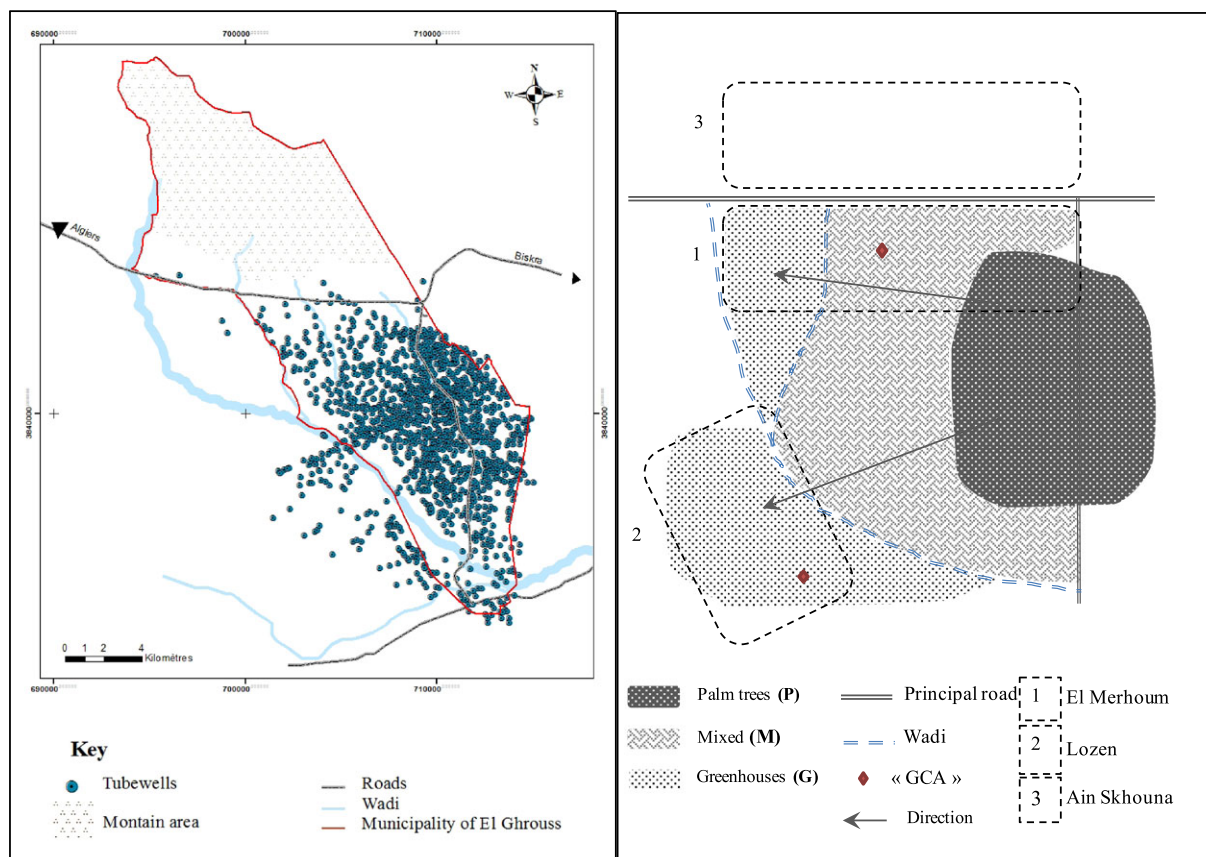


Figure 2. Three distinct areas based on the differentiated combinations of the three fronts and their effects on the advance of the pioneer fringe [Colour figure can be viewed at wileyonlinelibrary.com]

study area, and is marked by a very active land market, which constitutes the first front. Informal tenancy is very common, especially for horticulture. Water is available thanks to the different agreements struck between actors for drilling collective boreholes and organizing the access to water, which is the second front.

The proximity of the national road and the town of El Ghrouss has facilitated access to electricity and transport links to Merhoum, the third front. The pioneer fringe extends from east to west, and started on the basis of old artesian sources (now dried up) in the traditional oasis. Initially, it was the 83–18 law on access to agricultural land-ownership that was behind the development of the 'bare' lands of Merhoum. Access to water was provided by diesel-powered pumps until the arrival of electricity in 1989. Date palms were the main crop cultivated during this period. The first tunnel greenhouses appeared in the 1990s. These greenhouses were developed by migrants from northern Algeria boasting great expertise in this domain. Farmers are now coming to the area in search of better working conditions, land, groundwater, good temperatures for early crops and close proximity to wholesale markets for the country's major cities. This new 'Eldorado' is attracting growing numbers of farmers who are investing or simply highlighting their know-how and capacity for hard work. Total electricity coverage in the Merhoum area was achieved in 2014.

Waiting for public infrastructure in Lozen

Lozen, situated to the south-west of the oasis (Zone 2 in Figure 2), belongs both to the municipality of El Ghrouss and the neighbouring municipality of Doucen. Still 'virgin' in terms of cultivation a few years ago, Lozen is now undergoing a rapid agrarian shift, evolving from a vast tract dedicated mainly to extensive sheep farming to a pioneer form of agriculture based on developing new land and securing access to water. Lozen is dominated by *arch* land belonging to the Bazid tribe, which lives in the municipalities of El Ghrouss and Doucen. Traditionally, the Bazids only sell land to fellow tribe members. This rule, however, was broken by the El Ghrouss farmers when they sold part of the land appropriated under the Access to Agricultural Land Property to non-tribal purchasers. Once access to the land was obtained, the new owners constructed illegal boreholes, which is still a relatively easy process in this pioneer fringe. In this locality—which is known as '*le large*' (literally that which occupies or delimits a considerable space) since it consists of rangelands as far as the eye can see—there are no close neighbours to report on anyone drilling a borehole; nor are there any patrols by the local authorities. Some farmers have even gone so far as to build closed boreholes, setting them aside for the day they start farming their land.

The farms in Lozen are mainly devoted to greenhouse horticulture. The low agricultural density means there is little risk of phytosanitary disease. The main difficulty in this area lies with the third front, i.e. public infrastructure. The majority of boreholes are powered by diesel or using an informal system whereby electric cables are stretched for several kilometres from electrified areas. The farms are scattered, with very little interconnection. Ten kilometres or so of trails have been laid by the farmers themselves as they wait for new infrastructure to be developed. The farmers still find it difficult to attract workers because of the lack of infrastructure and public services. It is a desert landscape, with very little housing and even fewer shops or other services (schools, post offices, transport, etc.).

A public irrigation scheme was recently created, allowing access to land and water in Lozen. This scheme includes three boreholes connected to electricity. These improvements have attracted more and more farmers, reassured by the availability of electricity in the surrounding area and water in the boreholes. This state investment suggests that the pioneer fringe in this area will soon take off.

Land blockages in Ain Skhouna

To the north of the municipality of El Ghrouss, in the foothills of the Ziban mountains of the Saharan Atlas, there is an area that is still sparsely cultivated despite the progress of the infrastructure front (roads, markets, electricity network are all readily accessible) and the availability of groundwater. Ain Skhouna (Zone 3 in Figure 2) literally means 'hot spring', in reference to the Albian borehole found in the area, which is 2000 m deep and was constructed by the water management department. The water is at 52°C, and the borehole irrigates the handful of farms via an open cooling system.

However, in spite of the borehole and infrastructure, the locality has not experienced the same agricultural dynamism as Merhoum, even though they are only separated by the national road. So far, it is the land that is blocking any form of agricultural development, owing to several legal disputes. Ain Skhouna mainly consists of uncultivated municipal land. The municipal land was sold several times before being recovered by the municipality due to disagreements between farmers.

DISCUSSION AND CONCLUSION

Our analysis of the territorial expansion in El Ghrouss shows how the advance of the pioneer fringe is the product of three interrelated fronts: land, water and public infrastructure. All three are required for agricultural development to gain full speed. Agricultural development then relies on the mobilities of lessees and sharecroppers, who often arrive

from hundreds of kilometres away from the study area, bringing in the remaining productive resources (mainly capital, know-how and their workforce; see Amichi *et al.*, 2015). These 'frontier entrepreneurs' (Kopytoff, 1987), however, do not wait for all three fronts to be developed, but participate actively in developing access to land and water and often legitimize, by their presence, the implementation of public infrastructure, such as roads and the electricity grid.

We showed that the agricultural dynamic in the pioneer fringe in our study imbricated two distinct farming systems, where greenhouse horticulture, practised by lessees and sharecroppers, fuelled the expansion of date palm plantations of the landowners on what was previously pastoral rangeland. Bisson (1991) analysed a similar transformation process on what can be called an internal date palm frontier (see Chauveau *et al.*, 2004) in Tunisia's Nefzawa, also at the expense of pastoral rangeland. Interestingly, Bisson (1991) also highlighted the importance of the imbrication of two distinct cropping systems in this pioneer fringe, combining alfalfa, intended for the recently settled nomadic populations and their livestock, with short-term gains and date palms generating profit over the long term. A 'euphoric' agricultural development was thus well under way in the early 1990s in the Nezaoua (Bisson, 1991). Some 25 years later, agricultural development in the south of Tunisia is still booming around the profitable *deglet nour* date palm variety (Mekki *et al.*, 2013), but there is no real indication on how this pioneer fringe continues to operate. In El Ghrouss, a comparison with the data provided by Khiari (2002) indicates that the surface area under greenhouses has not substantially changed from 2000 to 2015 and has even slightly decreased. However, we showed that greenhouse horticulture remains essential for continuously fuelling the expansion of date palm groves, the surface area of which increased by almost 40% during the same period. At the same time, Naouri *et al.* (2017) reported that the surface area of greenhouse horticulture in the larger Biskra *wilaya* (administrative department), in which the El Ghrouss municipality is located, more than tripled over the past 15 years. This suggests that El Ghrouss, which constituted one of the first and most important pioneering fringes in Biskra, has been replaced by other more dynamic pioneering fringes elsewhere in the *wilaya*.

As Monbeig (1981) suggests in his analysis of a case history in Brazil, the role of the state in colonizing new territories is decisive: 'A pioneer fringe is a matter of state'. Becker (1986) promotes the same idea, emphasizing the pivotal role played by the state in settling new land—as launched in 1940 in Brazil ('the March Westwards')—for colonizing the interior of the country and fostering national expansion. In our case, even though the state-driven agricultural development projects are often considered a failure

(Otmame and Kouzmine, 2013), these projects certainly provided legitimacy to the private agricultural boom that ensued. More prosaically, the state preceded and accompanied private initiative, in particular through the 1983 land reform (Daoudi and Colin, 2017) and by providing subsidies, thereby facilitating the formal and informal colonization of agricultural land. Moreover, we have shown in Biskra how each of the fronts combines state action and private initiative. In Lozen, for example, farmers buy land, dig boreholes and plan trails until the state takes over, installing the power grid and replacing tracks with roads.

Our work on the advance of the pioneer fringe, which was carried out on a local scale, offers a detailed analysis of the importance of private initiative and the interrelation between state and private actions. The same type of interconnection has also been observed elsewhere in the Mediterranean, for example in southern Spain (Mignon, 1974) and in Egypt (Acloque Desmulier, 2014). Private initiatives can become drivers of pioneering action. However, although state intervention appears at first sight to be absent from the agricultural dynamics, it is nevertheless an essential element. Only the public authorities have sufficient resources to create the infrastructure necessary for territorial transformation (Mignon, 1974). Private initiatives, for their part, go hand in hand with flexibility in choosing crops and the arrangements and agreements between actors for accessing natural and human resources (land, water and labour), all of which contribute to the strong agricultural dynamic in the region.

We also showed that the state does not always intervene in an unambiguous and coherent manner. For example, the measures undertaken by the agricultural services encourage greater production and a larger agricultural area by increasing the number of grants for agricultural concessions to private investors. At the same time, the water management services are attempting to restrict access to groundwater by cutting down on borehole permits. The energy sector is continuing to expand the electricity grid, and sees farmers as new customers, including for illegal boreholes. It is clear that the state apparatus is both 'omnipresent and tolerant' (Brochier-Puig, 2004).

This agricultural development does not fit in with a development plan drawn up in an integrated territorial policy. Rather, it allows for expansion in the form of a pioneer fringe. This process allows farmers who have come from elsewhere to try their luck in the hope that, through sheer hard work, they may be able to settle permanently in the territory; one day, perhaps, they may become owners of a palm plantation and achieve a good standard of living by building up holdings and a private income. The lack of a collective vision for territorial development means that it is unlikely that renewable resources will be regulated in the short term, particularly water which is not inexhaustible and which may one day shatter the advance of this Eldorado.

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