

Chapter 12

Conclusion

by Hein de Haas

12.1. Diverging patterns of agricultural transformation

12.1.1. Oasis ideal types or oasis myths?

The literature on oasis agriculture often refers to an ‘oasis ideal type’, represented by intensive subsistence agriculture in three vegetation layers.¹ According to this ideal type, the upper vegetation layer would be formed by the date palm, the very symbol of oasis agriculture. The second layer would consist of lower fruit trees such as the fig, almond, olive, and pomegranate. The third and lowest layer would be that of the, mostly annual, crops, such as cereals (barley, wheat, sorghum), alfalfa and various vegetables. The cultivation in several vegetation layers would optimise agricultural production on a limited surface with limited water resources. Moreover, the integration between crop cultivation and animal husbandry, the latter circulating all biomass not consumed by humans produced within the oasis system, would maintain soil fertility.

The literature on oasis agriculture often presumes a so-called ‘oasis effect’, which refers to subhumid micro-climate that would be created by the two high tree layers, favouring the growth of annual crops, by protecting them from the strong radiation, low humidity and high temperatures of the sub-Saharan climate (cf. Riou 1990, Larbi 1989). In this way, the oasis would be a rather ‘ideal’ agricultural system, optimising production in this arid environment. In brief, traditional oasis systems would be the apotheosis of sustainable and productive traditional farming systems in arid environment, based on indigenous knowledge.

However, this oasis ideal type should be seriously called in question (cf. Crossa-Raynaud 1990: 319-20). First of all, the three above-described vegetation layers do often not exist on one plot, as most do contain only two layers, and many plots are completely treeless. Where several vegetation layers do exist, the competition for light, nutrients and water is enormous. Empirical research demonstrated that the planting of alfalfa in a date palm grove entails a significant decrease in date yield (cf. Skouri 1990:333). From the objective of pure production maximisation, traditional oasis agriculture therefore seems ‘irrational’ (cf. De Haas 1995).

Moreover, the wrong starting point of the ‘oasis effect’ hypothesis, seems to be the climatic conditions prevailing in high summer. The extremely harsh summer conditions only prevail during three or four months of the year. The winter half year (October - April) and not the summer constitutes the main cultivation season for annual crops, especially cereals, in most oases. In wintertime, the temperatures and light intensity are not extreme at all, and shade will seriously reduce yields. Cultivation of a large variety of crops in several layers should therefore not primarily be understood from the perspective of production maximisation.

The existence of a large variety of crops on a limited surface should primarily be seen in the light of the general need of self-sufficiency of traditional oases (De Haas 1995:39).

¹ See also chapter 2.

Until the 20th century, oasis dwellers were obliged to fulfil themselves most of their dietary needs. Cultivating only one or a small number some (best-adapted) crops was therefore not possible. A great variety of crops had to be produced on a limited surface. Diversification of production should also be seen in the light of risk spreading. For example, a monoculture of dates would theoretically be more productive in terms of weight and market value than the mixed cultures of the traditional oases. However, date harvests show large annual variations depending on climatic conditions or diseases. By cultivating several crops at the same time, the risks of crop failure are spread, and the risk of one-sided soil nutrient depletion decreases. In absence of fertilisers, it was also absolutely necessary to cultivate fodder crops and hold livestock in order to produce sufficient manure (De Haas 1998). Alfalfa, the main fodder crop in oases, has the extra advantage of its nitrogen-binding, soil-enriching capacities. Such crop associations were vital in order to maintain the fertility and viability of the traditional oasis system.

12.1.2. The realities of oasis agriculture: diversity and transformation

Despite the many changes that occurred during the 20th century, agriculture remains the most important local economic activity in the eleven Moroccan and Tunisian oases under scrutiny. In many oases, agriculture seems to reflect the ‘ideal type’ of traditional oasis agriculture at first sight. This is especially the case in oases with relatively abundant water resources, such as the oases of the upper Todgha and Mareth. Nevertheless, at a closer look, a high degree of spatial differentiation in cropping patterns is revealed, which point at the fundamental diversity that characterise traditional oasis systems.

Firstly, this differentiation seems mainly related to the local bio-physical environment, notably the quantity and quality of land and water resources and the climate. Diverging socio-economic conditions (e.g. trade relations, ethnic relations), the specific characteristics of the inherited agro-hydrological infrastructure² as well as the local institutions managing this infrastructure, play a role in determining traditional cropping patterns too.

Secondly, the differentiation points at the inherently dynamic nature of oasis agriculture. It seems a misconception to conceive oasis systems as being stable and ideal ecosystems, which have reached their apotheosis, and are largely unchanging. This general equilibrium thinking, that tends to dominate perceptions on traditional peasant societies in general, is prevalent in literature on oasis agriculture. In reality, however, oasis systems have always been flexible and shifting throughout history, responding to environmental shocks (e.g. droughts, floods, long-term climatic change), shifting and mutating trade relations (e.g. products needed for the transsaharan trade), the ever-changing political-military situation (e.g. the arrival of new dynasties, tribal conflicts, tribute-protection agreements) and the introduction of new techniques, crops or animals (e.g. *khettaras*³, introduction of camels).

² The agro-hydrological infrastructure can be defined as the ensemble of man-made, physical structures enabling water extraction, irrigation and agriculture. In oases, the most prevalent structures are river dams, *khettaras*, intricate networks of irrigation channels, water storage basins, terraces, and land tenure patterns. Recently, motor pumps and modern irrigation systems have been added to the traditional infrastructure. Traditional oases are generally characterised by very sophisticated and complex agro-hydrological infrastructures, and their proper maintenance is essential for the very survival of desert

³ A *khettara* consists of a number of wells linked by an underground tunnel. This tunnel conducts the water originating from an underground source further downstream. Since the slope of the tunnel is always smaller than that of the terrain above, the tunnel comes to the surface after several kilometres’ distance, after which it

Although oasis systems have always been diverse and dynamic, the changes that occurred in the 20th century seem to be more drastic and rapid than ever before. Current oasis agriculture is going through a profound agricultural transformation, which entails increasing reliance on motor pumping, changing cropping patterns and increasing specialisation on certain crops, and the creation of new agricultural extensions outside traditional oases, and growing orientation on markets. It is important to stress that these transformations are not uniform but highly diverse across locales. They not only take different forms, but also seem more advanced in some oases and countries than in others. This diversity should again be explained and understood not only from local variations the local bio-physical context, but also from the changing political-economic context at the national and international level.

12.1.3. Transformations of traditional oasis systems

Among all research oases, oasis agriculture in Fatnassa in inland Tunisia seems the most ‘modernised’, i.e. relatively intensive and market-oriented. The ideal typical ‘multi-layered’ agriculture of the traditional type is almost completely absent here. During the past decades, a tendency towards mono-cropping of date palms is noticed. In Fatnassa and most other continental oases of Tunisia, the dominance of the date palm stands out. It concerns the monocropping of the highly remunerative variety *Deglet Nour* produced for the world market. Hence, the production of other fruit trees and olives has become marginal. Only limited vegetables, fodder crops – mainly alfalfa – and cereals are cultivated between and beneath the palms.

In the coastal oases of Mareth, agriculture is more diverse than in Fatnassa, and is often practised in several crop layers, according to the above-described oasis ‘ideal type’. In Mareth and the maritime oases of Tunisia in general, the date seems increasingly be outclassed by fruit trees, whose produce is partially sold on national and international markets. Although dates rank second in numbers and production in Mareth, the poorer quality is reflected in its important use for home and fodder consumption. Surfaces occupied by fruits trees such as pomegranate trees and apricots seem to be increasing at the cost of the high date palm trees, which tended to dominate the oasis.

This trend towards agricultural intensification has its drawbacks: under the present circumstances of flood irrigation, water is not sufficient. A switch towards the more efficient, localised drip irrigation could halt this trend but in this case, but this would entail the disappearance of the annual crops. In Mareth, there are concerns on the future of date palms. Compared to the continental oases, their quality is relatively poor quality compared with the varieties grown on continental oases (*Deglet Nour*). Moreover, there is the degree of maintenance is poor and illegal extractions of palm juice up sometimes lead to the exhaustion and death of trees.

As compared to Tunisia, in Morocco agricultural practices are generally more traditional as reflected in a more important share of subsistence production and lower capital intensity, mirrored in a lower level of mechanisation and more traditional methods of water extraction. In the Todgha oases, most plots are semi-open, with two layers of vegetation, mostly combining date palms or almond trees with alfalfa or cereals. This seems the most typical pattern of traditional oasis agriculture of the Todgha. As in other oases, the existence of this multi-cropping pattern should be seen in the light of the need self-sufficiency and risk-spreading for traditional peasant households. On this kind of plots, the tree cover is generally

not very dense, with the trees mainly located at the fringe of the plots, so that we can often hardly speak of a 'layer'. If many trees are planted on the plots themselves, the second layer of annual crops visibly suffers from the lack of light and nutrients. In the upper Todgha, plots bordering the river bed are often densely planted with one layer of mainly olive trees, since regular floods risk to destroy annual crops.

The spatial differentiation among the oases of the Todgha can first and foremost be explained by diverging local combinations of water and land availability. In the upper part of the Todgha valley, water is abundant but the main problem is the lack of space. Here, plots are extremely small and scattered, hindering any form of mechanisation and intensification. Extensions are impossible to realise due to the absence of arable land outside narrow valley. Alfalfa is now the dominant crop in this part of the valley and the once prevalent cereals are disappearing. More downstream, water is the scarcest resource and land is relatively abundant. Here, water scarcity is tackled by motor pumping, allowing 'vertical' intensification in the ancient oases or 'horizontal' intensification through the creation of new extensions. Plots are often large enough to allow a certain degree of mechanisation and in these zones almonds tend to become the dominant tree crop at the expense of dates.

The most intensive and yielding agriculture is taking place at open treeless plots, which can be found in the whole valley, but especially in the more spacious lower Todgha and the recent extensions. Open plots contain a large variety of crops, with a domination of alfalfa in the upper valley and cereals in the lower valley. If enough water is available, open fields carry two crops per year, typically wheat in the winter half year and maize or vegetables in summer. Differences in water availability explain that the fields of the upper Todgha are cultivated all year round, and that in the lower Todgha many fields lie fallow in the summer half year.

In Morocco, the date stands traditionally prominent in the traditional cropping system but, as is in the case in Mareth, it becomes outshined by other tree crops – olives and almonds in particular – in terms of marketed value. Cereals are declining, reflecting a cautious trend from subsistence to market, in which cereal production becomes less profitable compared to other crops. Fodder crops – again mostly alfalfa, but also maize – have increased in importance at the cost of cereals, which is a sign of the increased importance of animal husbandry. Only in the lower Todgha oases, subsistence production of cereals is still important.

12.1.4. Developments in collective land and water management

Traditional oasis agriculture entailed the implementation of various ingenious irrigation techniques, mostly developed by indigenous knowledge using innovations adopted from elsewhere. As the maintenance of these systems was generally labour-intensive and complicated, the establishment and subsequent preservation of the agro-hydrological infrastructure required a well-developed collective organisation on oasis-level. Water management in the Tunisian oases under scrutiny was traditionally rooted in the exploitation of small natural springs, and in the Moroccan oases mainly through river irrigation (upstream) and *khettara* irrigation (downstream).

In the Moroccan oases, the village community is still responsible for the organisation of collective labour to maintain of the irrigation system and for the settlement of conflicts in the oasis over water or land. However, with the imposition of a modern state structure and modern law, as well as the growing individualisation, the position of these traditional

institutions has been largely undermined, without the state properly taking over their function. Therefore, common law has become increasingly difficult to enforce, and free riders' behaviour has become frequent, which entail increasing conflicts among water users. Through these processes, the village community is less and less capable of guaranteeing the maintenance of irrigation channels, dams and other water works. This is leading to the growing decline of the agro-hydrological infrastructure, especially of the intricate *khattara* systems. Neither do these traditional institutions have any control over the recent installation of individual motor pumps as well as the establishment of new agricultural extensions in the desert.

Besides the local institutions that regulate water distribution among peasants within one oasis, the Moroccan oases under investigation knew one institution regulating the distribution of river water among the different oases of the valley, namely the *nouba*, or 'water round' on valley level. Already in the colonial period, central authority intervened by enforcing a new arrangement of water distribution between oases. After independence, it changed again under the influence of the central government, favouring the villages in the upper basin and around the valley's main town Tinghir. The most important change was the creation of a summer and a winter *nouba*. The winter *nouba*, in force from September until March, provides water to all the oases in the basin except those of the Aït Atta tribe. However, villages in the downstream part are under-endowed if their large area is taken into account.

The preferential treatment of upstream villages becomes particularly clear during summer. The perennial flow of the river is almost constant throughout the year, but in the summer the extremely high temperatures and the high evaporation significantly increase the water needs of crops. During the summer half year, only villages in the upper basin are entitled to water. This new *nouba* has resulted in a doubling of the irrigation frequency in summer in the upper basin and made possible the year-round cultivation of fields in that part of the basin. Notwithstanding the current relative peace, the post-colonial *nouba* has remained a contested institution and this escalates during periods of drought. Recently, as an answer to increased disputes on land and water, the crisis of traditional institutions, and the decline of agro-hydrological infrastructure, modern village associations have spontaneously emerged recently, which often aspire to assume a role in agricultural development too.

In Tunisia, the institutional environment with respect to water management, is dominated by modern water users' associations⁴, which have been created by the state, and which have replaced ancient community institutions. The aim of these associations is to regulate distribution of water pumped from deepground wells created by the state. In the Tunisian oases under investigation, traditional water extraction techniques, which are still partially functional in Morocco, have largely been abandoned. Here, agriculture relies almost entirely on pumping, either by the state or by individuals. In the latter case, pumping is officially 'illegal' but mostly tolerated in practice.

In general, motor pumping becomes increasingly important for the irrigation of plots in the traditional oases. Whereas in Tunisia the transformation from the use of traditional water extraction techniques to pumping has already been initiated in the colonial era, in most Moroccan oases this transformation has only gained considerable ground since the 1970s. Moreover, as compared to Morocco, the Tunisian state plays generally a more active role in water management and oasis agriculture in general.⁵

⁴ 'Associations d'Intérêt Collectif'

⁵ It should be mentioned, however, that the Moroccan state is more actively intervening in the water management of the larger oasis areas, notably the Drâa and Tafilalt, mainly by constructing large dams. Nevertheless, its general level of involvement in oasis agriculture is lower as compared to the Tunisian state

12.1.5. Recent agricultural extensions

The total area under cultivation in most oases under scrutiny has increased significantly during the second half of the 20th century. This seems to reflect a general trend in the Maghreb, which comprises the extension of oases by the creation of new irrigated perimeters on former pastoral land outside the traditional oases. Under normal circumstances, oasis perimeters can only be extended when additional water resources are tapped, which highly associates this development with increasing reliance on pumping. Also in the traditional oases, pumping is increasingly replacing traditional water extraction techniques, except at places where abundant surface water is available, such as in the upper Todgha valley. In the extensions, however, agriculture is entirely based on mechanised water pumping. The research confirmed the hypothesis that individual farmers often prefer to localise new investments in new, until recently, barren areas outside the traditional oases, where traditional constraints, such as the inflexible collective regulations concerning water availability, water distribution, conflicts over shading of neighbouring plots, and extremely scattered land property do not play a role (cf. Bencherifa 1991: 132-134).

Among the research oases, Mareth 2 in Tunisia is the oldest extension. It was developed from the 1930s onwards as an extension to the historical oasis of Mareth, now called Mareth 1. In the other oases, extensions are generally more recent. The important extensions of Fatnassa are of a later date than those of Mareth, with most extensions created since the 1950s. Most extensions in both Fatnassa and Mareth are controlled and initiated by the state, although some extensions are 'illicit' private initiatives. In Mareth, itself the oldest extension in the sample, recent extensions have only been modest. In particular in Fatnassa, private extensions occur, which are initiatives of farmers profiting from new legislation enabling the privatisation of communal lands, but nevertheless illicitly exploiting underground water resources through private pumps. In addition, in Fatnassa, an important number of farmers use motor pumps in the plots to supplement the centrally distributed irrigation water, which is often not sufficient.

In the water scarce lower Todgha, there here has been a boom in pumping and a rapid creation of extensions, which started in the 1970s, but gained further ground in the 1980s and 1990s. In the upper Todgha, extensions are non-existent due to a lack of arable land outside the traditional oasis, which is hemmed in between steep mountains. Extensions only occur in the oases of the lower river basin, where suitable 'empty' arable land is still available in the surrounding plains. Those farmers in the upper basin oases wanting to increase their farm turn to areas in the lower basin or outside the basin in rather distant regions.⁶ As in Fatnassa, farmers in the lower Todgha also install pumps in the old oasis to supplement the water from traditional sources, whose water flows are often decreasing or have entirely desiccated, through bad maintenance of the hydraulic infrastructure, through excessive pumping, or both.

In the new extensions, there is a clear tendency towards specialisation on a small number of fruit trees at the expense of annual crops. In Fatnassa, most of the new extensions are planted by date palms of the high-quality *Deglet Nour* variety. In Mareth, the extension movement seems to be highly associated by an increase in horticultural and olive plantations. In the lower Todgha, the extensions coincide with an considerable increase of the surface planted by almond trees, the main cash crop of the Todgha.

⁶ For example, in the more humid Middle Atlas mountains, where farmers purchase relatively cheap land for the extensive cultivation of cereals.

12.1.6. Agricultural techniques

With respect to irrigation and agricultural production methods, the Tunisian oases are generally more modernised than the Moroccan ones, although the variability between oases within the same region or country tends to be high. Concrete irrigation channels, irrigation pipes, drip irrigation, and sometimes even plastic greenhouses heated at night by thermal water from deep irrigation wells exist in Tunisia, but are very rare or completely absent in the Moroccan oases. On the other hand, individual motor pumps are more common in Morocco than in Tunisia, especially in the water scarce and land abundant lower Todgha basin. The difference can be explained by the state-led central distribution of irrigation water in Tunisia.

Nevertheless, the variation between oases in the same country seem high. In Fatnassa chemical fertiliser is used by a majority of farmers, whereas in Mareth 1 and 2, this is limited to a minority of farmers. In Morocco, farmers in the lower Todgha tend to use fertilisers more frequently than in the upper Todgha, where agriculture is stagnant and largely reflecting traditional patterns. In both countries, mechanisation is mostly limited to the new extensions, where plots are relatively spacious, and tractors can be employed. In general, oasis agriculture remains fairly labour-intensive. Within the ancient perimeters, use of modern agricultural equipment is almost impossible to the small plot sizes and small-scale morphology of the agro-hydrological infrastructure.

12.1.7. The role of the state

In Tunisia, the state is omnipresent in the oases. However, in Moroccan oases under investigation, the state is almost completely absent with regard to agriculture. This can explain that investments in modern irrigation techniques improving water efficiency, are more prevalent in Tunisia. These are the results of direct government investments in water saving infrastructure and subsidies for farmers applying water saving techniques such as pipes and tubes. In Tunisia, extension services, credit and subsidies are provided on a relatively large scale, while in Morocco they extension services seems more passive and agricultural credit schemes are largely lacking or non-accessible for small farmers. Most modernisations that are taking place in the Moroccan oases under investigation, are the result of private initiatives, with farmers carrying all the risks of the investment. Likewise, in Tunisia, modern inputs such as fertilisers and seeds can be accessed from the state through the water users' associations, whereas in Morocco most farmers have to obtain these inputs on the market at higher prices.

12.1.8. Overall evaluation

Agriculture in the eleven oasis under scrutiny in Tunisia and Morocco is clearly experiencing a transformation from traditional subsistence agriculture to new, relatively modern forms of agricultural production. The most general, unequivocal development is the shift towards motor pumping. With regard to production techniques and cropping patterns, transformation processes are only partial, and occur rather slow and highly uneven across space. Despite a modest trend towards increasing cash cropping, agricultural production is still largely destined for household subsistence needs, with the possible exception of the commercial date agriculture of Fatnassa. In Mareth, the transformation towards motor pumping started earlier than in Fatnassa, but agricultural patterns in the latter oasis are more modern and market-

oriented. In the ancient Moroccan oases, developments have taken place at a slower pace. In the upper Todgha, agriculture is largely stagnant. In the oases of the lower Todgha, where new land is abundant, transformations are taking place more rapidly.

12.2. Water and land resources⁷

12.2.1. Quality and quantity of water resources

In the Todgha valley, water resources have a surface or subsurface, alluvial origin. They seem sufficient and of good quality in the upstream sector (from the "gorges" to Aït El Meskine), but the quantity and quality decrease downstream. The latter as a consequence of the leached salts from upstream lands and the contact with a shallow, gypsiferous and saline, marly substrate. In some downstream oases, salinity of irrigation water is a potential risk for agriculture. In this downstream sector a high pH indicates a possible high Na concentration, which when paired with a low salinity - electrical conductivities below 1 dS m^{-1} - constitutes a soil sodification risk. Unfortunately, water analyses are from 1981 and is not possible to ascertain if the lower risks then stated apply at present. Localised visual indications on the soil surface at some places in the lower Todgha (e.g. Boutaghat and the Ghallil plain) indicate an already light sodification problem.

In Tunisia, water resources are essentially deep groundwater and seem sufficient for the coastal oases (Mareth) but insufficient in the continental ones (Fatnassa) where evapotranspiration is much higher. Water quality is quite homogeneous at both sites and has been stable over the past ten years, moderately to highly saline, with no apparent risk for sodicity. In Mareth, but in especially in Fatnassa, irrigation waters have relatively high electrical conductivities, indicating a high salinisation risk for the soil and the consequent need of artificial drainage. Especially on fields near to the *chotts*, soils often present symptoms of salinisation-sodification, mostly affecting their soil physical properties. These problems are aggravated by poor maintenance of drainage ditches.

Where drainage characteristics of the soil are good and water tables relatively deep such as in most Todgha oases, problems related to soil salinisation and sodification are generally less prevalent. In Tunisia, only in very recent times, oasis farmers are becoming aware of the importance of drainage in irrigation agriculture, and open ditch drains can be found in both Mareth and Fatnassa. In the Moroccan oases drainage systems are non-existent.

12.2.2. Water management

In Tunisia, water is provided and controlled by government agencies, and as a consequence the risks of insufficient water supply are reduced. There are, however, important differences between the two oases under scrutiny. In Mareth, the 'water round' has a length of 15 days⁸, which seems sufficient for present day agricultural uses. In Fatnassa, however, the same water turn lasts one month, which is a long interval, especially during summer. In Morocco, government agencies do generally not interfere in the water management of small and

⁷ This paragraph has been written with Albert-Solé Benet

⁸ In practice, this generally means that each plot can be irrigated each two weeks.

medium-sized oases, such as the Todgha. There are two major differences with the Tunisian situation:

First, in many Moroccan oases, natural ‘gravity’ water resources (river irrigation) and traditional water harvesting techniques, notably *khettaras*, are still important. Secondly, in Morocco all agricultural water pumping is the result of private initiatives. In the oases of the upper Todgha valley, natural water is abundant all year round, and pumping is not necessary. More downstream, pumping becomes more important as a complement to natural water sources. In some downstream oases and in their recent extensions, farmers are entirely dependent on pumping. Individual pumping demand relatively high investments, and risks of insufficient water supply are present in the downstream Moroccan oases, especially in dry years.

12.2.3. Soil properties and soil degradation

In the Todgha valley, soils are essentially alluvial in origin and while loamy in general, somewhat coarser layers alternate with finer layers depending on the history of floods and subsequent sedimentation. Their texture is more influenced by tributaries than by the main river: Far upstream, near the ‘gorges’, soils are clayey loams, in the middle part silty loams while downstream soils become sandy loams and even loamy sands. Soils are usually thicker than one metre and their relative elevated position, as fluvial terraces, favours a good drainage, though there are exceptions where a very thin soil is found over shallow petrocalcic horizons.

Because of their recent sedimentary history and the climatic characteristics of the area, soils are in general very young, with a poorly developed A horizon above a C horizon, except on old terraces (Taghzout) where calcic and/or petrocalcic horizon have developed and where upper horizons have been salinised due to a deficient drainage or insufficient leaching and might even become sodic if poor drainage conditions persist essentially under localised heavy textures. In the Moroccan oases under study, salinisation problems seem relatively limited, as irrigation water is generally less saline. However, in some oases located in the lower Todgha, and also from numerous other Moroccan oases outside the research area similar problems are reported, and problems related to salinity might well increase in the future. In general the organic matter contents in surface horizons is quite low except where manure has been recurrently applied.

In the coastal region of Tunisia (Mareth), soils are also of alluvial origin, and consequently contain horizons with different textures, from sandy loams to clayey loams, but the influence of eolian processes has brought a surface sandy layer over a good part of the soils. Soil salinity is kept moderate and presents no or little risks under light textures, but becomes especially hazardous under heavy textures and shallow water tables (less than one metre) near the northern boundary where a *sebkha*⁹ is found. Organic matter is very low except where manure has recurrently been applied, which only occur in a few cases. Soil degradation in Mareth is reduced to the extreme north-east end of the irrigated perimeter where waterlogged soils are due to a very shallow water table because of the proximity of the *sebkha*.

In the continental oases of Tunisia (Fatnassa), soils have a colluvial and eolian origin but the proximity to Chott El Djerid confers them a gypsiferous status, the strongest the closest to the *chott*. The high salinity of most of their soils is essentially due to both the capillary rise from highly saline *chott* waters and the lack of internal drainage, aggravated by

⁹ A *chott* or *sebkha* is a salt lake.

progressive gypsum clogging of pores. Curiously, the relatively high gypsum contents has not been able to counteract a clear sodicity problem in some of the soils, a problem scarcely reported and poorly studied. Moreover, boron levels attain toxic levels even for the relatively tolerant date palms in the most saline soils in the vicinity of the chott. Organic matter is also very low in general.

In Fatnassa, soil salinity is a more generalised problem along with a potential risk for soil sodicity where fine textures are present. The risk of salinisation seems to be increasing, especially towards the *chott* in the new extensions where the water tables are raising dangerously close to the surface. Moreover, water supplies and the efficiency in its distribution could also become a major problem. Another concern is the lack of efficient drainage. The depth of drainage channels (sometimes 1 m and 1.5 m), taking into account their separation (over 200 m) are not sufficient to maintain an adequate salt balance into soil profiles. The proof is the high salinity and/or extreme sodicity of some soils.

In the Tunisian oases, where all soils are in an almost flat position and most surface horizons are sandy, water erosion would only occur on occasion of floods and would be localised essentially along natural drainage ways. In Morocco, especially in the higher Todgha, the risk of soil erosion is much higher during regular floods of the Todgha, on plots that are located on terraces directly adjacent to the river bed. This explains that many plots adjacent to the river bed are planted with (fruit) trees, and that annual crops are mostly avoided.

In general, risks of wind erosion are minimum inside the oases because of an almost continuous plant cover. Nevertheless, the oasis boundaries of the Tunisian Fatnassa oases and the Moroccan lower Todgha (especially the Ghallil plain) are subjected to sand encroachment from neighbouring areas. Thus, soil degradation by both water and wind erosion is not a large problem within oases, and is mostly affecting plots located at the fringes of the oases.

In all oases under scrutiny, the levels of organic matter are very low. Traditionally, this was compensated by periodical floods which brought fine sediments with clay minerals and organic matter. In the Todgha valley, regular floods still contribute almost annually to soil fertility. Even without flooding the fields directly, the sediment load of irrigation water during heavy rains is very high, as a consequence of erosion in the upstream parts of the basin. In the Tunisian oasis of Mareth, the beneficial effects of periodical floods of the Oued Segui have disappeared, as a result of soil conservation schemes upstream of the oases, along with the deviation of the main channel of the *oued*.¹⁰

12.3. The economic role of international migration

12.3.1. Recent trends in international migration

Although migration is a general phenomenon in all research oases in Morocco and Tunisia, there are many differences concerning the migration destinations and what we might call the 'migration phase'. From all oases, internal migration to other regions is probably an age-old phenomenon. International migration however, is more recent, and began in the late 19th century, and increased steadily during the following century. In the Tunisian oases and in the upper Todgha valley, migration reached its peak in the late 1960s and early 1970s with the

¹⁰ *Oued* means river or valley.

large-scale labour migration to Europe, especially France.

In those oases, migration seems to be somewhat stagnating now, and declining in Tunisia. The more marginal, isolated oases in the lower Todgha valley (Taghia, Tadafelt) that did not participate intensively in international migration in the 1960-70s, have been increasingly involved in migration to new destinations in southern Europe, in particular Spain and Italy, since the late 1980s. Table 12.1 clearly indicates the importance of migration in all oases under study, with 20 to 60 percent of all households involved in international migration.¹¹

Table 12.1. IMAROM research sites and migration characteristics of surveyed households

| Oasis | Country | International migrants (including returnees) | | Non-migrants (including internal migrants) | | Total | |
|-----------------------|---------|-------------------------------------------------|-------------|-----------------------------------------------|-------------|------------|-------------|
| | | Count | Percentage | Count | Percentage | Count | Percentage |
| Zaouia Sidi Abdellali | Morocco | 42 | 34.1 | 81 | 65.9 | 123 | 100 % |
| Tikoutar | Morocco | 47 | 44.8 | 58 | 55.2 | 105 | 100 % |
| Ait El Meskine | Morocco | 43 | 60.5 | 28 | 39.5 | 71 | 100 % |
| Tadafelt | Morocco | 37 | 31.9 | 79 | 68.1 | 116 | 100 % |
| Taghia | Morocco | 15 | 21.4 | 55 | 78.6 | 70 | 100 % |
| Boutaghat | Morocco | 33 | 38.8 | 52 | 61.2 | 85 | 100 % |
| Ichmarine | Morocco | 26 | 39.4 | 40 | 60.4 | 66 | 100 % |
| Iâadouane | Morocco | 58 | 50.0 | 58 | 50.0 | 116 | 100 % |
| Mareth 1 | Tunisia | 25 | 37.9 | 41 | 62.1 | 66 | 100 % |
| Mareth 2 | Tunisia | 23 | 39.6 | 35 | 60.4 | 58 | 100 % |
| Fatnassa | Tunisia | 25 | 27.1 | 67 | 72.9 | 92 | 100 % |
| Total | | 374 | 38.6 | 594 | 61.4 | 968 | 100% |

Source: IMAROM research

In the oases of the upper Todgha, and in Morocco in general, migration seems to be rather persistent, and is continued through illegal emigration or family formation. In general, migration seems to be more persistent in Morocco than in Tunisia. For all oases under investigation, France is still the dominant destination, although a significant minority of Moroccan emigrants lives in the Netherlands and Belgium. Recently, migration is getting increasingly oriented on destinations in southern Europe, notably Spain (for Moroccans) and Italy (for Tunisians and Moroccans).

Although new patterns of international migration seem to be emerging in Tunisia as well (for example, to Libya and Italy), diverging patterns of social and economic development in both countries might to explain partly why the propensity to emigrate remains high in Moroccan oases and seems to be declining in Tunisia. This seems in line with comparative studies on country level, which concluded that, although migration pressures are expected to remain high for the entire Maghreb in the coming two decades, migration potentials are particularly high for Morocco as compared to Tunisia, where the demographic transition is more advanced, unemployment at lower and income at higher levels (cf. Cogneau & Tapinos 1995; Giubilaro 1997; Müller 1998).

These general patterns seem to be partly reflected in the oasis areas of both countries. Moreover, most Tunisian oases are located relatively near to the coast or in relative proximity to larger towns, whereas most Moroccan oases are located hundreds of kilometres of the

¹¹ In this chapter, internal migration has not been distinguished as a separate category, as the oasis studies indicated that the income and investment behaviour of internal migrants and nonmigrants do not show significant differences, with the main difference being that internal migrants tend to be slightly less active in agriculture than nonmigrants.

country's economic heartland at the Atlantic coast. This seems also to increase the need for migrating internally, whereas in Tunisia, especially in the coastal oases, more local employment possibilities outside agriculture seem to be available in diverse sectors such as tourism, retail trade, industries or civil services. This also seems to enhance the market integration of oasis agriculture.

12.3.2. Migration, schooling and income

Although the general level of schooling in oases is low compared to national averages, the populations of the Tunisian oases are on average better educated than their Moroccan counterparts. The percentage of people with secondary and university education is significantly higher in Tunisia than in Morocco. Data suggest that in Tunisia, migrants are less schooled than nonmigrants, whereas the correlation seems to be the opposite in Morocco. There are no obvious reasons explaining this difference. However, the fact that oasis dwellers with a higher education degree, which are relatively frequent in Tunisia, are less inclined to migrate internationally than people with lower degrees, might be related to the fact that, Tunisian labour market is relatively better able to absorb the higher educated than Morocco. Ameliorating employment conditions for this group seems to decrease their tendency to migrate (cf. Giubilaro 1997:80), whereas in Morocco, unemployment among the higher educated is relatively high.

Table 12.2 Mean monthly cash household income in €¹²

| Mean household income per months in Euro | International Migrants | | Non-migrants | | Total | |
|------------------------------------------|------------------------|--------------------|----------------|--------------------|------------------|--------------------|
| | Mean | Standard Deviation | Mean | Standard deviation | Mean | Standard deviation |
| Morocco I ¹³ | 512.0 (169) | 461.7 | 238.2 (246) | 332.3 | 349.1 (n=415) | 411.9 |
| Morocco II | 544.3 (132) | 595.3 | 248.4 (205) | 894.5 | 364.3 (n=337) | 803.0 |
| Mareth 1 | 536.1 (22) | 138.2 | 310.0 (39) | 153.24 | 391.52 (n=61) | 183.14 |
| Mareth 2 | 528.8 (23) | 104.7 | 239.8 (34) | 129.9 | 356.37 (n=57) | 186.3 |
| Fatnassa | 440.0 (25) | 241.3 | 234.0 (67) | 128.93 | 290.3 (n=92) | 189.47 |

Source: IMAROM fieldwork

¹² The following exchange rates have been used for the conversions in €: Moroccan Dirham 9.8278; Tunisian Dinar 1.2833.

¹³ Morocco I are the four oases studied by the University of Amsterdam (see also chapter 6). Morocco II are the four oases studied by the University Mohammed V Rabat (see also chapter 7).

Table 12.3 Possession of satellite dish and migration (%)

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|---------------|----------------|----------------|----------------|----------------|
| | No | Yes | No | Yes | No | Yes |
| Morocco I | 56.8 (96) | 43.2 (73) | 83.7 (206) | 16.3 (40) | 72.8 (302) | 27.2 (113) |
| Morocco II | 35.42 (17) | 64.58 (31) | 52.94 (153) | 47.06 (136) | 50.44 (170) | 49.56 (169) |
| Mareth 1 | 20.0 (5) | 80.0 (20) | 57.5 (23) | 42.5 (17) | 43.1 (28) | 56.9 (37) |
| Mareth 2 | 56.5 (13) | 43.5 (10) | 65.7 (23) | 34.3 (12) | 62.1 (36) | 37.9 (22) |
| Fatnassa | 80.0 (20) | 20.0 (5) | 97.0 (65) | 3.0 (2) | 92.4 (85) | 7.6 (7) |

Source: IMAROM fieldwork

Table 12.4 Possession of television and migration (%)

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|---------------|--------------|---------------|--------------|---------------|
| | No | Yes | No | Yes | No | Yes |
| Morocco I | 5.3 (9) | 94.7 (160) | 28.0 (69) | 72.0 (177) | 18.8 (78) | 81.2 (337) |
| Morocco II | 8.3 (4) | 91.7 (44) | 26.0 (75) | 74.1 (214) | 23.4 (79) | 76.6 (258) |
| Mareth 1 | 8 (2) | 92 (23) | 20 (8) | 80 (32) | 15.4 (10) | 84.6 (55) |
| Mareth 2 | 0.0 (0) | 100 (23) | 2.9 (1) | 97.1 (34) | 1.7 (1) | 98.3 (57) |
| Fatnassa | 0.0 (0) | 100 (25) | 1.5 (1) | 98.5 (66) | 1.1 (1) | 98.9 (91) |

Source: IMAROM fieldwork

Table 12.5 Possession of refrigerator and migration (%)

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|--------------|---------------|---------------|---------------|---------------|
| | No | Yes | No | Yes | No | Yes |
| Morocco I | 59.2 (100) | 40.8 (69) | 88.6 (218) | 11.4 (28) | 76.7 (318) | 23.4 (97) |
| Morocco II | 38.3 (18) | 61.7 (29) | 59.7 (173) | 40.3 (117) | 56.7 (191) | 34.3 (146) |
| Mareth 1 | 0.0 (0) | 100 (25) | 10.0 (4) | 90.0 (36) | 6.2 (4) | 93.8 (61) |
| Mareth 2 | 0.0 (0) | 100 (23) | 11.4 (4) | 88.6 (31) | 6.9 (4) | 93.1 (54) |
| Fatnassa | 12 (3) | 88 (22) | 3 (2) | 97 (65) | 5.4 (5) | 94.6 (87) |

Source: IMAROM fieldwork

In all oases under investigation, migrant households tend to earn significantly higher incomes than nonmigrants households, which is largely due to migration remittances (table 12.2). It is striking that the relative differential between mean migrant and nonmigrant incomes is almost the same in all oases, international migrant households earn about two times the average income of nonmigrants (in all Moroccan oases and Mareth II this is about 2.2 times more, in Mareth II and Fatnassa about 1.8 times). It should be noted, however that standard deviations are high, especially in Morocco, where they tend to be at least two to three times higher than in Tunisia. This reflects a high variation in incomes within the groups of migrants and nonmigrants.

No large differences exist between the oases under investigation. The research data indicates that the general level of income is almost the same in the Tunisian and the Moroccan oases. This was in contrast to expectations that household incomes would be higher in Tunisia, which is wealthier than Morocco on the national level. The income data seem somewhat suspect, if we compare other indicators of socio-economic status, such as possession of luxury consumer goods and household appliances (some of them are listed in tables 12.3 - 12.5). From these figures, it would appear that Tunisian oasis households are relatively wealthier than their Moroccan counterparts .

Especially in Mareth, nonmigrant households are relatively wealthy compared to nonmigrant households in other oases. This seems to be linked to the better local non-agricultural employment opportunities the Tunisian coastal area has to offer, such as in the touristic, service and government sectors. The gap between migrants and nonmigrants is larger in the oasis of Fatnassa, which could also be attributed to the fact that the general standard of living of coastal regions is higher than that of the in deep country regions. In that respect, Fatnassa resembles more the Moroccan oases under investigation. It should again be stressed that the standard deviations are high, revealing a high income differentiation within the groups of migrants and nonmigrants.

International migration remittances represent a very important source of cash income for both Tunisian and Moroccan oases, although their relative importance is higher in Morocco. In both countries, many households that do not participate in international migration, do participate in internal migration and receive remittances sent by internally migrated household members. The number of households without any economic links to internal or international migrants at all, is very limited. Moreover, many nonmigrants households are locally active in the housing construction or commercial sectors, which are partly sustained by investments of migration households. Migration seems to have a general impact on the local economies via multiplier effects. In fact, contemporary oasis economies are all very open and depend heavily on external income.

Table 12.6 Monthly agricultural cash income and migration in €

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|--------------------|---------------|--------------------|----------------|--------------------|
| | Mean | Standard Deviation | Mean | Standard deviation | Mean | Standard deviation |
| Morocco I | 61.1 (168) | 85.9 | 32.8 (245) | 55.0 | 44.3 (412) | 70.5 |
| Morocco II | 100.7 (132) | 166.6 | 44.0 (205) | 100.3 | 66.2 (337) | 133.0 |
| Mareth | 113.8 (39) | 70.60 | 153.1 (70) | 82.43 | 139.0 (109) | 80.3 |
| Fatnassa | 94.8 (25) | 71.84 | 105.6 (66) | 78.08 | 102.6 (91) | 76.2 |

Source: IMAROM fieldwork

Cash income from agriculture are relatively low compared to total households income (table 12.6) In the Moroccan oases, cash agricultural income only represents 12 to 19 percent of the total household income, and does not show much variation between international migrants and nonmigrants. In Tunisia however, agricultural income is important represents between 18 and 21 percent of the total households income for migrant households, but 44-49 percent of the total cash income of nonmigrant households. The cash income from agriculture, is far higher for Tunisian nonmigrant households than for their Moroccan counterparts. This seems

to support the hypothesis that Tunisian oasis agriculture is more oriented on the market, but also that there are apparently less obstacles to relatively poor, Tunisian nonmigrants to invest agriculture. In the Moroccan oases under investigation, these obstacles seem indeed rather high, as in the upper Todgha no land for production extension is possible, and in the lower Todgha the costs and risks connected to individual pumping are high, forcing many poor households to de-intensify their agriculture.

Especially in Morocco, most of the agricultural production is still destined for own consumption, and only a small proportion of the harvest is traded. Moreover, almost all households have supplementary sources of income outside agriculture, such as through migration. In Morocco, mean household cash income from agriculture tend to be about the double for migrants as compared to nonmigrants. In general, almost all oasis households dispose of several sources of income. The number of households that completely rely on subsistence agriculture seems to be disappearing rapidly, reflecting a general trend towards diversification of economic activities and risk spreading. It would therefore be erroneous to consider contemporary oases as purely rural and agricultural.

In all oases, migration has contributed to higher standards of living. Migrant households generally live in larger, more luxurious houses, and possess frequently consumer goods such as satellite receivers, videos, tv sets and means of transport such as motorbikes and cars, although the differentials between migrant and nonmigrant households in Tunisia seem less pronounced than in Morocco.

Table 12.7 Mean monthly consumptive expenses per household in €

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|--------------------|----------------|--------------------|----------------|--------------------|
| | Mean | Standard Deviation | Mean | Standard deviation | Mean | Standard deviation |
| Morocco I | 150.2 (168) | 83.8 | 107.0 (244) | 92.5 | 124.6 (412) | 91.4 |
| Morocco II | 153.9 (132) | 100.8 | 101.1 (205) | 74.4 | 121.8 (337) | 89.4 |
| Mareth I | 241.0 (25) | 114.2 | 126.5 (41) | 75.1 | 169.8 (66) | 106.9 |
| Mareth II | 245.9 (23) | 78.1 | 196.0 (34) | 125.1 | 216.2 (57) | 110.6 |
| Fatnassa | 208.7 (25) | 81.1 | 148.3 (67) | 62.1 | 164.8 (92) | 72.6 |

Source: IMAROM fieldwork

12.3.3. Consumption, education, and housing

In both the Moroccan and the Tunisian oases, migrant households tend to have higher daily expenses on food, clothes, electricity and schooling. Nevertheless, the differences are not very high (generally less than 50 percent higher), and are not proportionate to the wage gap existing between migrants and nonmigrants, except for Mareth I where migrants consume 1.9 times more than nonmigrants. This reflects the universal pattern that low income households tend to spend a relatively high proportion of their income on food, clothes and other basic needs. Increase of income only leads to a relatively small increase in this kind of daily expenses. The research seem to falsify the common hypothesis that migrants tend to waste their income on conspicuous consumption.

International migrants tend to spend significantly more on schooling of their children than nonmigrants. Apparently, education is a high priority, and is regarded as a true

investment strategy and life insurance for the parents. This trend has been observed in all oases under investigation.

Another general trends are the high expenses of migrants on housing. In all research oases, migrants households spend far more on housing and the equipment of housing. Investments of housing seems to occur especially in the first phases of migration, as it generally concerns the highest investment priority of households after migration. The need to dispose of proper, decent housing is very high and is understandable to some extent, regarding the rather primitive conditions prevailing in the traditional habitat.

The high investments on housing should not only be explained by the simple quest for more luxury or status within the own community, as has been done in much of the migration literature. Often, profit making is the objective too: Many migrants households tend to build more than one house, often located in small urban centres near the oasis or in the big cities along the coast, with the objective of profit making by letting them out on lease. In Morocco, a significant correlation has been found between investments in housing and revenues from leasing real estate.

12.4. The impact of international migration on agriculture

Concerning agricultural investments, two clear trends emerge (table 12.8). Firstly, the mean agricultural investments per households tend to be far higher in Tunisia than in Morocco. Although the data from both countries do not seem perfectly comparable due to differences in research methodology (investments have initially been recorded over different time periods), there seems to be a clear difference. This possibly reflects better agricultural investment conditions in Tunisia, and, possibly, higher incomes, although on this point the data seem too shaky to come to a firm conclusion.

Secondly, migrant households tend to invest higher sums than nonmigrant households in all oases except Mareth. As with other income and investment variables, the differential between migrants and nonmigrants tends to be higher in Morocco than in Tunisia. In the Moroccan oases, migrants invest four to five times more (on the average) than nonmigrants in agriculture, challenging prevalent views in migration literature suggesting that migration leads to a withdrawal of local economic activities, in particular agriculture. On the other hand, if we compare expenses on farming equipment in Tunisia, we observe clear anomalies from the trends observed in Morocco. In Fatnassa, international migrants invest only two times more, and in Mareth there is hardly any difference at all.

Table 12.8 Agricultural investments and migration (purchase land, pumps, other equipment and plantations) in € (1994-1998)

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|--------------------|---------------|--------------------|---------------|--------------------|
| | Mean | Standard Deviation | Mean | Standard deviation | Mean | Standard deviation |
| Morocco I | 897 (163) | 1.965 | 136 (243) | 494 | 441 (406) | 1353 |
| Morocco II | 517 (132) | 1.243 | 123 (205) | 345 | 299 (337) | NA |
| Mareth | 2,413 (30) | 2.101 | 2,283 (35) | 2.882 | 2.343 (65) | 2.534 |
| Fatnassa | 2,330 (25) | 2.020 | 1,264 (58) | 2.050 | 1,585 (83) | 2,088 |

Table 12.9 Possession of motor pumps and migration

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|--------------|---------------|--------------|---------------|---------------|
| | No | Yes | No | Yes | No | Yes |
| Morocco I | 56.8 (96) | 43.2 (73) | 83.7 (206) | 16.3 (40) | 72.8 (302) | 27.2 (113) |
| Morocco II | 71.0 (95) | 28.0 (37) | 88.3 (181) | 11.7 (24) | 81.9 (276) | 18.1 (61) |
| Mareth | 91.7 (44) | 8.3 (4) | 96.1 (73) | 3.9 (3) | 94.4 (117) | 5.6 (7) |
| Fatnassa | 60.0 (15) | 40.0 (10) | 74.6 (50) | 25.4 (17) | 70.7 (65) | 29.3 (27) |

Source: IMAROM fieldwork

In both Morocco and Tunisia, migrant households tend to have a more intensive agriculture, both in labour in capital terms, showing a higher variety in cropping patterns and more investments in fertilisers (table 12.10), HYV seed, fruit tree and date palm tree offshoots, and animal fodder, than nonmigrant households. It is striking that in Fatnassa, fertilisers are used by the great majority of all farmers, reflecting the more modern character of agriculture in this date growing oasis. Again, the investment differentials between migrants and nonmigrants seem higher in Morocco than in Tunisia. In all oases, the use of paid agricultural labour is clearly more frequent among migrants than nonmigrants (table 12.11) In both Morocco and Tunisia, possession of heavy agricultural equipment such as tractors is limited to only a small fraction of the population. The limited degree of mechanisation seems partially related to the reduced size of plots and holdings in general.

Investments in wells and motor pumps vary between oasis, depending on their specific location and the local availability of water resources, but are particularly prevalent in Fatnassa and some oasis of the lower Todgha (table 12.9). In these oases, individual pumping is the only means by which agriculture can be intensified and extended, given the rarity of natural water resources, and the limited capacities of the state's motor pumps in Fatnassa. In the upper Todgha, natural water resources are so abundant, that pumping is not necessary. In both Fatnassa and the lower Todgha, migrant households have a higher tendency to invest in motor pumping than nonmigrant households, although the differential between migrant and nonmigrant investments is again higher in Morocco than in Tunisia.

Table 12.10 Use of fertilisers and migration

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|--------------|---------------|--------------|---------------|---------------|
| | No | Yes | No | Yes | No | Yes |
| Morocco I | 46.1 (77) | 53.9 (90) | 67.3 (165) | 32.7 (80) | 58.7 (242) | 41.3 (170) |
| Morocco II | 55.3 (73) | 44.7 (59) | 80.5 (165) | 19.5 (40) | 70.6 (238) | 29.4 (99) |
| Mareth I | 88.0 (22) | 12.0 (3) | 97.6 (40) | 2.4 (1) | 93.9 (62) | 6.1 (4) |
| Mareth II | 47.8 (11) | 52.2 (12) | 51.4 (18) | 48.6 (17) | 50 (29) | 50 (29) |
| Fatnassa | 4.0 (1) | 96.0 (24) | 28.4 (19) | 71.6 (48) | 21.7 (20) | 78.3 (72) |

Source: IMAROM fieldwork

Table 12.11. Use of paid labour and migration

| | Intern. Migrants | | Non-migrants | | Total | |
|------------|------------------|---------------|---------------|--------------|---------------|---------------|
| | No | Yes | No | Yes | No | Yes |
| Morocco I | 39.3 (66) | 60.7 (102) | 75.6 (186) | 24.4 (69) | 60.9 (252) | 39.1 (162) |
| Morocco II | 47.0 (62) | 53.0 (70) | 76.6 (157) | 23.4 (48) | 65.0 (219) | 35.0 (118) |
| Mareth I | 72.0 (18) | 28.0 (7) | 73.2 (30) | 26.8 (11) | 72.7 (48) | 27.3 (18) |
| Mareth II | 26.1 (6) | 73.9 (17) | 42.9 (15) | 57.1 (20) | 36.2 (21) | 63.8 (37) |
| Fatnassa | 4 (1) | 96.0 (24) | 14.9 (10) | 85.1 (57) | 12 (11) | 88 (81) |

Source: IMAROM fieldwork

Apparently, there are less obstacles for nonmigrants towards agricultural investments in Tunisia. This might be related to the fact that investments seem less risky than in Morocco, as access to water resources is more certain and cheaper. Summarising, we can state that investments by migrants play a significant, though not unique, role in agricultural transformations. Again, it should be noted that standard deviations are high, and in Morocco even extremely high, indicating that one should remain extremely cautious with generalisations on behaviour of migrant versus nonmigrant households: investors and noninvestors can be found in both categories.

Among all IMAROM oases, agriculture in Fatnassa does seem the most intensive, due to flourishing date palm cultivation and the links with international export markets. Agriculture in Mareth is more extensive, in particular in Mareth 1, where the population is very much oriented on other activities. In the Moroccan research oases and in Fatnassa, local economic activities outside agriculture are more limited as compared to Mareth, and the agriculture is relatively intense in the entire valley, but more labour intensive and oriented on subsistence farming than in Fatnassa. Especially in the lower Todgha, however, a cautious trend towards increasing cash cropping of almonds is existing, in particular initiated by migrant households.

12.5. Evaluation of the hypotheses

In the preceding paragraphs we have made a synthesis of the results from the socio-economic as well as bio-physical fieldwork in the Tunisian and Moroccan research sites. Based on these empirical conclusions, we will now evaluate the hypotheses formulated in chapter 3. These hypotheses were an elaboration and operationalisation of the general IMAROM research questions. It should be stressed that the conclusions for the specific research sites cannot be generalised unreservedly for all Moroccan or Tunisian oases. For example, we will conclude that the level of state involvement in the Moroccan oases is lower than in Tunisia. However, in some other (non-researched) oases the level of state involvement is much higher than in the research oases. The function of this analysis is rather to elaborate and test theories and hypotheses on the complex interactions between migration, agricultural transformations and resource exploitation in oases, and to explain the huge spatial differentiation across oases.

12.5.1. International migration and investments in agriculture

The first set of hypotheses relates to the extent to which there is a relation between migration and agricultural development. The first three hypotheses are related to the specific relation between migration remittances and investments in agriculture:

- I. More migration¹⁴ coincides with higher migration remittances**
- II. More migration remittances coincide with higher cash income**
- III. Higher cash income leads to higher capital investments in agriculture**

Research in all oases confirm that international migrant households have much higher (approximately double) mean incomes than nonmigrant households, and that a substantial part of cash income provides from migration. It should be noted that the variation within groups is very high, indicating that there are also nonmigrant households with higher incomes and that not all international migrant households are rich. Nevertheless, the research seem to confirm hypotheses I and II. It should be noted, however, that hypothesis only holds for international migration, as the incomes of internal migrants do not significantly differ from nonmigrant households.

The data analysis equally seems to confirm the hypotheses III stating that the more wealthy households tend to invest more in agriculture than poorer households, although this hypothesis was falsified for the oasis of Mareth. Among those wealthy households, international migrant households are relatively numerous. Hypothesis III might seem so common-sense that some might find testing it superfluous. Nevertheless, in the light of theories that suppose that migrants and wealthy households in general would tend to retreat from local economic activities, to rely on their external income, it is essential to observe that, in most oases, the contrary seems to be the case. International migrant households tend to invest more in agriculture than nonmigrants, which seems directly linked to the higher income of the first group. In the relatively wealthy oasis Mareth in Tunisia, the correlation between migration and investments is non-existent. The reasons for that are not clear.

Generally, it are the returned international migrant households who tend to have the highest incomes and the highest propensity to invest in agriculture. Typical agricultural investments are: purchase of motor pumps and digging of wells, purchase of land, and other

¹⁴ This research specifically considers *international* migration. Unless it is mentioned otherwise, ‘migration’ should be interpreted as ‘international migration’, and ‘migrants’ as ‘international migrants’.

agricultural equipment. The transforming and modernising oasis agriculture is increasingly dependent on capital investment. In the absence of well-functioning credit markets, the availability of an own, stable income seems essential. Migration is providing such a investment fund for many households.

Another hypothesis, which can be found in certain migration literature, is that, besides an income-effect, there is a qualitative ‘migration effect’:

IV. Migration leads to higher investments than predicted on the basis of income only, i.e. migration contributes to investment- prone attitudes

This hypothesis supposes that migrants would tend to invest more in local economic activities than nonmigrants from the same income categories, what would be explained by the supposed entrepreneurial, risk-taking attitudes of migrants and the know-how they accumulated in foreign countries. The data analysis seems to falsify this hypothesis. Controlling for income, we generally find nonsignificant correlations. Nevertheless, if we distinguish the different investments categories, we find that international migrant households tend to invest particularly in three specific sectors: the construction of houses, which could be expected, but also education, and, rather surprisingly, agriculture. For these three sectors, the correlations between migration and investments are higher than for other investment categories. Migrants invest relatively more in agriculture than in other sectors such as transport or trade.

V. High migration coincides with positive attitudes towards agriculture, which encourage capital investments in agriculture

The research revealed that attitudes towards agriculture tend to be highly complex and ambiguous. The relation between migration and attitudes regarding agriculture seems to be a two-sided, depending on the specific agricultural sector. On the one hand, migration seems to stimulate negative views on traditional forms of agriculture, as the confrontation with the wealth of migrants, seems to further devaluate the status of the traditional ‘peasant way of life’. In a way, traditional agriculture is associated with high poverty and the unequal socio-ethnic relations of before. The high aspirations of the young and better educated, are in contrast with the life traditional agriculture offers in their eyes. Although migration, through its effects on aspirations and more outward attitudes, seems to have further stimulated such a negative view on traditional life, it is also clear that this is not a migration effect as such, but a general tendency in rural areas of the Maghreb. These negative attitudes seem often absent or much weaker when speaking about modern forms of agriculture, which are generally much more positively evaluated. Youngsters who often lack the strong emotional bonds with traditional agriculture of their parents, may admire successful ‘business-like’ farmers who have established large, commercial farms. So, one should be prudent with stating that migration would inevitably lead to negative attitudes towards agriculture.

VI. Migration leads to the partial substitution of family labour by paid labourers.

The research confirmed that households involved in international migration tend to hire paid agricultural labourers more frequently than nonmigrant households. Nevertheless, there are no signs of a massive retreat of family labour from agriculture by international migrant households. This is surprising, as much of the migration literature supposes such a negative

‘lost labour effect’ on local agriculture. So, the paid labour is not completely substituting family labour, but rather additional or only partially substitutional. Paid labour is especially prevalent in case of agricultural extensions, which cannot be maintained by the family alone. In Morocco, traditional sharecropping arrangements are still existing as an alternative for paid labour, but seem to loose ground.

12.5.2. Political-economic and bio-physical conditions for agricultural investments

The second set of hypotheses related to the different contextual variables that shape actual investments in agriculture and that determine the diverging agricultural developments taking place in the oases of Morocco and Tunisia.¹⁵ These political-economic and bio-physical circumstances vary between different oases, regions and countries, and may partly explain the highly diverging patterns of agricultural transformations in the oases of the Maghreb.

VIII. Effective agricultural support by governments, access to credit, low levels of corruption, legal security, and political stability lead to higher investments in agriculture

This hypothesis turned out to be very difficult to test, as the specific circumstances in each oasis cannot be held constant, which makes it impossible to objectively test this hypothesis on the influence on ‘national’ factors such as the quality of the government’s economic policies, legal structures and overall stability in a country. Although we must refrain from drawing definite conclusions, it seems that in Tunisia the overall investment conditions are better than in Morocco. This relates mainly to better economic conditions, as both countries are relatively stable politically. Moreover, the creation of state-subsidised central drillings and water users’ associations has made pumped water accessible at lower prices and lower risks. Also in other domains, the Tunisian state plays a more active role in promoting agriculture, at least in the oases under scrutiny. This could explain the far higher tendency of the surveyed Tunisian oasis households, migrants and nonmigrants alike, to invest in agriculture.

The following set of hypotheses relates to local bio-physical factors determining agricultural investments.

IX. Low local land prices lead to higher investments in agriculture

X. Good land quality lead to higher investments in agriculture

Land scarcity and high land prices play a role in the traditional oases, where plot sizes are extremely small and land prices high. In many cases, this is hindering investments in agriculture, as there is often no perspective for agricultural modernisation, mechanisation or extension. This scarcity of land, combined with the complexities of the collective agro-hydrological infrastructure, explains that farmers often prefer to invest outside the traditional oases in the new agricultural extensions, which are particularly prevalent in the lower Todgha and in Fatnassa. If no new agricultural land is available outside the traditional oasis, such as in the higher Todgha, land scarcity can even be an absolute obstacle to agricultural development. Purchase of land in ancient oases is often not an attractive option, as prices

¹⁵ Hypothesis VII was omitted as it actually summarised hypotheses VIII-XII.

tend to be very high. Thus, land scarcity and high land prices can form a fundamental obstacle for investments in particular oases, suggesting that hypotheses IX is correct.

Whether investments particularly take place on spots with good land quality (hypothesis X), is rather unlikely. It seems that land and water scarcity and also water quality play a larger role than the quality of land resources. In Fatnassa, for example, many soils suffer salinisation and sodification. Although this is a serious problem lowering productivity of agriculture, this seems not to hinder farmers from investing in agriculture. Agricultural investments are particularly taking places in Fatnassa and in the lower Todgha, where land degradation risks are actually higher than in the more stagnant oases. This can be possibly be explained by the fact that the quality of land resources can be manipulated by technical interventions, such as sand suppletion, drainage, adaptations in irrigation methods and frequencies, and manuring the land. After all, the quality and quantity of water resources, besides agricultural techniques, have a high influence on the soil quality. Quality of water resources is much more difficult to manipulate than soil quality.

XI. Easily accessible water resources lead to higher investments in agriculture

XII. Good quality water resources lead to higher investments in agriculture

For individual farmers, the accessibility of water resources plays a high role. Nevertheless, in most oases, water availability as such is not a fundamental obstacle to agricultural development at least on the short term, as it can be accessed by most farmers either by tapping natural water resources (upper Todgha), through private pumping (lower Todgha and Tunisia), or through water distributed by the government (Tunisia). In some way, there is even a reversed correlation as suggested in hypothesis XI: The lowering of water of water through pumping lead to the desiccation of natural sources and existing wells, forcing farmers to invest in new, deeper wells and more pumps.

However, water scarcity will play an increasing role, if the costs obtaining this water seem to get higher. Such a situation seems already developing in particular areas of the lower Todgha. Since the state is not intervening and is not creating central drillings such as in Tunisia, farmers are forced to effectuate the investments in wells and pumps individually, which raises costs and risks, which become increasingly high if water tables drop and fuel prices rise. This seems to constitute an important obstacle for investments, and even forces poorer households to partially or entirely withdraw from agriculture, as they do not dispose of sufficient capital to invest.

In the same degree as the scarcity of land, the quality of water resources plays an essential role in the success of agriculture. In case farmers find highly saline water (for example in Boutaghat in the lower Todgha), they generally abandon this well, as agriculture is virtually impossible with such water. Nevertheless, it should be stressed that farmers in various oases are maintaining an intensive agriculture using rather saline waters.

12.5.3. Ecological consequences of changing land and water management

Changing and specialising cropping patterns, increasing use of pumps and other agricultural machinery, the creation of agricultural extensions outside the traditional perimeters, and an increasing orientation on the market, are gradually transforming oasis agriculture. These transformations have important ecological consequences.

XIII. Higher investments in agriculture coincide with increased pumping of water compared to flows of gravity water

XIV. More government involvement leads to decreased individual pumping

Data analysis clearly confirmed that new investments in agriculture coincide with increasing pumping (hypothesis XIII), as a more intense cropping system and the increase of the agricultural surface make natural water sources (wells, small rivers, *khattaras*) insufficient. Moreover, traditional water extraction techniques are loosing ground, due to the decline of traditional institutions regulating the management of the agro-hydrological infrastructure. In the Moroccan Todgha valley, almost all water pumping is done by farmers or small groups of farmers, privately installing motor pumps in the old oases and in the recent extensions. The state does not control this development. In Tunisia, water supply is strongly regulated by the central state. Nevertheless, several farmers have installed private, ‘illegal’, motor pumps. Apparently, there is a high need for proper disposal of water resources by individual farmers, leading to the conclusion that government regulation does not automatically lead to a decline in individual pumping. Whether this happens, very much depends on the effective control of laws and regulations by the very state, which is largely absent in Morocco, whereas the Tunisian state, in practice, tolerates many illegal pumps as well.

XV. More motor pumping lead to a reduced accessibility of water resources

XVI. Reduced accessibility of water resources lead to a reduced flow of gravity water

Hypotheses XV and XVI seem highly plausible, but turned out to be very difficult to verify with plain data, as neither detailed hydrological studies, nor regular observations on the depth of water tables, were available. Nevertheless, there are many indications (mainly emanating from interviews with farmers and own measurements) that in several oases increasing motor pumping is leading to falling water tables, which make water resources not impossible, but more difficult to access. In the lower Todgha, for example, existing wells have desiccated forcing farmers to dig deeper and to install heavier pumps. This is especially the case in the ‘Ghallil’ plain, in the extreme downstream part of the valley, where several farmers ran into serious problems due to water scarcity. Especially those who do not dispose of sufficient capital to access deeper water resources, are sometimes forced to retreat from agriculture. It is not clear whether this might possibly lead to increasing concentration of ‘hydrological power’ in the hands of a few rich farmers, but the loss of investments through excessive pumping should certainly be an area of concern.

Likewise, increasing pumping can indeed partially explain the desiccation of natural sources, which used to irrigate the traditional oases (hypothesis XVI). In the Tunisian oases, natural sources do hardly play a role anymore, in the Moroccan oases under scrutiny, *khattaras* are increasingly abandoned, as their water flows decreased significantly or stopped entirely. Pumping in upstream villages seems to play a partial role in these developments, indicating that the rise of a modern agriculture and the decline of traditional systems are two processes which tend to reinforce each other.

XVII. The breakdown of local institutions managing the traditional irrigation system leads to a reduced flow of gravity water

XVIII. Reduced or absent flows of gravity water lead to a higher stock of water pumped up

Falling water tables are not the only factor playing role in the decline of the traditional hydrological infrastructure. Especially the decline of the sophisticated *khattara* techniques, should also be explained by the breakdown of the traditional local institutions regulating the

maintenance of such systems. In oases where *khettaras* were not functioning anymore, this is often related to conflicts of interests within the community. Falling water tables and decreasing dependence on traditional water extraction techniques (as a result of pumping), leads to the increasing decline of traditional oasis systems (hypothesis XVII). And we have indeed seen that where natural sources are no longer available, many households refuse to abandon agriculture, and access new sources through pumping (hypothesis XVIII). In most Tunisian oases, the transition from natural through pumped water has already been completed. In many Moroccan oases, ‘gravity’ water sources (rivers, *khettaras*) still play an important role, but they are increasingly put under stress by the boom in pumping, which tends to undermine traditional systems.