Technical issues involved in modernizing farm irrigation system

Abstract

This paper results from the observation or participation to a number of farm irrigation modernization projects. The point of view tentatively adopted is the farmer's one. The effects of local constraints on modernisation options selected are analysed and some consequences on water productivity, water saving or social impacts listed. It appears clearly that modernisation policies should be designed in a participative way, that water saving potential doesn't always results in effective decrease in water consumption, but most often in water productivity increase. Due to the necessity of mind conversion along with technical conversion, the need for technology transfer is highlighted, concerning both farmers and dealers, to assure a minimum durability of modernisation. The use of a standardised framework to reach consensus to support technically modernisation process, can help guaranty modernisation cost effectiveness along with cost return.

Keyword: On-Farm irrigation, Irrigation Techniques, Modernisation, Support policy

Résumé

Cet article résulte de l'observation et de la participation à de nombreux projets de modernisation de l'irrigation au niveau de l'exploitation agricole. Le point de vie adopté est celui de l'agriculteur. L'effet des contraintes locales sur les options de modernisation choisies sont analysées et les conséquences sur la productivité de l'eau, les économies d'eau ou les impacts sociaux sont listés. Il apparaît clairement que les politiques de modernisation devrait être définies d'une manière participative, que les économies d'eau potentielles ne se traduisent pas systématiquement en baisse des consommations, mais pratiquement toujours en augmentation de productivité. Du fait de la nécessité de convertir les mentalité en même temps que les techniques le besoin de transfert de technologie est souligné, concernant à la fois les agriculteurs et les distributeurs, pour assurer un minimum de durabilité de la modernisation. L'utilisation d'un cadre normalisé pour atteindre le consensus pour accompagner techniquement le processus de modernisation peut aider à garantir l'efficacité économique en même temps que le retour sur investissement.

Mots clés: Irrigation à la ferme, Techniques d'irrigation, Modernisation, Politique d'appui

Technical issues involved in modernizing farm irrigation system

Bruno MOLLE, Cemagref, UMG G-EAU[1]

Introduction

In Mediterranean countries most available or accessible water resources are already exploited. Considering that the irrigated agriculture sector annually consumes up to 80% of water resources, and up to 90% in the peak demand period, every small decrease in this consumption will free more water for other uses and reduce conflicts.

To promote this objective, governments are implementing policies based on tariffs and quotas, as well as modernisation programs to improve equipment and practices (Molle, B. et al., 2004).

After years of massive investment in big infrastructures (Bouderbala, 2004), governments now prefer to provide support to small private farms. It appears to be more cost effective per hectare, allows farmers to get involved in the economic process, helps settle rural populations, and contributes to the development of local industry in rural areas while promoting agricultural extension service (Gadelle, 2002).

Moreover it appears that modernisation policies targeting farms are more successful when seeking step by step improvement, rather than through revolutionizing practices (Kay, 2001). Participatory management systems that involve farmers give them a greater stake in system operations, which facilitates communication between the farmers and policy makers (Loubier et al., 2006). This implies creating farmer associations that allow end users, managers and political authorities to interface (Spadana, 2004).

Modern irrigation techniques certainly have the potential to improve water and man power productivity. But their introduction is mostly driven by commercial stakes more than water saving concerns (Brabben, 2001).

The financial and administrative tools employed to help manage irrigation systems have improved situations, but on-farm system durability remains too poor. To be effective modernisation policies should be based on an integrated analysis of current situations and practices, encompassing different levels of scale from farm, to network and to river basin (Vidal et al., 2001).

The priorities of farmers are often very different from what other stakeholders think. These differences may lead to conflicts or at best misunderstanding. The recurring problem is that as farmers are not well represented, their expectations are not considered by other stakeholders, or through the “filter” of other experts.

With this in mind, the Inco-Wademed Concerted Action was developed to: i) assess water management experiences in Maghreb countries, ii) identify factors that hamper the implementation of water-saving measures, and iii) put forward recommendations for improving water demand management policies. To this end, a knowledge database of water management modernisation experiences and their results has been created (www.wademed.net) and workshops organised ("Modernisation of irrigated agriculture" Rabat-Morocco (2004), "Institutions and Policy making" in Tunisia (2005) and "Implementation of participative water management solutions", France (2006).

In this paper, the modernisation of farm irrigation systems will be assessed. The main focus will be on farmers and their expectation from water managers, policy makers, equipment dealers, manufacturers' or products processors.

By modernisation of farm systems we mean principally the conversion of farmers from traditional to supposed higher performance (*i.e.* modernised) practices and techniques. This is understood as the operation of water saving application technologies, most often the use of microirrigation, sometimes the

[1] LERMI (Laboratoire d'Essais et de Recherche sur les Matériels d'Irrigation); Cemagref, UMR-GEAU; 3275 route Cezanne; CS 40061; 13182 AIX EN PROVENCE Cedex 5; France; bruno.molle@aix.cemagref.fr; Tel: 00 33 442 66 69 62; Fax: 00 33 442 66 99 57

implementation of irrigation scheduling. All these should allow water to be saved provided a number of conditions are fulfilled.

Farmers and Water management

Farmers expect the water manager to provide them with a reliable water supply in terms of volume and time scheduling. The modernisation of irrigation systems usually involves adjusting irrigation equipment water-application timing and volume to plant water demand, both of which are linked to climatic and water supply conditions. Water supply reliability allows farmer to define a consistent crop selection strategy from anticipated water allocation and effective irrigation scheduling.

With unreliable water supply, precise irrigation scheduling methods cannot be properly implemented, even if the annual water volume at farmer's disposal is sufficient. However the principal criterion used by water managers to evaluate their own level of service is more monthly volume supplied than daily or at least weekly supply. Any insecurity in water supply will lead farmers to implement precautionary water management strategies that encompass variability in supply. In pressurised systems, the farmer will maximise water application when water is available and fill the "soil reservoir" to wait for the next water distribution shift (see Figure 1). This will obviously lead to leaching or drainage, and salt contamination of water tables. It results in unreliable hydraulic parameters and jeopardises application performance for those farmers that are more distant from the pumping station.

Figure 1 : Filling up of soil reservoir…!

To secure water supply, farmers tend to operate private pumping and/or storage, even with bad quality water. The networks will be considered as a mitigation solution (coastal area of Doukala, Gharb in Morocco). Pumping may contribute to soil salinity and related water table depletion due to leaching. In Tadla (Morocco) in 2005, tanks represented 4% of annual volume used by pressurised systems, giving an irrigation autonomy of 10 days.

If a reliable water supply is not guaranteed by consistent maintenance water supply cost recovery will become a problem. The farmer will hold the water manager responsible for his income decrease and refuse to pay for a service that prevents good production results.

Examples of co-management of water in a participative way can be found in the Tadla irrigation system (Morocco), the local water management company has helped to set up a microirrigation user association (ATIL[2]) to facilitate dialogue and help water management (Molle, B., 2006). In the Moulouya irrigation system (Tizaoui, 2004), the “Mohamed V” dam supplying water to the area is 55% clogged with sediments, the water management company, in cooperation with the government, has supported farmers to design and manage private storage tanks that are geo-textile lined, and to modernize their irrigation techniques. Such tanks almost doubled the total investment cost of plot distribution system.

Water restriction and management constraints have been accepted in these examples because farmers are associated to the management process and direct financial support is provided to help adaptation, along with technology transfer conducted by extension services.

When water becomes scarce, is inequitably distributed or its distribution unreliable, farmers generally pump in wells. The risk of over-pumping is high shifting the surface water management problem to a water table management problem. Restriction to pumping authorisation is the usual answer of policy

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[2] Association Tadla de l’irrigation Localisée

makers inducing more undeclared pumping sometimes subsidised! Examples are reported in Syria, coastal area of Gharb (Molle, B., 2006), China (Xinbo, 2006).

The way forward to reach water table management required knowing accurately the aquifer functioning (capacity, recharge efficiency…) then involving all users in the preservation of the water table level. This relies on aquifer and water consumption monitoring framework to work with objective data. Such management has been in Parisian basin (France, AND-I, Cemagref, 2006) along with the definition of quotas. Farmers have undertaken themselves the modernisation of their irrigation practices and methods.

Finally rules on access to pumping authorisation should be transparent, consistent with local situation (land property for example) and authorisation accessible for all farmers along with appropriate control. Once this is established, effective water management is possible through quotas or water pricing with different impacts on irrigation technique modernisation (Montginoul, 2004).

Access to financial support

Developing modern water saving techniques requires a minimum level of investment. Usually in developing regions, farmers have limited financial capacity and will thus need access to subsidies or low rate credits to help finance modernisation. Credit are accessed first by educated farmers, smallholders need administrative as well as technical assistance. Few successes of credit support to modernisation are reported in developing countries.

When subsidies are offered the first candidates are those who don't really need such support. The small holders apply later and in some cases can't gain access because of attribution rules. In Morocco and Tunisia (Molle, B., et al. 2004), subsidy policy was framed in such a way that under 5ha, projects are not cost effective. In Morocco, during the first 15 years of the modernisation program focussing on plot distribution equipment, the average subsidised projects size was 16ha and 12.5ha respectively for microirrigation and supplemental irrigation projects (AGR, 2003). Then the government decided to allocate subsidies to the complete system (storage, pumping, distribution) the average surface area decreased under 10ha in 2005. Observing that small holders didn't apply for subsidies, the Tunisian government decided to increase the rate up to 60%, when at least 3 farmers present a joint application. This was a success thanks to the help of extension services (CRDA) to design consistent and cost effective projects. The help of extension services is a key to reaching sustainable modernisation they help farmers' decision making on project dimensioning, validate dealers' sales propositions, suggest changes in system design, and participate in project start-up. Their agreement is needed before subsidy allocation.

Financial support policy to modernisation has to be designed to allow farming system cost recovery and not considered by farmers as a gift or a part of the public water management system.

Subsidies and technical support policies has allowed Tunisia in 2003 to increase the total surface irrigated by microirrigation to 22%, by sprinkler to 27% and by modernised surface irrigation to 25%, Vidal, et al. (2001) reported a 50% decrease in losses in citrus production areas.

Figure 2 : Combined irrigation system to initiate wet bulb in the soil before operating drip system

The consequences of modernisation policy priorities

The definition of priorities to be addressed through modernisation is key to reaching policy objectives. 3 priorities are mostly displayed:

- Decrease water use: the water saving objective is always given first, even if it is rarely met. It justifies a clear preference of policy makers for microirrigation solutions compared to more traditional sprinkler or surface systems, even if modernised, scheduling methods are seldom considered. But, when microirrigation is developed on large area, water consumption doesn't decrease (Molle, F., et al., 2004), farmers simply reallocate the water saved. Water savings originating in a change over to microirrigation can only be achieved if water supply is restricted (Tizaoui, 2004).
- Increase water productivity: this is usually considered as a regional economic objective and is always reached, at least for the very first years. Higher water productivity generally results in increased water demand from modernised farms, and may result in market saturation.
- Increase social welfare in rural areas: is a logical consequence of incomes increase. Nevertheless the orientation of governmental support may contribute to increasing the differences between small and large farm holders. On the other hand the modernisation policy impacts on regional economy and employment[3] and contributes to higher regional productivity and profitability.

Modernisation of traditional irrigation techniques may result in considerable changes in the existing hydraulic system balance, the existing beneficial losses will drop close to zero. Increasing water use efficiency increases net water consumption, decreases leaching and associated water transfers to downstream users (Molle, F. et al. 2006). Depending the scale level of water use efficiency calculation, modernisation of plot irrigation can be considered either good for individual farmer or bad for the balance of the aquifer.

Lastly sustainability of modernisation policies should be questioned at all scale levels from farm to regional level, considering employment, incomes, rural activity and social welfare to achieve regional sustainability. Numerous tools exist to help such processes, such as Olympe (Legrusse, 2001, Carmona, et al. 2005) and can be used in participative scenarios approaches before any policy decision.

Farmers' expectations with regards to Irrigation equipment manufacturers, and testing laboratories

Quality and durability

When governments actively support farm irrigation modernisation policies, there usually follows an expansion in the number of local dealers, installers and manufacturers. For example in Syria in 2002 approximately 140 irrigation companies were registered, for an irrigated surface area of 1.35 million ha and of which 0.2 million ha is under pressurised application systems. This excessive number results in intense competition, lower manufacturing quality decreasing the potential durability of irrigation systems. Such situation weakens “good” manufacturers because of unfair competition, and generates considerable money wastage that may be fatal to small holders with limited financial capacity.

As most equipment is manufactured from plastic compounds, low-cost raw materials are used or uncontrolled recycled plastics and money is saved on antioxidant additives. Products durability will thus be reduced due to early oxidation of plastics (figure 4&5).

Manufacturing quality is the second issue, especially in plastics moulding and extrusion. Figure 6 shows examples of bad moulding and heterogeneous wall thickness in PE pipes conducting to low performance and durability.

Quality of field system design and installation will be the third issue. It can be addressed only with the help of extension services.

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[3] In France, the rate of direct employment is 1 employee for 30ha in open field vegetable, 1 for 100ha for non-irrigated cereals., indirect employment rates are 15ha and 100ha respectively (AND-I, Cemagref, 2006). In southern France, the rates are 1 direct employment for 7ha and 1 indirect employment for 2.5ha for greenhouses productions..

Figure 3: Pipe cracking after only 2 years' use, Syria 2002.

Figure 4: Portion of capillary tubes coming from the same initial piece with localized anti-oxydant fault

Figure 6: moulding homogeneity default on a fitting and heterogeneous wall thickness of a PE pipe (90mm)

Figure 7 : Bad design: sprinkler operating under faulty pressure head

The place of testing and standardisation

To improve irrigation product quality the first step is to develop an evaluation and testing policy that establishes real performance characteristics obtained from an independent laboratory using standardised protocols. The government plays a key role in developing such laboratories and promoting quality verification mechanisms linked to modernisation policies.

In Morocco between 2002 and 2004, the simple fact that testing of products to be subsidised was made compulsory resulted in an increase in dripper quality (Laiti et al., 2004): the highest quality class represented 60% of tests in 2002 and 72% in 2004. Such a policy, conducted on new products after standardised sampling, should be extended to products taken randomly from the field after installation. Testing, which can be very simple, could be conducted by regional extension services at a very low cost.

The competition among dealers to provide cheap solutions for poorly educated farmers, will inevitably lead to lower system quality. To prevent this, in Morocco and Tunisia, the government has linked subsidy attribution to equipment quality verification in the field. Subsidies are given to systems complying with minimum performance requirements. Such verification process has been very effective in support to farm irrigation systems subsidy policy. They lead to better system design (as illustrated further) and reduce the number of incompetent system installers.

Implementing a standardisation process will help involve manufacturers in this quality policy. It provides a framework allowing all stakeholders to reach a consensus on technical aspects of irrigation. This process is managed by a standardisation committee, made up of representatives of all stakeholders. Such committee should be balanced, as achieved in Morocco (Molle, B. et al. 2004) and not monopolised by one category of stakeholders. It can be further consulted as a reference group on modernisation policy evaluation in a totally transparent way. Moreover the standardisation committee is in a position to help identify regional technical stakes and define R&D needs, bridging the gap often observed between field evaluation and academic research concerns.

The standardization process relies on references obtained by independent laboratories which verify the levels of performance of irrigation systems or products with those put forward by manufacturers. These laboratories should be public so as to not come under commercial pressure. A small part of modernisation program funds could be put aside for this purpose. From our experience creating independent irrigation testing laboratories is a cost effective water saving initiative, provided they are closely associated to the modernisation program.

These laboratories should have resources to operate tests and integrate an international network for benchmarking. That's what INITL[4] is attempting through cross testing, information, samples and methodologies exchanges (INITL, 2005).

As most irrigation products are manufactured from imported plastics, manufacturers should create their own quality insurance processes to verify the characteristics and quality of compounds they will use in their manufacturing processes. The implementation cost of such verification laboratories requires a minimum manufacturing plant size to be effective. It can be externalised provided it is justified by market demand. In Syria in 2002 negotiation between manufacturers and the Damascus Chamber of Commerce was initiated to create a small private laboratory dedicated to plastic material testing. In 2006 without any willingness from the government to operate a quality policy nothing has been made. Though it could certainly contribute to cleaning up the market, reducing the number of manufacturers based on quality and performance criteria, saving considerable amounts of private as well as public money.

Technology transfer and extension activities

Equipment modernisation is generally associated with more complicated operation processes. It requires specific skills that farmers may not possess and technical support that is not often available. By consequence the dealer must offer an extension service role… when selling his equipment. To avoid such distortion, any modernisation policy should associate financial and technical support. The implementation of a technology transfer framework can be successfully managed by a national laboratory in cooperation with local extension services. Technology transfer concerns operation as well as maintenance of modernised systems. If a public support is welcome to help technology transfer, it is the responsibility of the dealer to tell farmers how to maintain their systems, so that a satisfactory level of durability is attained. Appropriate documents have to accompany system delivery, for example, in Morocco subsidies are not attributed if these documents are not provided.

In microirrigation systems, if maintenance is satisfactory, system durability should be more than 10 years. In France the average life duration is often lower than 5 years. The main reason for such poor durability is bad filtration characteristics and incorrect maintenance which lead to partial clogging of drippers. When the farmer is not aware of the deterioration of system distribution performance, observing locally plants showing evidence of scarcity, he will consider application to be insufficient and increase irrigation duration. In Tunisia, Mailhol et al. (2005) measured water efficiency under 3-years old dripper systems and discovered that 50% of them were less efficient than some traditional surface systems! A long term reference study conducted in South Africa (Reinders et al., 2003) showed that after 2 years of operation of 42 farm microirrigation systems, the average flowrate CV passed from 3.1% (2.1 to 4.2%) to 8.2% (2.7 to 22.2%). 67% of pressure regulating drippers and 42% of non regulating were considered clogged (i.e. flowrate has changed by more than 20%). A training program managed by the national laboratory of ARC in Pretoria that focuses on maintenance processes is underway.

[4] International Network of Irrigation Testing Laboratories, 21 members in 2006 (CENTEC, Australia, Brazil, Canada, China, Egypt, France, India?, Italy, Israel, Japan, Korea?, Mexico, Morocco, Portugal, South Africa, Spain (2labs), Syria?, USA, Zimbabwe.

Figure 5 : Durability of microirrigation systems (3 year old system)

Figure 6 : Manufacturing quality of fittings and riser (2 months old sprinkler)

Appropriateness of modernisation policies

To ensure that options are adapted to local conditions (water quality, reliability of supply, availability of spare parts, farmers skills, farmers financial capacity…), a thorough investigation should be carried out prior to any modernisation of field irrigation systems. The national laboratory is in position to prepare guidelines for modernisation in different contexts. This process has been successfully implemented in Morocco where national laboratory prepared guidelines on minimum design characteristics of field systems with regional extensions engineers. These guidelines are used to check modernisation project consistency technically as well as financially speaking.

If equipment subsidies are applied, the rates must be fitted to the local financial conditions. The objective is to generate a lever effect by a focussed financial incitation in regard of the total costs of irrigation. In France irrigation costs represent approximately 20 % of the total cropping costs, among which 50 to 70 % represent equipment cost for mechanised systems. As a consequence subsidies applied to equipment will incite to renew equipments. Even if it represents a small part of the investment it can have an enhanced effect on the productivity of the system and on water productivity. The degree of incitation will depend on the proportion of the subsidy related to the cost of equipment, the maximum amount per project and the technical rules applied to access the support. In Jordan, successful modernisation in microirrigation has been achieved by providing farmers with a good quality filter, provided the farmer has invested in a new good quality distribution system.

Finally the modernisation policy should be evaluated periodically and revised if required. A set of indicators are needed to evaluate changes in farm performance in terms of water and more generally input productivity, incomes and cost recovery. Indicators ranking will comply with modernisation policy priorities.

The use of actor models (Legrusse, 2001) can be very helpful for identifying gaps in modernisation processes as well as anticipating the consequences of policies decisions at the farm scale, and then at the small region scale in terms of production, productivity, incomes, employment…

Farm products processing and marketing

The priority of the farmer is to assure a minimum level of income for his family and venture. His production strategies are subject to this objective. Small family farms prefer to ensure daily income, while bigger farms will seek credit for investment to obtain higher profits and to meet longer term objectives. Small farms will diversify production to ensure regular incomes (producing milks, poultry, eggs, vegetables for example) while bigger farms will focus on profit making.

Generally the small farms are connected to local markets and not to industrial or exportation networks. Production is usually variable in terms of quality and quantity. These farmers are not organized, are subjected to the constraints and fluctuations of the market and are unable to secure their production process. They may grow some specific crops to access water, for example in Morocco sugar (beet or cane) or milk production give access to water rights (national strategy), part of this water is often diverted to other more cost effective crops. These farmers mostly use traditional surface irrigation techniques. They will convert to modern techniques if they are obliged to, it was observed in Moulouya (Morocco) and in Tunisia for water scarcity reasons, or implementation of quotas.

On the other hand, bigger farm holders or dual activity farmers will specialise production and contract with food processing industry based on quality and quantity requirements. They are committed to implement specific production processes and techniques, including irrigation. Irrigation is considered a prerequisite for access to such markets as it is considered important for quality and production regularity. These farmers will be very receptive to any modernisation program that improves the reliability of their production system and that secures their incomes. By grouping with others, they try to maintain maximum levels of added value of their productions on the farm, storing, sorting, packing and conditioning products as seen in European countries. Modernisation policies should promote such cooperative solutions for groups of farmers based on shared management of equipment.

Cooperative organisation by grouping farmers allows better irrigation and cropping technology transfers, and may contribute to water savings (dissemination of scheduling techniques, deficit irrigation methods…). The WUAs can be a first step in achieving this new form of organisation.

Farmers and water savings

Productivity issues for farmers

In terms of productivity, farmers are primarily focused on land productivity by trying to maximise the gross profit margin per hectare (Montginoul, 2004). Consequently, their priority will be to extend their irrigated surfaces, reallocating water saved through modernisation to new plots. Water productivity is not a priority issue compared to land productivity, except when water becomes scarce or volumes limited. If water price increases, water is considered as an input and managed accordingly on the farm. It will be allocated where cost return is the highest. In both cases scheduling methods are keys for reaching high productivity, it must be part of the modernisation process and water saving will be a secondary achievement.

When farmers develop private pumping they will favour this solution to that of a public network. It is generally more reliable, doesn't require any anticipation (water shifts), and in some (many?) cases, unauthorised pumping is not punished… When water shifts are too long it is the only way to gain access to modernisation, anticipate irrigation scheduling and thus reach higher water productivity. Private pumping is not considered expensive by the farmer when equipment has been already purchased, direct operating costs (energy) will be regarded as the only cost, despite it represents one thirds of irrigation costs on the average (Goossens, 2005). In addition pumping usually provides water of better quality in terms of suspended material, making it easier to filter for microirrigation. When salinity increases in water tables, water from the public supply will be used to mitigate salinity.

Figure 7 : Private pumping for potato production, Doukala, Morocco,

Cost effectiveness of modernisation

Modernisation is generally cost effective during the first years because of production increases for an equivalent amount of water. For example water productivity has been increased by a factor 2 in the Doukala management area for different drip irrigated vegetable crops (Majouj et al. 2004) compared to traditional hand moved sprinkler systems subjected to leakage, sprinkler ageing, worn out, inappropriate spacing, pressure variations, losses due to runoff, drift and evaporation... Long term cost effectiveness will be obtained provided maintenance is correct and the necessity for farmers to achieve cost return has been understood from the beginning.

As mentioned previously to be cost effective a modernisation project must attain a minimum surface scale, this concerns irrigation as well all infrastructure required for products processing, storage, conditioning, transportation... Farmers are often reluctant to group with neighbours to operate equipment in common. Nevertheless, the need for heavy equipment and infrastructure in modern agriculture requires a minimum surface area to decrease its unit cost. For instance, in northern France, vegetable production (potatoes, beans, spinach…) are considered to be cost effective from 100ha… on 500ha minimum for crop rotation needs. Farmers have to group to form CUMAs (Cooperative for shared Use of Agricultural Machines) which provide a solid framework for the management of such associations. Under the same legal framework, there are examples of group of farmers managing a centre pivot, wells or pumping stations. The principle of WUA with extended purpose can apply too.

Last, considering that modernisation is mostly associated to conversion of gravity to pressurised systems the changes in energy cost must be considered carefully. A synthetic table extracted from Goossens (2005) established from various situations in developing as well as developed countries is of interest in cost structure changing perspective. This table associated to actual efficiency of application gives and idea on associated water and energy costs, which are often closely related.

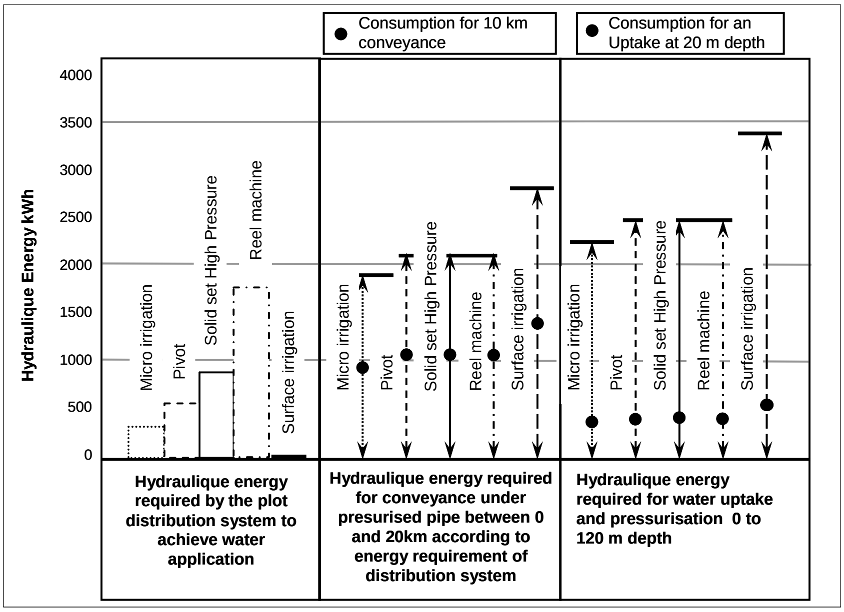

Figure 9: Estimation of energy consumption of irrigation according to water mobilisation (Goossens, 2005)

Efficiency of farmers practices

In modernised areas, farmers still use practices inherited from the past (*e.g.* microirrigation is stopped when water begins to pond). When they observe head losses increase they often: remove the filter cartridge (Figure 10), don't replace it when damaged, are unaware that some drippers cannot be cleaned (Figure 8), and when a part of the plot appears dry, they just increase total plot application… When performance decreases too much, they just keep the pipes and convert to improved basin irrigation (Figure 9). After such failures these farmers are very reluctant to modernise their practices, and in addition, they discourage their neighbours from migrating to more water saving techniques.

This is widely observed, except in the areas where extension services are active. They assure technology transfer, and make transition more efficient. Where no technical support is proposed, the dealer will be the technical reference… even if many are honest and don't take advantage of the situation, they may not be competent, especially in recently modernised areas.

On the other hand farmers usually purchase the cheapest equipment, disregarding its performance and durability. They consider it will always be better than former surface techniques. Very often small farmers don't have the finances to purchase the equipment, even when subsidised. Such a "service" has a price, in Jordan valley the dealer applies a 30 to 50% over costs if he is paid after cropping…

When price competition is very tough, dealers will buy cheaper products. It results in constant changing of makes and models which makes it complicated to find spare parts when required. Dealers should commit to a minimum follow up for spare parts (at least 5 years) to allow consistent maintenance and keep good equipment durability.

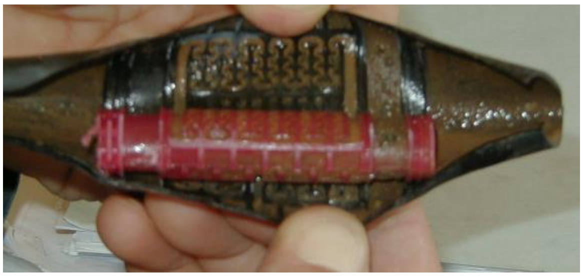

Figure 8 : Particles deposit in a GR dripper

Figure 9 : Nil delta, new lands: Use of microirrigation PE pipe for basin irrigation

Figure 10 : Nil delta, Filter cartridge plugging

Finally, when speaking with farmers in areas under modernisation they prefer a step by step modernisation strategy to allow minds to adapt to the changes involved, instead of a complete overhaul of methods and practices. Farmers appear very conservative especially when they don't understand the process whether it be political or technical in nature. Modernisation policies should also promote improvement of traditional methods and practices waiting for low educated farmers to adapt.

Conclusions

To be effective, modernization of farm irrigation requires a global approach to the problem. The consequences of irrigation system modifications on water consumption and on farm economic performance must be properly assessed. During the planning of the modernisation policy, all stakeholders should be involved. This participative planning has to reserve a prominent place for farmers on whom the success of the process heavily depends. This involvement could be made through a steering committee which will have to work at first on the definition of the modernisation policy framework, and then estimate yearly its consequences for revision purposes.

The points on which the modernisation policy steering committee will have to focus are the following:

- Access to water and water supply: reliability of water supply and access to water are decisive for the farmer when organising his water volume or quota management strategy. The farmer will first try to secure his water resource before optimizing its use. Then he will firstly anticipate modernization of his equipment to optimise water application, secondly, he will think about changing his scheduling practices to increase land and water productivity. Water productivity is not necessarily associated to water saving at farm as well as regional levels. Water saving at the farm scale will benefit other farmers if water use is limited. If not, water saved will be reallocated to other plots.
- Transfer of technology: on a regional basis, the whole technical environment must be improved (farmers, extension staff, dealers) along with modernisation. The dealers often tend to sacrifice equipment quality to decrease prices. To avoid a decline in system performance and durability, a regulation process should be set up to define the minimum technical characteristics of products (parts) and field systems. A standardisation process can meet this requirement, reaching consensus on technical issues through a participative process. The standardisation committee will serve as a reference body for the work of modernisation process steering committee.

Once modernization is underway, its success depends heavily on good technical assistance, at least over the first 2 to 3 years, through frequent visits to farmers and the establishment of farmer managed demonstration sites.

In developing countries, where numerous farmers have limited financial means, the access to subsidies or loans will allow modernization to reach the small holders. The subsidy policy, providing a powerful modernisation policy control mechanism, will have to focus on equity of allocation between the farmers to limit any social risks associated with the industrialization of agriculture.

As the modernization process is long and complex, and involves numerous stakeholders, periodical auditing, managed by a modernisation policy steering committee, is necessary. Modernisation policy efficiency must be questioned and analysed using performance indicators to appreciate:

- The level of modernization development (surfaces concerned, techniques used, regions involved, size of projects, proportion of collective projects…).
- The cost benefit ratio of the modernisation process: cost of cubic meter saved at local and regional scales, evolution of water productivity, evolution of the volumes applied per hectare… including negative effects on water management areas and water distribution equity.
- The equity of modernization and its social impact: size and number of farms concerned, impacts on employment on local and regional scale, average farm income…

Numerous works on this subject should be adapted for awareness campaigns and used for regional analysis of irrigation modernisation stakes. It is one of the objectives of the Wademed European program and of the Sirma[5] program supported by the French government (2003-2007).

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