

## Ultra-Low Energy Drip Irrigation for MENA Countries **Drip Irrigation in Morocco**

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## **Executive Summary**

Agriculture is an important part of the economic and social well-being of Morocco, and the use of irrigation is a significant component for the sector, particularly considering the declining trend in precipitation and associated variability. Water scarcity and shortages have increased and they have become a significant constraint to agricultural development in the country. The Moroccan government launched the Green Morocco Plan (*Plan Maroc Vert*) in the latter part of the last decade as a means to promote national agricultural development, part of which focuses on the optimization and saving of irrigation water.

Approximately 80% of irrigation schemes in Morocco consist of inefficient surface irrigation methods (Arrifi, 2010). Thus, the *Programme national d'économie d'eau en irrigation* (PNEEI) (National Irrigation Water Saving Program) was launched in 2007, under the Green Morocco Plan, with the goal of disseminating drip irrigation to approximately half of the irrigated area within 10-15 years of its inception (Berrada, 2009; MAPM, 2014). This would largely be achieved through incentivizing farmers or groups of farmers to convert to or install drip irrigation systems on their land through State subsidies.

While drip irrigation has been hailed as a promising solution to Morocco's water shortage problems, current adoption rates have been quite low, with some watersheds reporting an adoption rate as low as 10% (Jobbins et al., 2015; Kalpakian et al., 2014). Possible reasons for this have been lack of access to capital; land titles that prevent access to credit, loans and subsidies; weak presence or knowledge of relevant bureaucracies or programs; and limited scholastic education, among other reasons. Drip irrigation systems have various strengths and weaknesses from a farmer perspective, but the weaknesses seem to disproportionately affect the poor and small farmers.

Subsidies for drip irrigation systems are under the Agricultural Development Fund (*Fonds de développement agricole* or FDA) and can be split into two broad groups: Universal aid for individual investors, and aid for aggregation projects<sup>1</sup>. The former applies to individual farmers or groups of farmers (as well as to breeders and investors), and is what is most common; aid for aggregation projects have yet to be implemented. The general procedure for subsidies under the universal aid scheme involves three general steps: (1) Application for prior approval, which is undertaken prior to the implementation of a project; (2) project implementation and completion; and (3) the subsidy request, submitted after project completion.

The role of the private sector is important in the subsidy process, especially for those farmers who cannot afford installing drip irrigation systems prior to receiving subsidies (as it is only granted after project completion). In this context, there are agreements that can be arranged between private companies and the farmers so that such systems can be installed successfully.

Private companies who install drip irrigation systems obtain equipment from manufacturers or suppliers (either Moroccan or from abroad). However, the manufacturers/suppliers must have a

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<sup>1</sup> An aggregation project is a specific model whereby farmers are organized around private actors or professional organizations with a strong managerial capacity. It is a partnership between the producers (aggregates) and the private sector (aggregators) (MAPM, 2014).

qualification certificate, and the equipment they sell must have been tested at the National Hydraulics Laboratory (*Laboratoire Nationale d'Hydraulique*).

## **Part I: Status of drip irrigation in Morocco**

### **1. Overall information on irrigation and water resources in Morocco**

Morocco has a Mediterranean-type, semi-arid to arid climate, with large spatial and temporal variability in precipitation, as well as large variations in amounts (Berrada, 2009; Ministry of Water, 2016). The distribution of average annual rainfall is as follows (Ministry of Water, 2016):

- > 800 mm in the North;
- 400-600 mm in the Central Region;
- 200-400 mm in the Oriental and Souss regions;
- 50-200 mm in the South Atlas;
- And < 50 mm in the Sakia El Hamra and Oued Eddahab basins.

Average annual rainfall is estimated at 140 billion m<sup>3</sup>, with a high inter-annual variability. Figure 1 illustrates the spatial distribution of precipitation in Morocco.

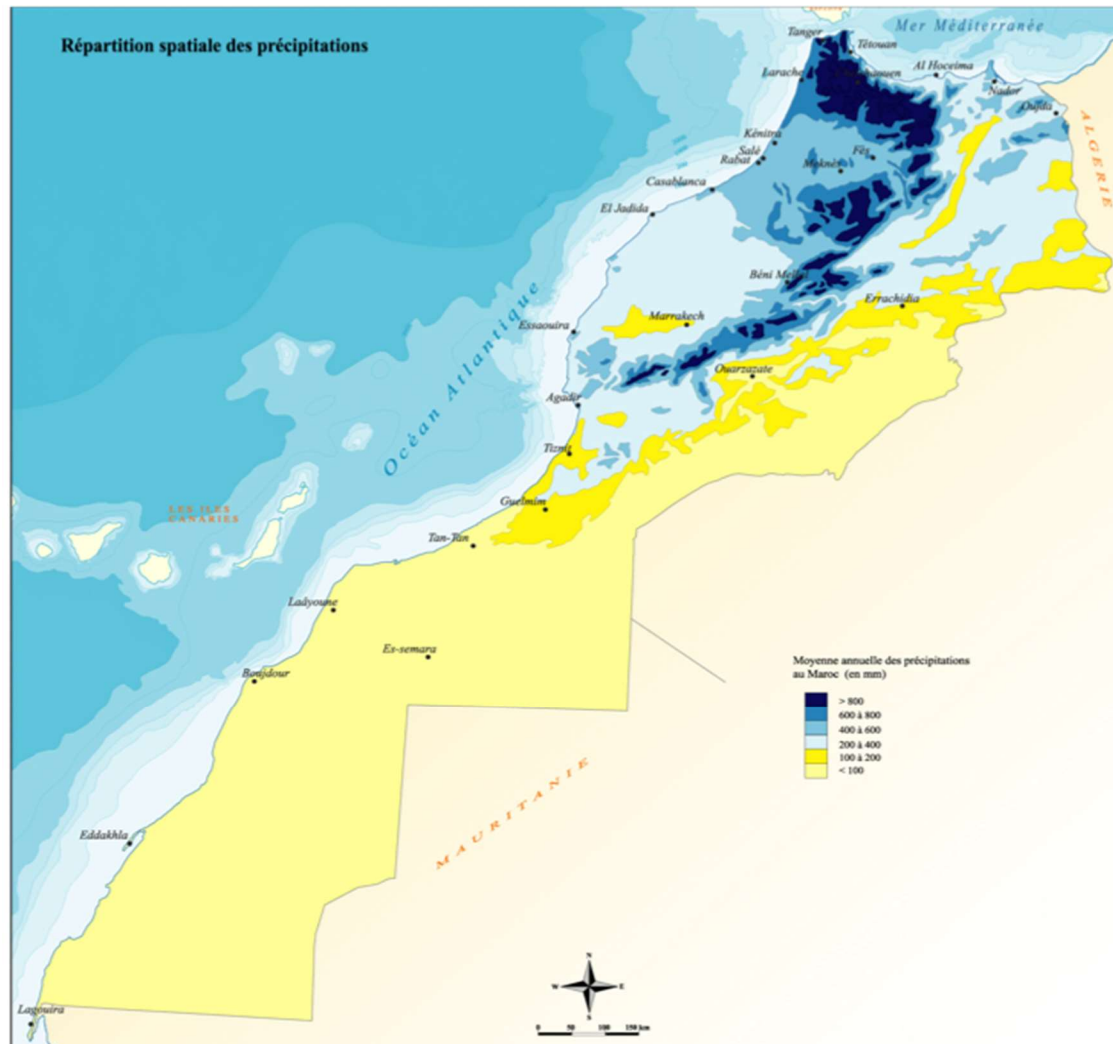


Figure 1. Spatial distribution of precipitation amounts in Morocco (Ministry of Water, 2016).

Morocco has experienced frequent droughts in the recent past, which, along with aging infrastructure, rapid population growth, and the expansion of its economic and industrial base, has led to water shortages (Berrada, 2009). Exacerbating the problem of water shortage is the decreasing precipitation that Morocco has been experiencing over the years; there has been a decline of about 33% over the last 40 years (Kalpakian et al., 2014). The overall decline in rain- and snow-fall has led to a decline in surface water flows. Furthermore, a series of intense droughts, unprecedented in the last 500 years, have struck the country since 1981 (Jobbins et al., 2015). In response to this onset of droughts, reduced precipitation and surface water flow, and the increasing access to and affordability of rural electricity, diesel pumps and fuel, many farmers have dug private wells and have started pumping groundwater, often without the required permits (Jobbins et al., 2015; Kalpakian et al., 2014). Consequently, the number of wells has increased from a handful to about 9000 during the last 30 years, and aquifers across Morocco have been rapidly depleted.

The share of freshwater use claimed by agriculture in Morocco is high in comparison with other economic sectors; Berrada (2009) places the amount at 85%, while Kalpakian et al. (2014) states that agriculture accounts for 92% of water consumption. Furthermore, much of this water is “wasted” due to various issues, such as siltation of dams, aging infrastructure, and the prevalence of inefficient flood-irrigation systems, such as the *Robta*<sup>2</sup>, in irrigated perimeters (i.e. traditionally known as the command area) (Berrada, 2009). Approximately 80% of the acreage in large-scale irrigated perimeters is flood-irrigated using traditional methods. It is estimated that with the *Robta*, only about half of the water that enters the field is used by the crop (Berrada, 2009; Jobbins et al., 2015). The other half goes unused mostly through deep percolation below the root zone. Several methods to increase flood-irrigation efficiency have been introduced but their adoption by farmers remains low due to factors such as the relatively high cost of land leveling.

According to MAPM<sup>3</sup> (2014), irrigation is an important part of the regional and national economies. While occupying on only 15% of the cultivated area in Morocco, irrigated agriculture contributes approximately 45% of the added value in agriculture and is responsible for 75% of its exports. These contributions are even more important in dry years, when rainfed areas are severely affected. With respect to the different crops, irrigation contributes to the production of 99% of sugar crops, 82% of vegetable crops, 100% of citrus fruits, 75% of forage crops, and 75% for milk. The irrigated sector secures about 120 million working days/year, with about 1.65 million jobs, of which 250 thousand are permanent. It also contributes to the improvement of farmers' incomes, which have increased by 5 to 13 times due to this technology (depending on the irrigation schemes); the creation of other public services, such as drinking water, electrification, etc.; and has had significant impacts on other sectors. Thus, irrigation plays an important role in agriculture, in the Moroccan economy, and in the livelihoods of farmers.

The current irrigated area is around 1.5 million hectares of which two thirds are equipped by the government (Alaoui, 2013). In Morocco, approximately 70% of farms are smaller than 2 ha (Jobbins et al., 2015), and surface irrigation techniques account for approximately 80% of the equipped area

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<sup>2</sup> A traditional flood irrigation method that involves furrow flooding over a series of small basins (Berrada, 2009).

<sup>3</sup> *Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts* or MAPM

in Morocco (Arrifi, 2010). The distribution by type of schemes, according to Alaoui (2013), is 47% for large hydraulic, 23% for small and medium hydraulic, and 30% for private irrigation.

According to Jobbins et al. (2015), among other strategies, such as institutional reforms, drip irrigation has been promoted by the State as a technical solution for commonly used, inefficient irrigation technologies. State subsidies to support adoption of drip irrigation have been offered: there is currently a standard subsidy of 80%, with 100% offered to farmers with land smaller than 5 ha or that are part of collective projects (see section 1.1.4.).

For additional overall information on irrigation and the agricultural sector in Morocco: See the Excel documents “Information\_2014-2015” and “Information\_2013-2014” for total agricultural area, total irrigated area, production per crop (tons), and population for each region. The latter contains data pertaining to the rainfall for old regional administrative areas, for the 2008/2009 and 2013/2014 growing seasons, while “Information\_2014-2015” contains some precipitation data for the updated regional administrative areas, but much data is missing. “statistiques\_de\_la\_production\_vegetale\_-campagne\_2014-2015” contains information on cropped area, production (100 Qx), and yield (Qx/Ha) for each crop, within each DPA and ORMVA. The pdf “Le Maroc en chiffres, 2015 (version arabe & anglaise)” contains cropped area and yield at the national level for the 2012-2013 year at the national level (and 2013-2014), from page 51-55. Note: Regions were changed in 2015, therefore data for regions cannot be combined.

## **2. Green Morocco Plan (*Plan Maroc Vert*)**

To conserve water and optimize its usage in irrigation – produce more with less – the government of Morocco put forth an ambitious plan to deploy drip irrigation to about half of the total irrigated land by 2022 (Berrada, 2009). This would be achieved primarily through the conversion of flood-irrigated land to modernized drip irrigation systems. The government provides a generous subsidy to landowners who adopt this technology, as an incentive. This is part of the larger Green Morocco Plan (*Plan Maroc Vert*), which was implemented by the Ministry of Agriculture, Maritime Fisheries, Rural Development and of Water and Forests (*Ministère de l’Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts* or MAPM) (MAPM, 2014).

The Green Morocco Plan is a new agricultural development strategy for Morocco, based primarily on two central pillars: Modern agriculture with high added value; and solidarity agriculture (MAPM, 2014). The objective of Pillar I is the accelerated development of agriculture with high added value and high productivity that fully meets market requirements and is adapted to market rules (MAPM, 2014). The objective for Pillar II, solidarity-based agriculture, is to significantly increase the agricultural income of the most vulnerable farmers, especially in marginal areas (MAPM, 2014).

Aggregation projects are an important central aspect of the Green Morocco Plan. It is an innovative model for organizing farmers around private actors or professional organizations with a strong managerial capacity. It is a partnership between the producers (aggregates) and the private sector (aggregators), which makes it possible to overcome the constraints linked to the fragmentation of



land structures for the private sector, while ensuring that farms benefit from modern production techniques and financing, as well as access to internal and external markets (MAPM, 2014).

The Green Morocco Plan places agriculture at the center of the Moroccan economy as the main engine of growth in the national economy, with huge impacts in terms of GDP growth, job creation, exports and poverty alleviation (MAPM, 2014). Expected impacts of the Green Morocco Plan include (MAPM, 2014):

- Significant development, growth and income generation as a means to reduce rural poverty, thus justifying the implementation and mobilization of significant financial, institutional and managerial resources;
- A notable improvement in agricultural GDP, exports and private investment;
- More effective poverty reduction – both in the countryside and in the disadvantaged suburbs;
- A clear improvement in the purchasing power and quality of food for the Moroccan consumer;
- Maximization of trade security.

As part of the Green Morocco Plan, under *mesures transverses du Plan Maroc Vert* (transverse measures of the Green Morocco Plan), an irrigation investment program was implemented in 2007: the *Programme national d'économie d'eau en irrigation* (PNEEI) (National Irrigation Water Saving Program), with an investment of approximately 50 billion Dh (5 billion USD) over 10 years (Berrada, 2009; MAPM, 2014). The goal of this plan is to modernize irrigated agriculture in Morocco through the large-scale development of drip irrigation, primarily through the conversion of existing low-efficiency irrigation techniques, such as gravity methods (MAPM, 2014). This would be implemented primarily in large-scale and private irrigation schemes and aims to reduce water stress in agriculture, considered as the main limiting factor in improving productivity (Arrifi, 2010; MAPM, 2014). The program envisions a massive conversion of surface and sprinkler irrigation techniques to drip irrigation on 550,000 ha, over a period of 10 years (note: Arrifi (2010) states 15 years); thus the conversion rate is aimed at about 55,000 ha/year (MAPM, 2014). Its objective is to equip about 50% of the irrigated area at the national level. Berrada (2009) states slightly different information: "The goal of PNEEI is to equip about 555,000 ha of irrigated land with drip irrigation from 2008 through 2022". Furthermore, according to Berrada (2009), this ambitious plan looks to equip 700,000 ha (which is approximately 50% of the total irrigated land) in Morocco with drip irrigation by the year 2022. The main tool used to encourage growers to adopt drip irrigation is a government subsidy (Berrada, 2009).

The PNEEI is important to the State as the government considers drip irrigation as the best hope to bridge the gap between water supply and demand in agriculture (Berrada, 2009). PNEEI predicts significant water savings, which would come from reduced runoff and deep percolation compared to flood-irrigation methods. Some of the benefits of implementing the PNEEI would be:

- Water savings of 20 to 50% compared to existing irrigation practices;
- Crop yield gains of 10 to 100%;
- Increased farm revenue;
- Reduced labor; and



- Protection of the soil and water resources e.g., by reducing leaching of salts, nitrates, and other pollutants into the groundwater.

There are also other strategies proposed by the Department of Agriculture for the conservation and development of water resources (MAPM, 2014):

- The valuation of water resources mobilized by the dams, achieved by reducing the gap between the areas containing dams and the irrigation schemes, on 108,440 ha of land. This equipment gap is mainly located in the Sebou basin.
- Ensuring the maintenance and rehabilitation of collective irrigation perimeters.
- Institutional reform of the irrigation sector, in particular for large-scale irrigation schemes, in order to improve its competitiveness and performance and to optimize water use, through the encouragement of public-private partnerships (PPP) for the management of collective irrigation schemes.
- Continued efforts to promote participatory irrigation management, particularly in the small-medium-scale irrigation schemes, so as to involve and empower users in the management of irrigation networks and water valuation.

Berrada (2009) reports that approximately 163,000 ha were equipped with drip irrigation through 2008, most of which was done on an individual basis and outside the main irrigated perimeters. See “Information\_2013-2014” and “Information\_2014-2015” for more information on drip irrigation, according to the Ministry of Agriculture, Maritime Fisheries, Rural Development and of Water and Forests. Information on ORMVA websites may have slightly different values.

While individual farmers may install drip irrigation on their land, collective projects can also be implemented, where hundreds if not thousands of farmers are grouped together (Berrada, 2009). In these collective projects, the government will build the infrastructure to bring pressurized water to the farms and each farmer will equip their land with drip irrigation and receive a 100% subsidy – see section 1.1.4 in Part II for more details (Berrada, 2009; MAPM, 2016). Aggregation projects can also be implemented as a means for large-scale conversion/installation of drip irrigation (MAPM, 2014). The aggregation system is one of the foundations of the Green Morocco Plan. It is a partnership between the farmers and the commercial and industrial sectors of the value chain, thus organizing the farmers around private actors or professional organizations with a strong managerial capacity. This makes it possible to overcome the constraints linked to the fragmentation of land structures while ensuring that aggregated farms benefit from modern production techniques and financing, as well as access to the internal and external market. Aggregation projects have not been implemented to date and are simply theoretical at this point (Mr. Moussadek Rachid, INRA, personal conversation, 3 April 2017). Public-private partnerships (PPP) are also being encouraged as an improved method of managing collective irrigation schemes (MAPM, 2014).

### **3. Prevalence of drip irrigation in Morocco**

See Excel documents “Information\_2013-2014” and “Information\_2014-2015” (first Sheet) for information on drip irrigated areas in Morocco for 2008/2009, as well as realizations for 2008-2014 (cumulative 2008-2014) in the document “Information\_2013-2014”, and realizations for

2008-2015 (cumulative 2008-2015) in “Information\_2014-2015”. Drip irrigation goals for 2020 are also included. The information in these Excel documents were compiled from the MAPM website (MAPM, 2014), and is divided by region in Morocco. Note 1: Some information on the individual ORMVA websites may present slightly different values than those reported in MAPM (2014). Note 2: The Moroccan regions were modified in 2015, therefore data in the aforementioned documents cannot be combined.

#### **4. Government stakeholders/actors**

##### **4.1. Agence des Basin Hydraulique (ABH)**

The *Agences de Basin Hydraulique* (ABHs) are watershed management agencies under the jurisdiction of the *Ministère délégué auprès du Ministre de l'Énergie, des Mines, de l'Eau et de l'Environnement, Chargé de l'Eau* (Ministry delegated to the Minister of Energy, Mines, Water and Environment, in charge of Water), each responsible for at least one watershed in Morocco (Ministry of Water, 2016). The ABHs take charge of the administration and management of their watershed's/watersheds' water resources. Created in the late 1990s and early 2000s, their main tasks involved the coordination of water allocation among the various users, conducting studies, and monitoring and encouraging equitable, judicious, and sustainable use of water supplies (Berrada, 2009). They are equivalent to the Water Conservation Districts in the USA.

The Water Act devotes its Chapter 4 (Articles 13 to 24) to the planning of water basin management and the use of water resources (Ministry of Water, 2016). The law develops three instruments to ensure this:

- The territorial support represented by the watershed;
- The National Water Plan (Plan national de l'eau – PNE); and
- Master plans for the integrated management of water resources (*Plans directeurs d'aménagement intégré des ressources en eau – PDAIRE*) for each water basin.

The PNE is created on the basis of the results and conclusions of the PDAIREs. It is based on three pillars (Ministry of Water, 2016):

- Water demand management and water optimization.
  - The extension of the drip irrigation conversion program, based on the objectives of the Green Morocco Plan (2020), until 2030.
  - The acceleration of the hydro-agricultural development program with regard to existing dams or those currently being built.
- Water resources development through the continued mobilization of surface water through dams, the local development of surface water through small dams, the use of unconventional water resources (e.g. desalination of seawater and reuse of treated wastewater), and the ability to transfer water from surplus watersheds in the northwest to the western central drainage basins.
- Preservation of water resources, the natural environment and adaptation to climate change. Includes the preservation of water resources and the natural environment, adaptation to climate change, addressing water quality and pollution control, protection and sustainable

management of groundwater resources, watershed management and protection, and safeguarding and preserving sensitive areas such as wetlands and oases.

The PDAIREs must work in harmony with the PNE (Ministry of Water, 2016). The PDAIREs are the tools for the assessment, planning, management and development of the water resources for each basin. The ABHs are responsible for the elaboration of the PDAIREs, who create them for each watershed or group of watersheds under their jurisdiction.

For more information on individual ABHs, see <http://www.water.gov.ma/ressources-en-eau/agence-de-bassins-hydrauliques-abh/>.

#### 4.2. Office Régional de Mise en Valeur Agricole (ORMVA)

ORMVAs (*Offices Régionaux de Mise en Valeur Agricole*) are semi-autonomous agricultural agencies that oversee irrigation water infrastructure and management in nine irrigated areas in Morocco: Doukkala, Gharb, Haouz, Loukkos, Moulouya, Ouarzazate, Souss-Massa, Tadla, and Tafilelt (Berrada, 2009). They are under the Ministry of Agriculture, Maritime Fisheries, Rural Development and of Water and Forests (MAPM, 2014). Each ORMVA is in charge of executing the Green Morocco Plan for its jurisdiction through its Regional Agricultural Plan (*Plan Agricole Régional* or PAR), including the aspects concerning the conservation and optimization of irrigation water and the conversion of irrigation schemes into drip irrigation schemes (ORMVAH, 2014). Their responsibilities include carrying out studies on and implementing hydro-agricultural equipment; agricultural development; management of hydro-agricultural equipment and water resources for agricultural use; extension of cultivation techniques and vocational training; development of plant and animal production; and promotion of agro-industries. Surface water allocation can also be a part of their mandate, which is administered to farmers based on available supplies and the crops grown according to a priority-based system, every few weeks (Berrada, 2009).

#### 4.3. Directions Provinciales de l'Agriculture (DPA)

The *Directions Provinciales de l'Agriculture* (DPAs) are agricultural service agencies, under the Ministry of Agriculture, Maritime Fisheries, Rural Development and of Water and Forests, that promote, monitor, and regulate agricultural development in the regions not served by the ORMVAs (Berrada, 2009). The document « tel\_admin\_dpa » gives the contact information for each DPA.

### **5. Typical layout, use and specifications of drip irrigation systems**

Some of the tables in sections 1.1.4. and 1.2.3. list typical equipment for drip irrigation schemes.

According to Arrifi (2010), the investment cost for the first installation of a drip irrigation system is approximately 36,000 Dh/ha (3,600 USD/ha), or 60,000 Dh/ha (6,000 USD/ha) when water storage basins are included.

The technical bulletin/research grant report by Berrada (2009) outlines a specific layout and components for drip irrigation systems he personally visited in Beni-Amir and Beni Moussa. See Figure 2 for a schematic of a typical drip irrigation system, according to Berrada (2009).

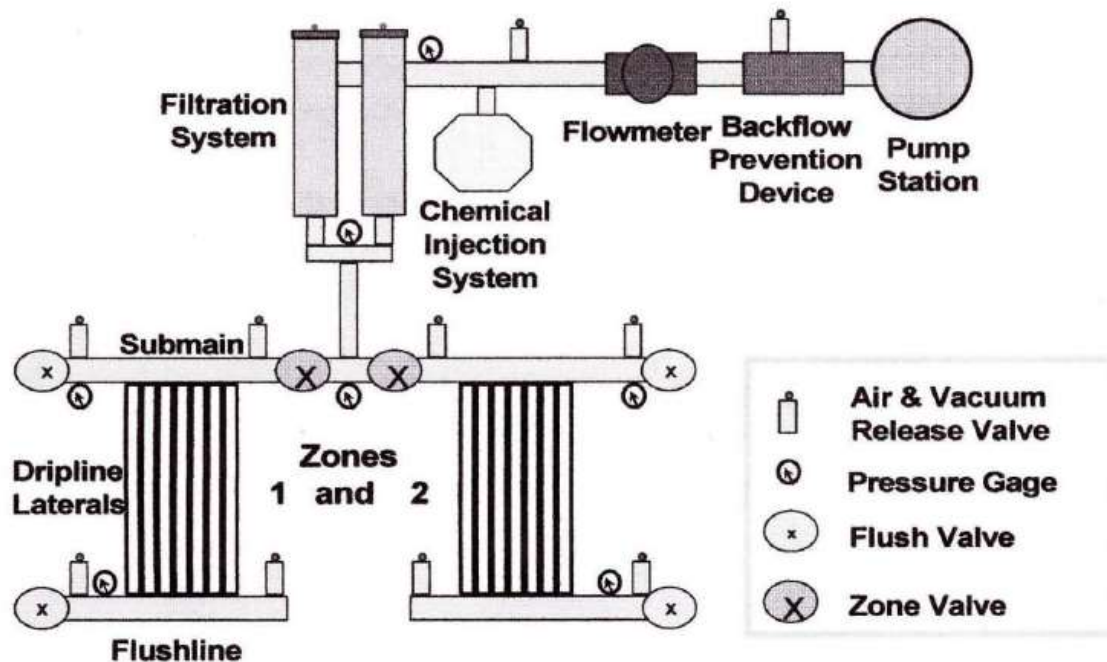


Figure 2. Typical drip irrigation system configuration (Berrada, 2009).

## 6. How do farmers typically know when and how much to irrigate?

Drip irrigation is done, theoretically, on a daily basis (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). The daily water needs of the crop must be met and are calculated based on climatic factors. These water requirements (expressed as a volume) are converted into irrigation duration. The farmers can use equipment that does automatic irrigation, or they can manually manipulate the equipment to change the irrigation duration (such as when it rains). Automatic meteorological stations can also be installed to determine the daily watering requirements.

## 7. Crops drip irrigation is used on

According to Berrada (2009), for a specific anecdote/case study, the majority of the drip irrigation installations were for horticultural crops, particularly fruit trees, and belonged mostly to medium and large landowners. Unofficial ORMVAT data indicate that at least 80% of the acreage approved to receive the drip irrigation subsidy from July 2002 through November 2008 was for fruit trees (mostly citrus). Berrada (2009) predicts that once most of the fruit orchards and vineyards, for example, are fitted with drip irrigation, the pace of adoption of this technology may slow down.

For related information, see “Information\_2014-2015”, “Information\_2013-2014”, “statistiques\_de\_la\_production\_vegetale\_-campagne\_2014-2015”, and “Le Maroc en chiffres, 2015 (version arabe & anglaise)”. These documents also include objectives for 2020.

Note: In Morocco, as in most of the Mediterranean countries, cereal systems (i.e. cereals/livestock/olive tree) are predominant (Balaghi, 2014). Within the Green Morocco Plan there is the conversion programme of cereals to orchards. As part of the Plan’s Pillar II, fruit trees are currently being planted in areas where cereals are unsustainable, with an objective of about 1 million ha by 2020. The plantations are designed to improve farmers' income and reduce land degradation, through optimal fertilization, rainwater harvesting, supplemental irrigation practices, and by preserving soils against erosion.

### **8. Current adoption rate by farmers**

According to Jobbins et al. (2015), although farmers in Bitit and Ain Chegag communities, in the Sebou watershed, recognise the potential benefits of drip irrigation, only 10% of farmers had adopted it. In another study in the Saïss Basin (sub-basin of the Sebou), only about 10.2% of the farmers use drip irrigation by (Kalpakian et al., 2014). Data for other areas was not found, but it is hypothesized that numbers would be similar, and diffusion remains at rather low levels.

### **9. Strengths and weaknesses of drip irrigation according to farmers**

Strengths (Alaoui, 2013; Berrada, 2009; Jobbins et al., 2015; Kalpakian, 2014):

- Reduced labour
  - Rather than needing to employ part-time labourers to channel irrigation waters, the drip irrigation system allowed small farmers to irrigate alone and with minimal effort.
- Reduced energy costs of groundwater pumping (mostly reported for large scale farmers).
- Ability to convert efficiency savings in water and energy into larger irrigated areas (large scale farmers).
- Reduce fuel use
- Increased outputs and income
- Saves water
- Many times, the costs outweighed the benefits for farmers, especially for smallholder farmers. Weaknesses include (Alaoui, 2013; Berrada, 2009; Jobbins et al., 2015; Kalpakian, 2014):
- Difficulties in accessing subsidies, especially for smallholder farmers.
- Little value seen in saving water:
  - Farmers with more assured water supplies have few incentives to conserve water to benefit downstream users.
  - Any water efficiency savings resulting from drip irrigation could be used by others without restriction. This is especially important for smallholder farmers.



## **10. Obstacles to adoption**

Alaoui (2013), Arrifi (2010); Berrada (2009), Jobbins et al. (2015), and Kalpakian et al. (2014) cover this in great detail. The information they present applies to specific jurisdictions, but are hypothesized by this author to be highly relevant for many other regions in the country as well.

Some of the obstacles include (Alaoui, 2013; Arrifi, 2010; Berrada, 2009; Jobbins et al., 2015; Kalpakian, 2014):

- High investment costs, lack of money, and difficulty accessing initial credit/loans.
- Subsidies.
  - Difficulty accessing subsidies.
  - Complexity, lengthiness and cumbersomeness of the subsidy process.
- Debt.
- Non-familiarity with drip irrigation.
- Type of crops grown
- Complicated water laws (e.g., in the Haouz)
- Land titles. Common forms of ownership include *Melk* (private property), *Urfi* (informal, unregistered but communally recognised), *Sulaliya* (tribal or communal title), *Habous* (a religious endowment), *Guich* (formerly used as compensation for military service) and *Domain* (state land) (Jobbins et al., 2015).
  - Land titles that cannot be mortgaged for access to credit to finance drip irrigation process, especially seeing as subsidies are only granted at the end. However, there exist possibilities of arrangements with private companies that can overcome this (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). In other areas, new laws allow mortgages for land for which legitimate use rights have been officially documented (Jobbins et al., 2015).
  - While offering a subsidy of 80% or 100% was an effective means of supporting small farmers on private property, it did not reduce access barriers for all small farmers, particularly the most marginalised groups (Jobbins et al., 2015).
  - Some land titles have reportedly been harder to access subsidies than others (e.g. *Urfi* or *Sulaliya*) (Jobbins et al., 2015).
- Weak presence of relevant bureaucracies and of help at the farm level, and geographic remoteness from administrative offices
- Lack of awareness of subsidy program, or of different organizations (e.g. ABH).
- Farms that are too small, or too fragmented, to realise benefits from drip irrigation, particularly where they are not able to develop cooperative agreements with their neighbours.
- Literacy, knowledge, paperwork, and education impeding ability to get loans and subsidies.
- Social barriers to access subsidies, such as customary law, levels of social capital, and specific obstacles faced by women farmers.
- Ability to procure a well permit from water management authorities.
- Lack of knowledge about the drip irrigation and its implications for them.

Many of these obstacles to adoption, such as difficulty accessing subsidies and initial credit/loans, is especially relevant for poor and smallholder farmers (Berrada, 2009; Jobbins et al., 2015). According to Jobbins et al. (2015), in each case study, wealthier farmers were better able to adopt

drip irrigation than small farmers. Although the State offers subsidies of up to 100% to offset high initial investment costs, many small farmers experience significant barriers to access subsidies and credit.



## **Part II: Economic situation/ecosystem of drip irrigation in Morocco**

### **1. Subsidies**

The State grants financial assistance for agricultural investments made by farmers (individuals or legal entities) through subsidies granted under the Agricultural Development Fund (*Fonds de développement agricole* or FDA) (MAPM, 2014). While the FDA concerns more than just irrigation, with regards to drip irrigation, the subsidies are meant to incentivize farmers to install/convert to drip irrigation systems, and thus contribute towards the goals of the Green Morocco Plan.

There are two types of subsidies:

- Universal aid for individual investors (MAPM, 2014; Crédit Agricole, 2016): These subsidies are meant for all farmers, breeders and investors in the agricultural sector. To prepare their applications for state aid and to retrieve the requested documents, applicants are invited to contact the *Guichet Unique* (GU) of the *Direction Provinciale de l'Agriculture* (DPA) or of the *Office Régional de Mise en Valeur Agricole* (ORMVA) of their area. Examples of the documents to be submitted as part of the subsidy process are “MODELE DEMANDE APPROBATION PREALABLE” and “MODELE DEMANDE DE SUBVENTION”. The first document is a request for prior approval, and the second document is for a subsidy request.
- Aid for aggregation projects (MAPM, 2014; Crédit Agricole, 2016): These subsidies are available for the private actors/professional organizations (i.e. aggregators) and the agricultural producers/breeders (i.e. aggregates). There are three types of subsidies: (1) Rate subsidies (with a maximum amount) for drip or complementary<sup>4</sup> irrigation equipment, and for the acquisition of agricultural materials. These grants can be awarded to the aggregator as well as to the aggregates. (2) Subsidy for the aggregator for the project. (3) Flat-rate subsidy, per hectare or number of aggregates, is awarded to the aggregator in order to help finance its actions undertaken for the benefit of the aggregates. This flat-rate grant is granted to the aggregator provided that the minimum objectives of the aggregation project are met. The information in section 2.1.2. mostly applies to type (1). **It is important to note that subsidies for aggregation projects are only theoretical at this point in time and have yet to be implemented (Mr. Moussadek Rachid, INRA, personal conversation, 3 April 2017).**

#### **1.1. Universal aid for individual investors for irrigation projects**

It must be pointed out that in order to be eligible for financial assistance from the State, outlined in Joint Decree No 3417.10 of 22 Moharram 1432 (28 December 2010), projects must be designed and carried out as part of an overall project of water economy and has received prior approval, in accordance with the procedures described in the Decree (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

*Guichets Uniques* (one-stop shops or GUs) were created for each *Direction Provinciale de l'Agriculture* (DPA) and each *Office Régional de Mise en Valeur Agricole* (ORMVA) to serve as

<sup>4</sup> Reference to complementary irrigation refers to other types of irrigation (e.g. sprinkler, canon, etc.) (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

a single point of contact for farmers (Crédit Agricole, 2016). The GUs and the *Services Techniques* (Technical Services or TSs) are in charge of managing the FDA financial aid applications, and are two distinct entities in each DPA and each ORMVA (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017; MAPM and MEF, 2011). At the level of the ORMVAs, the GU is a unit that acts as a single point of contact for farmers in terms of granting financial aid, while at the DPA level, this role is attributed to the *Service des Aides et Incitations*. The TSs encompass all services of the DPA or the ORMVA, other than those under the *Service des Aides et Incitations* and the GU, which are concerned with the subsidy request process and are designated by the directors of the DPA and the ORMVA to review the applications for assistance.

Other than the groups mentioned above, there are other entities that are worth noting, with regards to the subsidy process (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017):

- The banks, particularly the Crédit Agricole offer products/services to farmers, with conditions, to help them.
- The MAPM is responsible for the budgeting of the subsidies within the framework of the FDA. It also monitors the subsidy program through a department dedicated to the financial aspects of the Ministry, and assists farmers in drawing up and designing their projects.
- The ABH's role is limited to granting farmers an essential document for their applications, namely the Authorization for the Use of the Hydraulic Resources. It is an authorization to dig wells and use the well water for irrigation.

Eligibility for the subsidies for hydro-agricultural projects are as follows (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017):

- Land that has not previously received financial support from the State for irrigation equipment;
- Irrigation equipment, which has received financial assistance from the State, is at least 8 years old and is degraded and non-functional at the date of filing of the application for prior approval;
- Land subject to crop conversion or substantial modernization as part of an integrated water saving project, involving an investment and justifying a radical change of existing irrigation equipment, and that has already received financial assistance from the State. In this particular case, the said existing equipment must be more than 8 years old on the date of filing the application for prior approval.

A schematic of the eligibility for State subsidies can be seen in Figure 3.

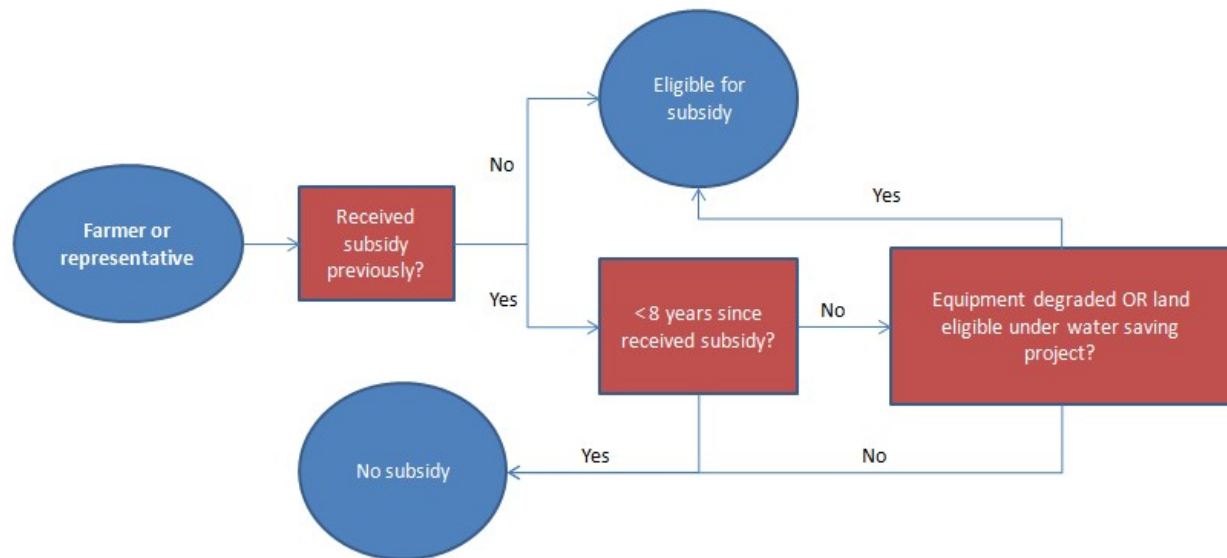


Figure 3. Eligibility schematic for state subsidy, for farmers or representatives of farmers/farmer groups (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

#### 1.1.1. Particular Cases and Applicants

Aside from being sought by individual farmers, subsidies can be sought by other types of applicants and be subject to other situations as well. The following is a summary of these particularities.

##### 1.1.1.1. Irrigation projects to be realized by tranches – farms larger than 60 ha

For projects of more than 60 ha (individual farmer) to be carried out in tranches (or installments), with some works common to the different sections required to be carried out before the equipment for the total area is installed, the amount of subsidy that these common works are eligible for is proportional to the area equipped in relation to the total area of the project (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). The farmer must present the project outline for the total area, planned from the first tranche, along with the corresponding implementation schedule. The total duration of the project must not exceed 30 months from the date of approval for the first tranche.

##### 1.1.1.2. Irrigation projects supervised by the government

At the request of a group of farmers, the services of the MAPM or the institutions under their jurisdiction (ORMVA, DRA, DPA) can provide the necessary technical assistance for the design of the project, the preparation of the specifications, the launching of tenders, and the implementation of the drip or complementary irrigation projects (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). Such projects may have the processes for the preparation and appraisal of applications simplified. The particularities of the arrangements would be defined within the framework of a specific agreement between the Administration and the beneficiaries. Applications must still be submitted to the GU, as usual.

#### *1.1.1.2.1. Collective drip irrigation projects carried out jointly by farmer groups or by associations of agricultural water users (AUEA)*

The farmers may benefit collectively from financial assistance granted by the State for equipment to be used in common (e.g. conveyance and distribution structures) (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). These collective projects can benefit from a subsidy rate of 100% for drip irrigation projects.

The applications for prior approval and the subsidy requests are submitted and processed under the same conditions as those for individual farmers, and must be submitted by the legal representative of the farmer group or association (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

The legal relationship of the member farmers with their properties is not required, but the applications must include the status of the group, the list of farmers, the individual proxies of the members in order to mandate the legal representative of the group, the commitment of the group or AUEA to ensure the maintenance and renewal of the works carried out, and operating certificates issued by the DPA or ORMVA for each of the members (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

Projects fulfilling the required conditions may be subject to the same simplifications as those provided for in the irrigation projects under the supervision of the government (section 1.1.1.2.). Subsidies are awarded according to the rates and maximum amounts for each member and for the overall group on the basis of the total area of the project (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

#### *1.1.1.3. Subsidy processes for different types of farmer properties*

The farmer follows the same steps to apply for subsidies and must file it with the same organizations, but they must also provide documents that justify their legal ties with the property in question, which varies by land status<sup>5</sup> (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). For example, for a *Melk*, a certificate may be required depending on whether the property is registered; rented land requires a lease for a period of at least 5 years; and collective land requires a certificate by the local authority and a declaration for the property, signed by the applicant. The document “PIECES ADMINISTRATIVES JUSTIFIANT LE LIEN JURIDIQUE DU POSTULANT” outlines the exact documents that must be submitted alongside applications in the subsidy process by the farmers, according to the different property statuses, to justify their link to the land that will be under investment.

Agricultural investments carried out on joint ownership properties (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017): farmers who make agricultural investments on their share of property may benefit from financial assistance provided that they sign a commitment, in the absence of obtaining the prior agreement of all the other co-owners, to:

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<sup>5</sup> Common forms of ownership include *Melk* (private property), *Urfi* (informal, unregistered but communally recognised), *Sulaliya* (tribal or communal title), *Habous* (a religious endowment), *Guich* (formerly used as compensation for military service) and *Domain* (state land) (Jobbins et al., 2014).

- Assume full and complete responsibility towards their co-owners, in the case of litigations which may arise either from a challenge to the State's aid, or from the introduction of a procedure for the sharing of the joint ownership property, which would lead to a questioning of the shared property and, consequently, to a possible questioning of the implemented project;
- Reimbursement in totality of the subsidy to the State in the event of destruction of the project as a result of such a litigation.

The members of agrarian reform cooperatives can benefit from financial assistance from the State with respect to their individual investments on individual lots of land of the agrarian reform, provided that such investments are authorized in advance by the DPA or ORMVA Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

### *1.1.2. Steps in the subsidy process*

#### *1.1.2.1. Application for prior approval*

The first step in the subsidy process for irrigation equipment is to submit an application for prior approval (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). The file is prepared before the implementation of the project and requires the prior agreement of the required governmental bodies.

Before the realisation of the project, the applicant must submit two copies (the original and a copy) of the application for prior approval to the GU, or one of its branches (MAPM and MEF, 2011). The GU, or its branches, check for the presence of all the required parts of the application. If the file is complete, a receipt for the file (numbered and dated) is given to the applicant immediately after the verification. Any incomplete application is returned to the applicant with a receipt specifying the missing parts.

The completed applications are registered by the GU and sent to the relevant TSs of the ORMVA or DPA for verification and examination of the documents (MAPM and MEF, 2011). If the required documents are not drawn up in accordance with the requirements, the TS shall notify the GU in writing, which shall notify the applicant in writing of the deficiencies found. Subject to provisions to the contrary, which are specific to certain categories of projects, an additional period of 3 months from the date of notification by the GU shall be granted only once to the applicant to satisfy the said deficiencies. After this time, the application is rejected, and a copy of the file is returned to the applicant. In this case, any new application for prior approval relating to the same project may be re-filed by the applicant and will be considered and treated as a new project. For the files deemed to be in good and due form, the TS shall study and check for the eligibility of the project for financial assistance from the State. If the project is eligible, a certificate of approval is drawn up by these services, which act as the authorization for the implementation of the project within the deadlines set out below.

From the date of prior approval, the Ministry of Agriculture reserves the right to make unannounced visits at any time to the project sites. Applicants should facilitate their work and support the completion of these checks (MAPM and MEF, 2011).



#### 1.1.2.2. Subsidy request

After completion of the project, the applicant deposits, within the set deadlines, a subsidy request, in duplicate (the original and a copy), to the GU, or its branches, of the DPA or ORMVA (MAPM and MEF, 2011). This is the second step in the subsidy process. The deadline for submission to the GU is 24 months for individual projects and 30 months for collective projects and/or projects implemented in tranches, from the date of prior approval (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

The GU, or its branches, checks the presence of all the required parts. If the file is complete, a receipt for the application (numbered and dated) is given to the applicant immediately after the verification (MAPM and MEF, 2011). Any incomplete file is returned to the applicant with a receipt specifying the missing parts.

The completed files are registered by the GU and sent to the relevant TSs of the DPA or ORMVA (MAPM and MEF, 2011). If the required documents are not drawn up correctly, the technical services concerned shall notify the GU in writing, which shall notify the applicant in writing of the deficiencies found. To complete the file and satisfy the deficiencies notified by the GU, the applicant has an additional period of 3 months from the date of the said notification.

In the case of files deemed complete and in good form, the TS shall then carry out on-the-spot checks on the completion of the corresponding projects. If the projects are deemed to be in conformity with requirements, a statement of achievement is drawn up by the TS, specifying their favorable opinion and the amount of the subsidy to be granted. This report shall be submitted to the GU, together with the original file, for the purpose of the decision to grant the subsidy (MAPM and MEF, 2011).

This decision, duly signed by the director of the DPA or ORMVA, or his representative, is transmitted to the relevant *Caisse Régionale du Crédit Agricole*, which releases the financial assistance for the beneficiary (MAPM and MEF, 2011). The GU invites the beneficiary, in writing, to report to the relevant *Caisse Régionale du Crédit Agricole* for receipt of the subsidy owed him.

If the completed project proves to be incomplete and/or non-compliant during the on-the-spot check, the TS sends a note to the GU, which notifies the applicant of the deficiencies found (MAPM and MEF, 2011). Subject to the contrary provisions specific to certain categories of projects, an additional period of 3 months shall be granted only once to the applicant to satisfy the said deficiencies. This period runs from the date of notification by the GU to the applicant. If the project is deemed non-compliant after expiry of the additional period granted, the applicant is notified by the GU of the termination of the subsidy request.

As subsidies are only granted after completion of the drip irrigation installation, the farmers may not always have access to adequate resources to finance the project before such funding is obtained. Banks offer credit, but farmers must be in good standing and must mortgage their land, which might not always be possible (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). Therefore, other options are available to overcome this situation, which are outlined in Part II section 2.

### 1.1.2.3. Delays, deadlines and timeframes

Processing times for the application of prior approval:

- Category 1 (C1) – Drip or complimentary irrigation projects (MAPM, 2016b; MAPM and MEF, 2011): 20 business days
  - 3 days for verification by the GU and transmission to the TS.
  - 15 days for the study and check of eligibility of the project and transmission of notification from TS to GU.
  - 2 days for transmission of notification from GU to applicant.

Processing times for subsidy request applications and of payment to applicant (MAPM, 2016b): 30 Working Days. All files are deposited at the GU against deposit receipts. Details about the breakdown of these 30 days can be seen in MAPM and MEF (2011).

The deadlines for submitting a subsidy request are presented in Table 1.

*Table 1. Timeframe for applying for subsidy<sup>1</sup> (MAPM, 2016b; MAPM and MEF, 2011).*

	Object or operation	Deadline for submission	
C1	Irrigation projects carried out on individual basis	24 months	From the date of prior approval.
	Irrigation projects carried out collectively and/or by tranches	30 months	

<sup>1</sup>Additional delays may be possible if the application is submitted by the applicant before the expiry of the original deadline.

### 1.1.3. Rates and maximum subsidy amounts (MAPM, 2016b)

Note: All information in this section comes from MAPM (2016b), unless otherwise stated.

*Table 2. Drip irrigation projects carried out on an individual basis, and additional facilities<sup>1,2</sup> (MAPM, 2016b).*

Drip Irrigation Projects		
Operation	Subsidy rate (% of cost)	Maximum subsidy amount (DH)
Well digging and casing	80	1,100 Dh / linear depth meter
Borehole digging and casing	80	2,000 Dh/linear depth meter
Supply and installation of water pumping equipment, including equipment for pumping, civil engineering works, and pumping station housing.	80	4,000 Dh/KW of installed power
Development of water storage basins for irrigation, including the coating.	80	35 Dh/m <sup>3</sup> of storage capacity
	80	5,600 Dh/ha



Supply and installation of head station: irrigation water filtration, fertigation, connection accessories, control and regulation equipment, automation equipment (equipment for remote control of valves, backwashing of filters , management of fertigation, control of pumps, remote control and water metering), including construction of housing for the head station.		
Supply and installation of supply and distribution pipes for irrigation water, including connection accessories and control and regulation equipment.	80	9,600 Dh/ha
Supply and installation of pipes and distributors of irrigation water, including connection accessories.	80	13,600 Dh/ha
<b>Additional Facilities</b>		
<b>Operation</b>	<b>Subsidy rate (% of cost)</b>	<b>Maximum subsidy amount (DH)</b>
Water storage basins	80	35 Dh/m <sup>3</sup> of storage capacity
Adaptation of the existing drip irrigation system in the context of densification of tree plantations.	80	13,600 Dh/ha

<sup>1</sup> The amount of subsidy that can be awarded is limited to 36,000 Dh/ha.

<sup>2</sup>In the case of the necessity that an irrigation water storage basin must be constructed, this maximum subsidy of 36,000 Dh/ha can be increased by the maximum amount illustrated in the table for water storage basins. This increase cannot surpass 16000DH/ha.

*Table 3. Drip irrigation projects carried out in the framework of collective projects or by small farmers, and additional facilities<sup>1,2,3</sup> (MAPM, 2016b).*

<b>Drip Irrigation Projects</b>		
<b>Operation</b>	<b>Subsidy rate (% of cost)</b>	<b>Maximum subsidy amount (DH)</b>
Well digging and casing	100	1,400 Dh/linear depth meter
Borehole digging and casing	100	2,500 Dh/linear depth meter
Supply and installation of water pumping equipment, including equipment for pumping, civil engineering works, and pumping station housing.	100	5,000 Dh/KW of installed power
Development of water storage basins for irrigation, including the coating.	100	For small farmers (5 ha and less): 60 DH/m <sup>3</sup> of storage capacity; for other farmers: 40

		DH/m <sup>3</sup> of storage capacity
Supply and installation of head station: irrigation water filtration, fertigation, connection accessories, control and regulation equipment, automation equipment (equipment for remote control of valves, backwashing of filters, management of fertigation, control of pumps, remote control and water metering), including construction of housing for the head station.	100	For small farmers (5 ha and less): 11,000 Dh/ha; for other farmers: 7,000 Dh/ha
Supply and installation of supply and distribution pipes for irrigation water, including connection accessories and control and regulating equipment.	100	12,000 Dh/ha
Supply and installation of pipes and distributors of irrigation water, including connection accessories.	100	17,000 Dh/ha
<b>Additional Facilities</b>		
Operation	Subsidy rate (% of cost)	Maximum subsidy amount (DH)
Water storage basins	100	For small farmers (5 ha and less): 60 Dh/m <sup>3</sup> of storage capacity; for other farmers: 40 Dh/m <sup>3</sup> of storage capacity
Adaptation of the existing drip irrigation system in the context of densification of tree plantations.	100	17,000 Dh/ha

<sup>1</sup> The amount of subsidy that can be awarded is limited to 45 000 DH per hectare.

<sup>2</sup>In the case of the necessity that an irrigation water storage basin must be constructed, this maximum subsidy of 45,000 Dh/ha can be increased by the maximum amount illustrated in the table for water storage basins. This increase cannot surpass 20,000 Dh/ha.

<sup>3</sup>Small farmers (5 ha or less in size) must provide proof of eligibility for 100% subsidy for localized irrigation and for 50% complementary irrigation subsidy (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

For the case of investment by AUEA or groups of farmers with respect to collective drip irrigation projects: For drip irrigation projects carried out by a group of farmers or by an AUEA for the benefit of member farmers, subsidies are granted according to the rates and maximum amounts per member and overall on the basis of the total area of the project. It is understood that for collective irrigation projects where the average acreage per adherent is less than or equal to 5 ha, the component relating to the head station has a maximum of 11 000 Dh/ha (MAPM, 2016b).

*Table 4. Complementary irrigation projects<sup>1,2,3</sup> (MAPM, 2016b).*

Operation	Subsidy rate (% of cost)	Maximum subsidy amount (DH)
Well digging and casing	50	800 Dh/ linear depth meter
Borehole digging and casing	50	1,200 Dh/linear depth meter
Supply and installation of water pumping equipment, including equipment for pumping, civil engineering works, and pumping station housing as well as water metering material.	50	2,500 Dh/KW of installed power
Development of water storage basins for irrigation, including the coating.	50	20 Dh/m <sup>3</sup> of storage capacity
Supply and installation of materials for irrigation water filtration and fertigation, including the housing construction.	50	3,500 Dh/ha
Supply and installation of supply and distribution pipes for irrigation water, sprinklers, pivots, laterals, and reels for all systems.	50	8,000 Dh/ha

<sup>1</sup> The subsidy is limited to 20,000 Dh/ha.

<sup>2</sup> In the case of the necessity that an irrigation water storage basin must be constructed, this maximum subsidy of 20,000 Dh/ha can be increased by the maximum amount illustrated in the table for water storage basins. This increase cannot surpass 10,000 Dh/ha.

<sup>3</sup> Small farmers (5 ha or less in size) must provide proof of eligibility for 100% subsidy for localized irrigation and for 50% complementary irrigation subsidy (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

#### *1.1.4. Constituents of applications (MAPM, 2016b)*

Note: All information in this section comes from MAPM (2016b), unless otherwise stated.

##### *1.1.4.1. Drip irrigation and complementary irrigation projects*

###### *1.1.4.1.1. Application for prior approval*

Before the realisation of the project can commence, the applicant must submit a request for project review, in duplicate, to the GU. This request must include the following:

- An application for prior approval.
- A certified copy of the applicant's National Identity Card (*Carte d'indentité nationale*).
- A certified copy of the articles and legal documents designating the persons authorized to act on their behalf, for legal persons.

- The documents justifying the legal link of the applicant with the land in question<sup>6</sup>.
- The technical file of the project, which must include:
  - The calculations of the project signed and sealed by the engineer who established the study and who carries the references of the company that established the study of the project.
  - The calculations must be carried out by a company approved by the services of the MAPM (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). Therefore, a certified copy of the certificate of qualification or approval of the company or the engineering firm must be submitted (MAPM, 2016b).
  - For companies and engineering offices not established in Morocco, the aforementioned certificate of qualification or authorization may be replaced by an equivalent document issued by the competent authorities of the country of origin or, if there is no equivalent document, a note on the know-how and the capacities of the company to carry out the requested studies supported by the human and material resources, the technical and financial references and the certificates of completion.
  - A detailed plan of the installation at an appropriate scale.
  - A detailed plan of the storage basin at an appropriate scale.
  - For basins with a total capacity of more than 10,000 m<sup>3</sup>, a note on the basin's stability, the manufacturing process and the safety measures.
  - A plan of the housing structures specifying dimensions and foreseen construction materials.
  - A side-view plan if the relief is significant.
  - The estimated quotations of the equipment, materials, and developments.
  - A certified copy of the qualifications of the company that created the quotations and that will undertake the project.
  - The commitment of the supplier(s) to comply, in the case of drip irrigation projects, with the provisions set out in the specification referred to in Moroccan Standard No 12.1.100-2007 (Installation of Drip Irrigation-General Requirements).
  - A test report on the hydraulic performance of irrigation equipment, issued within the last two years by the Hydraulics Laboratory of the Experimentation, Testing and Standardization Department (*Laboratoire d'hydraulique du service des expérimentations, des essais et de la normalisation*) of the MAPM.
  - Inventories of pumping groups and filters of the project.
  - For projects for the conversion of existing irrigation systems fed wholly or partly from a source of water for which authorization to draw water is necessary, according to the law on water, either an authorization or concession for water use from the *Domaine Public Hydraulique* (Public Domain Hydraulics or DPH), or a copy of the request for the regulation of the water source point-of-withdrawal, or at

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<sup>6</sup> The document "PIECES ADMINISTRATIVES JUSTIFIANT LE LIEN JURIDIQUE DU POSTULANT" outlines the different documents that must be submitted alongside applications by the farmers, according to different property statuses, to justify their link to the land that will be under investment. It also has information about the texts governing the status of the properties.

the very least a declaration of water withdrawal (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

- An authorization or concession from the DPH for new extension projects requiring new water withdrawals (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).
- The supporting documents for eligibility for the 100% subsidy for drip irrigation, and for complementary irrigation subsidies:
  - For small farmers eligible for the 100% drip irrigation subsidy, supporting documents justifying that the applicant has only 5 ha or less of land, and a declaration that he does not possess more than 5 ha nationally.
  - An attestation by the Department of Agriculture stating that the project in question adheres to a collective drip irrigation conversion program initiated or authorized by the State.
  - A certificate of aggregation for the aggregator and the aggregates (in the case of aggregation projects – see section 1.2 below).

#### 1.1.4.1.2. *Subsidy request*

After the completion of the irrigation project, the applicant must submit to the GU a subsidy request, with two copies. This application consists of:

- The certificate of prior approval issued by the GU.
- A subsidy request.
- Detailed final bills for completed works, equipment, and facilities and, where appropriate, memoranda relating to excavation work and digging of wells carried out by the farmer.
- A commitment by the applicant to conserve the investment and to maintain it in good functioning condition for at least five years, starting from the date when the work is completed.
- Attestation of the applicant's bank details.

#### 1.1.4.2. *Additional facilities: Water storage basin*

##### 1.1.4.2.1. *Application for prior approval*

Before execution of the project, the applicant must submit a request for project review, with two copies, to the GU. This request must include:

- An application for prior approval.
- A certified copy of the applicant's National Identity Card (*Carte d'identité nationale*).
- A certified copy of the articles and legal documents designating the persons authorized to act on their behalf, for legal persons.
- The documents justifying the legal link of the applicant with the land in question<sup>7</sup>.
- The technical file of the project, which must include:
  - A note justifying the need to develop the water storage basin to improve the water supply conditions.

<sup>7</sup> The document “PIECES ADMINISTRATIVES JUSTIFIANT LE LIEN JURIDIQUE DU POSTULANT” outlines the different documents that must be submitted alongside applications by the farmers, according to different property statuses, to justify their link to the land that will be under investment. It also has information about the texts governing the status of the properties.

- A description of the existing drip irrigation or complementary irrigation equipment.
- Calculations of the project including the conception and dimensioning of the basin, as well as calculations for existing equipment.
- A detailed plan of the basin at an appropriate scale.
- For basins with a total capacity of more than 10,000 m<sup>3</sup>, a note on the basin's stability, the manufacturing process and the safety measures.
- These notes and plans must be signed and sealed by the engineer that created them, with reference to the company that established the studies.
- A copy of the certificate of qualification or authorization of the company or office that created and approved the calculations.
- For companies and engineering offices not established in Morocco, the aforementioned certificate of qualification or authorization may be replaced by an equivalent document issued by the competent authorities of the country of origin or, if there is no equivalent document, a note on the know-how and the capacities of the company to carry out the requested studies supported by the human and material resources, the technical and financial references and the certificates of completion.
- Estimated quotations of the construction of the basin, the waterproofing of the structures and related equipment.
- A certified copy of the qualifications of the company that created the quotations and that will undertake the project.
- The supporting documents for eligibility of the 100% subsidy for drip irrigation, and for complementary irrigation subsidies:
  - For small farmers eligible for the 100% drip irrigation subsidy, supporting documents justifying that the applicant only has 5 ha or less of land, and a declaration that he does not possess more than 5 ha nationally.
  - An attestation by the Department of Agriculture stating that the project in question adheres to a drip irrigation conversion program initiated or authorized by the State.

#### 1.1.4.2.2. *Subsidy request*

After the completion of the project, the applicant must submit a subsidy request to the GU, with two copies. It must include:

- Certificate of prior approval.
- A subsidy request.
- Detailed final bills for completed works, equipment, and facilities and, where appropriate, memoranda relating to excavation work digging of wells carried out by the farmer.
- A commitment by the applicant to conserve the investment and to maintain it in good functioning condition for at least five years from the date on which the work is completed.
- Attestation of the applicant's bank details.



#### 1.1.4.3. Additional facilities: Adaptation of the existing drip irrigation system in the context of densification of tree plantations

##### 1.1.4.3.1. Application for prior approval

Before execution of the project, the applicant must submit a request for project review, with two copies, to the GU. This request must include:

- An application for prior approval.
- A certified copy of the applicant's National Identity Card (*Carte d'indentité nationale*).
- A certified copy of the articles and legal documents designating the persons authorized to act on their behalf, for legal persons.
- The documents justifying the legal link of the applicant with the land in question<sup>8</sup>.
- The technical file of the project, which must include:
  - The calculations of the project signed and sealed by the engineer who established the study and who carries the references of the company that established the study of the project.
  - A certified copy of the certificate of qualification or approval of the company or the engineering firm that has established and approved the calculation note.
  - For companies and engineering offices not established in Morocco, the aforementioned certificate of qualification or authorization may be replaced by an equivalent document issued by the competent authorities of the country of origin or, if there is no equivalent document, a note on the know-how and the capacities of the company to carry out the requested studies supported by the human and material resources, the technical and financial references and the certificates of completion.
  - A detailed plan of the installation at an appropriate scale.
  - The estimated quotations of the equipment, materials, and developments.
  - A certified copy of the qualifications of the company that created the quotations and that will undertake the project.
  - The commitment of the supplier(s) to comply, in the case of drip irrigation projects, with the provisions set out in the specification referred to in Moroccan Standard No 12.1.100-2007 (Installation of Drip Irrigation-General Requirements).
  - A test report on the hydraulic performance of irrigation equipment, issued within the last two years by the Hydraulics Laboratory of the Experimentation, Testing and Standardization Department (*Laboratoire d'hydraulique du service des expérimentations, des essais et de la normalisation*) of the MAPM.
  - For projects for the conversion of existing irrigation systems fed wholly or partly from a source of water for which authorization to draw water is necessary, according to the law on water, either an authorization or concession for water use from the *Domaine Public Hydraulique* (Public Domain Hydraulics or DPH), or a copy of the request for the regulation of the water source point-of-withdrawal, or at

<sup>8</sup> The document "PIECES ADMINISTRATIVES JUSTIFIANT LE LIEN JURIDIQUE DU POSTULANT" outlines the different documents that must be submitted alongside applications by the farmers, according to different property statuses, to justify their link to the land that will be under investment. It also has information about the texts governing the status of the properties.



the very least a declaration of water withdrawal (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).

- An authorization or concession from the DPH for new extension projects requiring new water withdrawals (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017).
- The supporting documents for eligibility of the 100% drip irrigation subsidy:
  - For small farmers eligible for the 100% drip irrigation subsidy, supporting documents justifying that the applicant only has 5 ha or less of land, and a declaration that he does not possess more than 5 ha nationally.
  - An attestation by the Department of Agriculture stating that the project in question adheres to a drip irrigation conversion program initiated or authorized by the State.

#### 1.1.4.3.2. Subsidy request

After the realisation of the irrigation project, the applicant must submit to the GU a subsidy request, with two copies. This application consists of:

- Certificate of prior approval.
- A subsidy request.
- Detailed final bills for completed works, equipment, and facilities and, where appropriate, memoranda relating to excavation work and digging of wells, carried out by the farmer.
- A commitment by the applicant to conserve the investment and to maintain it in good functioning condition for at least five years from the date on which the work is completed.
- Attestation of the applicant's bank details.

#### 1.1.5. Summary of subsidy process

The general procedure of the subsidy process is presented in Figure 4, while the detailed procedure for farmers or representatives of farmers/groups of farmers can be seen in Figure 5. Please see section 1.1.1. for details on particular cases and applicants, as well as section 1.1.2.3. for information on processing times and deadlines for the various steps in the process.

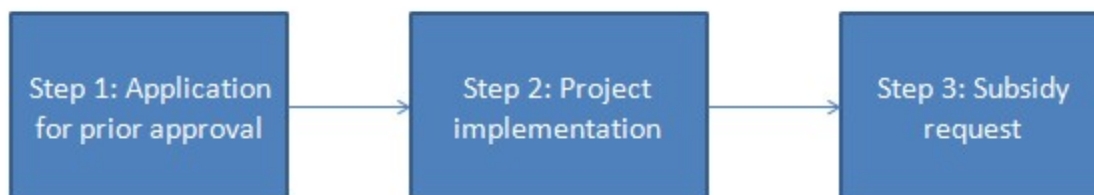


Figure 4. General procedure in subsidy process (MAPM, 2016b).

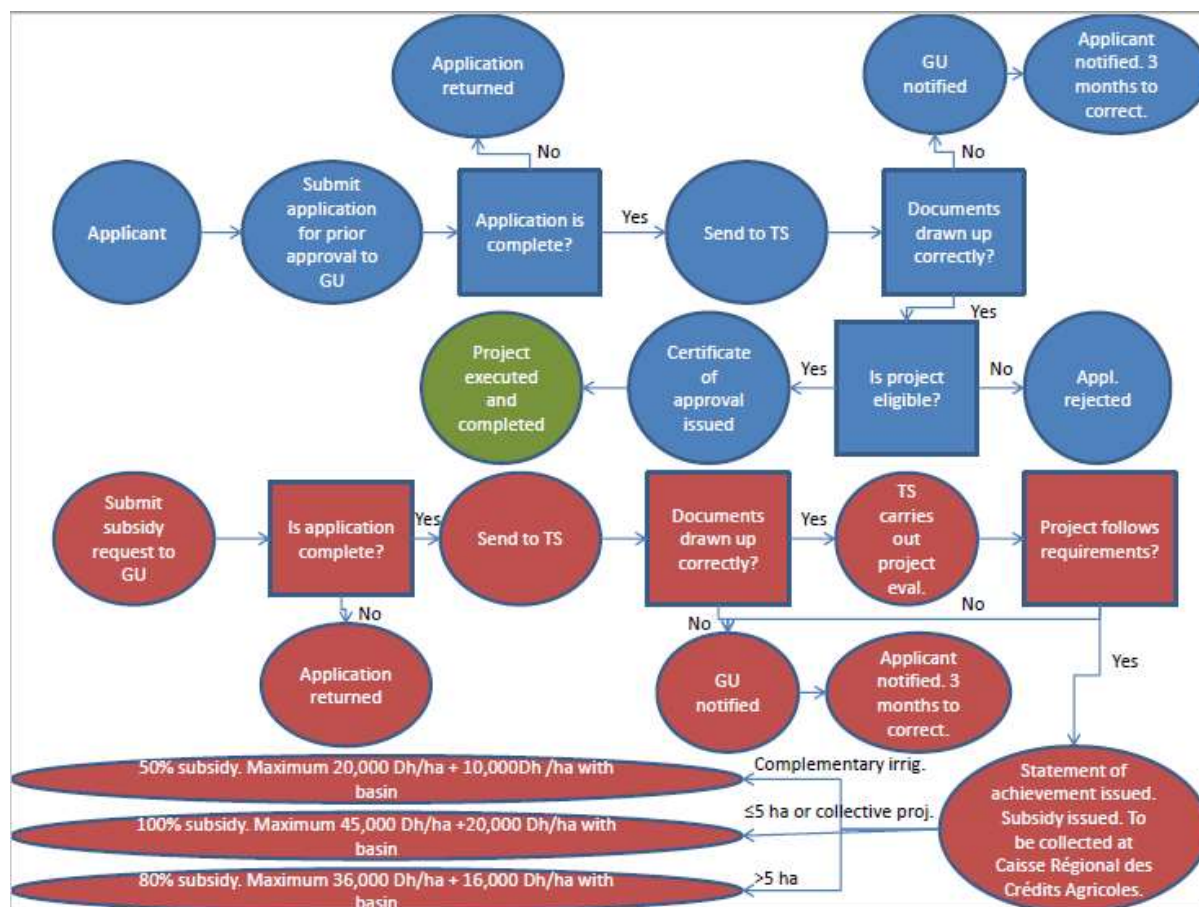


Figure 5. Detailed procedure in subsidy process (Chatou Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017; MAPM, 2016b; MAPM and MEF, 2011). (Blue) Application for prior approval. (Green) Project implementation. (Red) Subsidy request.

## 1.2. Aid for aggregation irrigation projects

Subsidies are granted in two installments (MAPM, 2016a):

- Installment 1: The first installment (2) of this subsidy is calculated according to the rates and maximum amounts fixed for the first installment. It is paid upon obtaining the certificate of aggregation and after the project has been completed.
- Installment 2: The second installment is calculated based on the rates and maximum amounts for the total subsidy (1), minus the amount granted in the first installment (2).
  - This second installment is provided at the end of the first year of the aggregates' delivery of production to the aggregator.
  - The request for the second installment is submitted by the aggregates or aggregator to the same GU.
  - The application for the second installment shall be admissible after at least one year from the filing of the application for the first installment and after delivery by the aggregates of their production to the aggregator.

### 1.2.1. Steps in the subsidy process

#### 1.2.1.1. Application for prior approval

Before the implementation of the project, the applicants (both aggregates and aggregators) must submit an application of prior approval for their irrigation projects to the GU, or its branches, of their jurisdiction's DPA or ORMVA (MAPM and MEF, 2015).

The procedures for processing the application for prior approval (and the subsidy request) are identical to those for universal aid for individual investors (sections 1.1.2.1 and 1.1.2.2.) (MAPM and MEF, 2015). The certificates of aggregation are attached by the aggregates/aggregators to their application for prior approval (and subsidy request) for the first installment.

#### 1.2.1.2. Subsidy Request

After the completion of the projects, subsidy requests for drip and complementary irrigation projects are submitted to the GU, or its branches, of the relevant DPA or ORMVA (MAPM and MEF, 2015).

The procedures for processing the application for prior approval and the subsidy request are identical for those for universal aid for individual investors (sections 1.1.2.1 and 1.1.2.2.) (MAPM and MEF, 2015). The certificates of aggregation are attached by the aggregates/aggregators to their application for prior approval and subsidy request for the first installment.

The rates and maximum amounts for these subsidies, as well as their respective standards, can be referred to in the joint order n°3074-14 of 12 kaada 1435 (8 September 2014), and are applicable only to the areas/crops and farms covered by the aggregation project (MAPM and MEF, 2015).

#### 1.2.1.3. Delays, deadlines and timeframes (MAPM, 2016a)

Note: All information in this section comes from MAPM (2016a), unless otherwise stated.

Processing times for the application of prior approval/agreement in principle:

- Category 1 (C1) : 20 working days
- NS : not submitted for prior approval

*Table 5. Deadlines for subsidy request of different installments<sup>1</sup> (MAPM, 2016a).*

Category	Object or operation	1st installment		2nd installment
		Deadline for file submission		Deadline for file submission
C1	Irrigation projects realized on an individual basis	24 months	From the date of prior approval	At least 12 months after the submission of the application file for the first installment and after delivery of the production.
C1	Irrigation projects by tranche	30 months		
NS	Flat-rate subsidy	Depending on the progress of the project		

<sup>1</sup>Additional delays may be possible if the application is submitted before the expiration of the initial deadline.

Processing times for subsidy request applications and of payment to applicant: 30 working days.  
All files are deposited at the GU against deposit receipts.

The deadlines for the subsidy request of the different installments can be seen in Table 5.

### 1.2.2. Rates and maximum subsidy amounts (MAPM, 2016a)

Note: All information in this section comes from MAPM (2016a), unless otherwise stated.

*Table 6. Drip irrigation projects (MAPM, 2016a).*

Operation	Total Subsidy (1)		First Installment (2)	
	Rate (%)	Maximum amount (Dh)	Rate (%)	Maximum amount (Dh)
Well digging and casing	100	1,400 Dh/linear depth meter	80	1,100 Dh/linear depth meter
Borehole digging and casing	100	2,500 Dh/linear depth meter	80	2,000 Dh/linear depth meter
Supply and installation of water pumping equipment.	100	5,000 Dh/KW of installed power	80	4,000 Dh/KW of installed power
Supply and installation of head station equipment.	100	11,000 Dh/ha for small farmers ( $\leq 5$ ha)	80	5,600 Dh/ha
Supply and installation of supply and distribution pipes for irrigation water.	100	12,000 Dh/ha	80	9,600 Dh/ha
Supply and installation on the land parcel of irrigation water pipes and distributors.	100	17,000 Dh/ha	80	13,600 Dh/ha
Total maximum amount (excluding water storage basin).		45,000 Dh/ha		36,000 Dh/ha
Irrigation water storage basin	100	60 Dh/m <sup>3</sup> for small farmers ( $\leq 5$ ha)	80	35 Dh/m <sup>3</sup>
	100	40 Dh/m <sup>3</sup> for all other farmers	80	35 Dh/m <sup>3</sup>
Total maximum amount for storage basin		20,000 Dh/ha		16,000 Dh/ha

Table 7. Complementary irrigation projects (MAPM, 2016a).

Operation	Total Subsidy (1)		First Installment (2)	
	Rate (%)	Maximum amount (Dh)	Rate (%)	Maximum amount (Dh)
Well digging and casing	70	1,120 Dh/linear depth meter	50	800 Dh/linear depth meter
Borehole digging and casing	70	1,680 Dh/linear depth meter	50	1,200 Dh/linear depth meter
Supply and installation of water pumping equipment	70	3,500 Dh/KW of installed power	50	2,500 Dh/KW of installed power
Supply and installation of irrigation water filtration and fertigation equipment	70	4,900 Dh/ha	50	3,500 Dh/ha
Supply and installation of supply and distribution pipes for irrigation water	70	11,200 Dh/ha	50	8,000 Dh/ha
Total maximum amount (excluding water storage basin)		28,000 Dh/ ha		20,000 Dh/ha
Irrigation water storage basin	70	28 Dh/ m3	50	20 Dh/ m3
Total maximum amount for storage basin		14,000 Dh/ ha		10,000 Dh/ha

### 1.2.3. Constituents of applications (MAPM, 2016a)

Note: All information in this section comes from MAPM (2016a), unless otherwise stated.

#### 1.2.3.1. Application for prior approval

Before projects can be commenced, the applicant must submit an application for project review, with two copies, to the GU. It consists of:

- An application for prior approval.
- A certified copy of the applicant's National Identity Card (*Carte d'indentité nationale*).
- A certified copy of the articles and legal documents designating the persons authorized to act on their behalf, for legal persons.
- The documents justifying the legal link of the applicant with the land in question<sup>9</sup>.
- The technical file of the project, which must include:
  - A calculation note for the drip irrigation projects signed and sealed by the engineer who drew up the study, and which bears the references (company name, trade register number, telephone, fax and address) of the company that prepared the project study.

<sup>9</sup> The document "PIECES ADMINISTRATIVES JUSTIFIANT LE LIEN JURIDIQUE DU POSTULANT" outlines the different documents that must be submitted alongside applications by the farmers, according to different property statuses, to justify their link to the land that will be under investment. It also has information about the texts governing the status of the properties.

- A certified copy of the certificate of qualification or approval of the company or the engineering firm that has established and approved the calculation note.
- For companies and engineering offices not established in Morocco, the aforementioned certificate of qualification or authorization may be replaced by an equivalent document issued by the competent authorities of the country of origin or, if there is no equivalent document, a note on the know-how and the capacities of the company to carry out the requested studies supported by the human and material resources, the technical and financial references and the certificates of completion.
- A detailed plan of the installation at an appropriate scale, signed and sealed by the engineer who established the study.
- A detailed plan of the storage basin at an appropriate scale, with a note on the basin's stability for those with a total capacity of more than 10,000 m<sup>3</sup>, the manufacturing process and the safety measures.
- A plan of the housing structures specifying dimensions and foreseen construction materials.
- A side-view plan if the relief is significant.
- The estimated quotations for equipment, materials, and developments.
- A certified copy of the qualifications of the company that created the quotations and that will undertake the project.
- The commitment of the supplier(s) to comply, in the case of drip irrigation projects, with the provisions set out in the specification referred to in Moroccan Standard No 12.1.100-2007 (Installation of Drip Irrigation-General Requirements).
- A test report on the hydraulic performance of irrigation equipment, issued within the last two years by the Hydraulics Laboratory of the Experimentation, Testing and Standardization Department (*Laboratoire d'hydraulique du service des expérimentations, des essais et de la normalisation*) of the MAPM.
- The catalogs of pumping groups and filters provided by the project.
- A certificate of aggregation for the aggregator and for the aggregates.

#### 1.2.3.2. Subsidy Request

##### **First Installment**

After the projects have been completed, the applicant must submit a subsidy request, with two copies, to the GU. This will include:

- Certificate of prior approval of the project in question.
- A subsidy request.
- The detailed final invoices.
- A commitment by the applicant to retain the investment and to keep it in good working order for at least five years from the date when the work is completed.
- Attestation of the applicant's bank details.

##### **Second Installment**



The request for the second installment shall be admissible after at least one year from the filing of the application for the first installment. The application for the 2nd installment consists of:

- An application for the second installment.
- For the aggregates: The discharge requested by the aggregator, and an attestation of the aggregate's production delivery to the aggregator, specifying the total quantity delivered.
- For the aggregator: An attestation of satisfaction of the commitments of the aggregator with the aggregates signed by the Director of the relevant DRA.

#### 1.2.4. Summary of subsidy process

The general procedure for the subsidy process can be seen in figure 6.



Figure 6. General subsidy process (MAPM, 2016a).

## 2. Role of private sector

Private firms that sell drip irrigation systems generally offer farmers help with the paperwork and administration for credit and subsidies. However, they charge for the service and many farmers distrust their motives (Jobbins et al., 2015; Kalpakian et al., 2014).

As was previously stated, not all farmers have access to adequate personal finances or to the credit necessary to finance drip irrigation projects, seeing as subsidies are only granted after completion of the works (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). This is particularly the case for small farmers, who can only receive loans from banks under certain conditions. These farmers can thus enter into agreements with private companies to offset these obstacles. They use private companies to install the system on their farms, which often propose to fully equip the farmers in return for a signed offset of assets, thus allowing the company to later recuperate the entirety of the subsidy once the project is complete. The farmers must also give the company a guaranteed cheque in case the subsidy does not come through. Apart from this agreement, any other agreements between the private companies and the farmers are informal ones.

The installation companies are only responsible for carrying out the design and the installation of the irrigation projects (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017). These companies cannot manufacture the equipment, and thus purchase it from manufacturers/suppliers (note: manufacturers can sell irrigation equipment to suppliers, which will resell the equipment to these companies). Irrigation equipment is either produced in Morocco or imported from manufacturers, suppliers, or importers from abroad. The MAPM has established a qualification system for these companies, and has a list of qualified companies that is constantly revised. The subsidy process requires the provision of these qualification certificates for these manufacturers/suppliers (as part of the application for prior approval) in order for beneficiaries to receive subsidies. Furthermore, the MAPM requires testing and approval of the irrigation



equipment at the National Hydraulics Laboratory (*Laboratoire Nationale d'Hydraulique*), which produces test reports of the equipment. This report is required as part of the application for prior approval in the subsidy process. The private companies installing the equipment are required to request the qualification certificate of the manufacturers/suppliers from the Ministry's Department of Irrigation, and all material installed must be tested at the National Hydraulics Laboratory.

Additional notes (Chati Toufiq and Moussadek Rachid, MAPM and INRA, email, 14 March 2017):

- Generally the subsidized material is controlled by the farmer and the TS of the ORMVA and DPA, at the time of its receipt.
- The TS assesses the quality of the installation before giving their approval for the subsidy.
- As mandated by the subsidy process, the installer is obliged to provide his services for a certain period of time. However, it should be noted that few companies accompany farmers when operating the equipment.

### **3. Drip irrigation cost**

The following is anecdotal information about the cost of drip irrigation systems for particular case studies in Morocco, meant to give a general idea:

- According to Kalpakian et al. (2014), each system costs approximately 30,000 Dh to install.
- The average cost of a drip irrigation system in the Oum er R'bia river basin was about \$5,700/ha (or 57,000 Dh/ha) and varied with farm size, crops grown, and degree of sophistication (Berrada, 2009). Approximately 70% of the farms equipped with drip irrigation systems had a water storage reservoir. The cost per hectare generally decreased as the number of hectares increased but not always.
- Table 8 below shows estimated drip irrigation system component costs for five projects submitted to the Tadla ORMVA (ORMVAT) in 2008 (Berrada, 2009).

*Table 8. Estimated drip irrigation system component costs of five projects submitted to ORMVAT in 2008 (Berrada, 2009).*

Project No.	1	2	3	4	5	Cost/ha	% of total cost
System component	Estimated cost (\$)						
Head station & water delivery	92,088	82,500	148,833	18,660	514,255	4,062	63%
Storage reservoir	36,399	40,433	60,073	14,916	139,155	1,380	21%
Pumps	30,413	4,375	7,695	2,813	106,969	722	11%
Shelter for the head station	5,714	11,198	9,636	4,979	30,128	292	5%
<b>Total cost</b>	<b>164,614</b>	<b>138,505</b>	<b>226,237</b>	<b>41,367</b>	<b>790,507</b>	<b>6,457</b>	<b>100%</b>
Land Area (ha)	25.4	37.1	25.6	4.7	118	210.8	
<b>Cost/ha</b>	<b>6,481</b>	<b>3,733</b>	<b>8,837</b>	<b>8,801</b>	<b>6,699</b>		
Reservoir Capacity (m <sup>3</sup> )	7500	7600	7200	1920	37000		
Crop	Citrus	Citrus	Sugar beets	Citrus*	Citrus**		

Projects 1 & 3 were designed by the same company.

\*Citrus trees and vegetable crops

\*\*Citrus trees and sugar beets

## **References**

- Alaoui, M. 2013. Water sector in Morocco: Situation and perspectives. *J. Water Res. Ocean Sci.* 2(5): 108-114, doi: 10.11648/j.wros.20130205.18.
- Arrifi, E. M. 2010. L'économie et la valorisation de l'eau en irrigation au Maroc: Un défi pour la durabilité de l'agriculture irriguée. Rabat, Morocco: Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts.
- Balaghi, R. 2014. The Green Moroccan Plan: A challenge strategy for a green economic growth. In *The Bioeconomy: A Challenge for the Development in the South and in the Mediterranean*. Rabat, Morocco: National Institute for Agronomic Research.
- Berrada, A. A. 2009. Assessment of drip irrigation in Morocco with particular emphasis on the Plain of Tadla. Fort Collins, Colo.: Colorado State University.
- Crédit Agricole. 2016. Fellah-trade: Les Aides Financières de l'Etat. Rabat, Morocco: Crédit Agricole du Maroc. Available at: <http://www.fellah-trade.com/fr/info-filiere/accompagnement/aides-financieres>. Accessed 5 March 2017.
- Jobbins, G., J. Kalpakian, A. Chriyaa, A. Legrouri, and E. H. El Mzouri. 2015. To what end? Drip irrigation and the water-energy-food nexus in Morocco. *Intl. J. Water Res. Dev.* 31(3): 393-406.
- Kalpakian, J., A. Legrouri, F. Ejekki, K. Doudou, F. Berrada, A. Ouardaoui, and D. Kettani. 2014. Obstacles facing the diffusion of drip irrigation technology in the Middle Atlas region of Morocco. *Intl. J. Environ. Studies* 71(1): 63-75.
- MAPM and MEF. 2011. Instruction conjointe du Ministre de l'Agriculture et de la Pêche Maritime et du Ministre de l'Economie et des Finances relative aux modalités de traitement des dossiers de demande de l'aide financière de l'Etat distribuée dans le cadre du Fonds de Développement Agricole. Rabat, Morocco: Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts and the Ministère de l'Economie et des Finances.
- MAPM. 2014. Ministry of Agriculture, Maritime Fisheries, Rural Development and of Water and Forests. Rabat, Morocco: Ministry of Agriculture, Maritime Fisheries, Rural Development and of Water and Forests. Available at: [www.agriculture.gov.ma](http://www.agriculture.gov.ma). Accessed 24 January 2017.
- MAPM and MEF. 2015. Avenant N°6 à l'instruction conjointe du Ministre de l'Agriculture et de la Pêche Maritime et du Ministre de l'Economie et des Finances relative aux modalités de traitement des dossiers de demande de l'aide financière de l'Etat distribuée dans le cadre du Fonds de Développement Agricole. Rabat, Morocco: Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts and the Ministère de l'Economie et des Finances.

- MAPM. 2016a. Aides aux projets d'agrégation. Rabat, Morocco: Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts.
- MAPM. 2016b. Irrigation & aménagements fonciers. Rabat, Morocco: Ministère de l'Agriculture, de la Pêche Maritime, du Développement Rural et des Eaux et Forêts.
- Ministry of Water. 2016. Ministère Délégué auprès du Ministre de l'Énergie, des Mines, de l'Eau et de l'Environnement, Chargé de l'Eau. Rabat, Morocco: Ministère Délégué auprès du Ministre de l'Énergie, des Mines, de l'Eau et de l'Environnement, Chargé de l'Eau. Available at: <http://www.water.gov.ma/>. Accessed 17 February 2017.
- ORMVAH. 2014. L'Office Régional de Mise en Valeur Agricole du Haouz. Marrakech, Morocco: Office Régional de Mise en Valeur Agricole du Haouz. Available at: <http://ormvah.com/>. Accessed 20 March 2017.