International Water Management Institute

# APPIA - IPIA

Amélioration des Périmètres Irrigués en Afrique
Improving Irrigation Performance in Africa

# Synthesis paper on irrigation performance in Kenya and lessons learn from the ten IPIA pilots irrigation schemes

**May 2005**

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RÉPUBLIQUE FRANÇAISE

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## Introduction and problems statement

### Resources and uses of water in Kenya

Kenya is doubly poor in water. It is physically poor in water with 80% of its territory in arid or semi-arid areas. Kenya is also economically poor in water because its financial capacity does not make it possible to carry out the investments necessary to mobilize the water resources which are not directly and easily workable. The following table indicates the key figures of water resources and abstraction in Kenya. These figures are put into perspective with those of Morocco, country which has carried out considerable investments in its water resources in a climatic, historical, political and economic context that does not compare to Kenya.

*Tableau : Water resources and abstraction in Kenya and Morocco (source FAO, AQUASTAT 2003)*

| | **Kenya** | **Morocco** |
|---|---|---|
| Landmass | 58 037 $Km^2$ | 44 655 $Km^2$ |
| Population | 34,2 millions | 31 millions |
| **Renewable water resources** | | |
| Average annual rainfall | 630 mm/year<br>366,000 $.10^6$m3/year | 346 mm/year<br>154 ,000 $.10^6$ $m^3$/year |
| Internal renewable natural water resources (1)<br>(% rainfall) | 20,700. $10^6$ $m^3$/year<br>(5, 7%) | 29,000. $10^6$ $m^3$/year<br>(18, 8%) |
| Total renewable water resources (2) | 30,700 $.10^6$ $m^3$/year | 29,000 $.10^6$ $m^3$/year |
| Renewable water resources per inhabitant | 897 $m^3$/year | 935 $m^3$/year |
| Total dam capacity | 4, 079 $.10^6$ $m^3$ | 16,091 $.10^6$ $m^3$ |
| **Water withdrawals** | | |
| Total | 2 ,735 $.10^6$ $m^3$/year | 12 ,607 $.10^6$ $m^3$/year |
| - Agriculture<br>(% total) | 2, 165 $.10^6$ $m^3$/year<br>(79 %) | 11,010 $.10^6$ $m^3$/year<br>(87 %) |
| - Domestic<br>(% total) | 470. $10^6$ $m^3$/year<br>(17 %) | 1 237. $10^6$ $m^3$/year<br>(10 %) |
| - Industries<br>(% total) | 100 $.10^6$ $m^3$/year<br>(4 %) | 360 $.10^6$ $m^3$/year<br>(3%) |
| - Per inhabitant | 87 $m^3$/year | 433 $m^3$/year |
| - % Internal renewable natural water resources | 13% | 44 % |

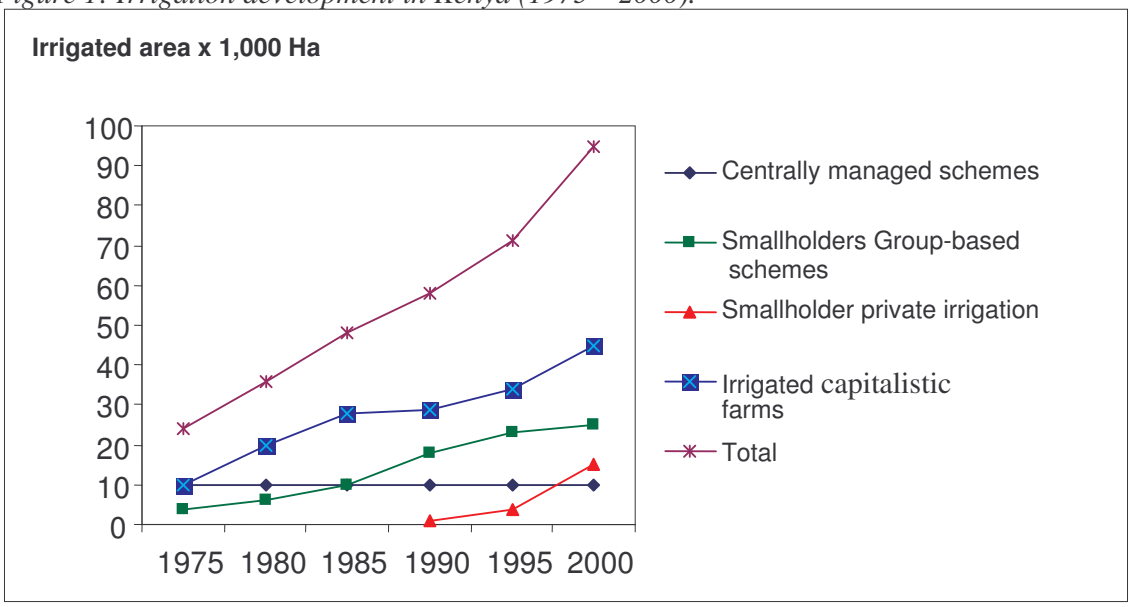
(1) Internal renewable natural water resources: Average annual volume of water conveyed in rivers(14,000 $.10^6$ $m^3$/year in Kenya) plus underground water recharge from rainfalls (6,700 $.10^6$$m^3$/year in Kenya).
(2) Total renewable water resources include transfers from neighbouring countries; for Kenya it is only the supply of water to Lake Turkana from Ethiopia.

**Irrigation development**

To face the challenge of food safety and food self-sufficiency, Kenya has made, as soon as the colonial period and above all after independence, considerable investments in irrigated agriculture. Since the end of the 1980s, the irrigation sector has been undergoing radical change: privatization of the marketing chains, irrigation management transfers to farmers, adoption of a total cost recovery policy, emergence of environmental concerns. During the same period of time, donors' support to irrigation development has been decreasing; the reasons mentioned by donors are low irrigation performance and poor sustainability of irrigation schemes.

Currently irrigation development is led by the private sector: smallholders who supply mainly the national market in fruits and vegetables and investors who export horticulture products to the European Union. Kenya has thus become since 1999 the first flower exporter to the European Union. The size and the purchasing power of the population of Nairobi and other main cities, the availability of low cost pumping systems (small motor pumps imported from Asia, treadle pumps) and last but not least, the will and adaptation capacity of Kenyan farmers are the main factors of the vigorous development of smallholder private irrigation primarily located in Mt Kenya area and Western Kenya.

*Figure 1: Irrigation development in Kenya (1975 – 2000).*




*Source: Ministry of Water & Irrigation (2000)*

The irrigation potential largely remains under used: approximately 100,000 Ha are currently irrigated i.e. only 20% of the potential estimated at 500,000 Ha. The smallholder private irrigation, which uses small pumps, only develops the areas near the easily usable water resources. A significant increase in the use of the irrigation potential implies new forms of public investments within the framework of an irrigation policy taking account of the current dynamics of development.

*Table 2: Irrigation typology in Kenya (as established for the APPIA-IPIA project).*

| | **Smallholders group-based schemes** | **Smallholders private irrigation** | **Centrally managed schemes** | **Irrigated capitalistic farms.** |
|---|---|---|---|---|
| **Total area** | 27,000 Ha | 15,000 Ha (rapidly increasing) | 10,000 Ha | 43,000 Ha |
| **Average scheme area** | 10 - 1 000 Ha (Number: 2 500) | 0,1 – 1 Ha | 900 – 6 000 Ha | 4 – 1 000 Ha |
| **Historical background** | Government led development in the 70's and 80's | Rapidly developing since the 90's | Development policy started after independence: taking over of colonial schemes and construction. | Rapidly developing since the 90's |
| **Source of funds** | Government (or NGOs) | Farmers | Government | Kenyan and foreign investors |
| **Operation & maintenance** | Water Users Associations or Water undertakers | Farmers | Public agencies i.e. National Irrigation Board, undergoing irrigation management transfer with difficulties. | Waged work force. |
| **Water abstraction and conveyance** | Stream diversion or pump<br>Open canals, in a few cases sprinkler irrigation. | Motor pump, treadle pump or bucket water abstraction. | Stream diversion or pump<br>Open canals water distribution. | Motor pump<br>Drip or sprinkler irrigation. |

In group-based irrigation schemes and centrally managed schemes where the process of irrigation management transfer has started, water users have to make the difficult apprenticeship of irrigation self-management. Irrigation management skills remain quite far away from current farmers' capacities, in particular for operation and maintenance of pumping systems and canals, distribution of water, management of the O&M fee.
The government of Kenya is currently preparing a policy for revitalizing irrigation development that it regards as the most effective solution to increase agriculture productivity and farmers' income. The effective and sustainable management of irrigation schemes and the productivity of irrigated agriculture are therefore major challenges to be primarily addressed by irrigating farmers.

Aware of the government of Kenya concern, the French government offered Kenya to participate to the APPIA-IPIA project, a project implemented in 7 African countries[1]. APPIA-IPIA objective is producing and disseminating information methods for improving irrigation performance. Among its activities, the project organized training in action to rapid participative performance assessment and action planning of ten selected irrigation schemes in Kenya.

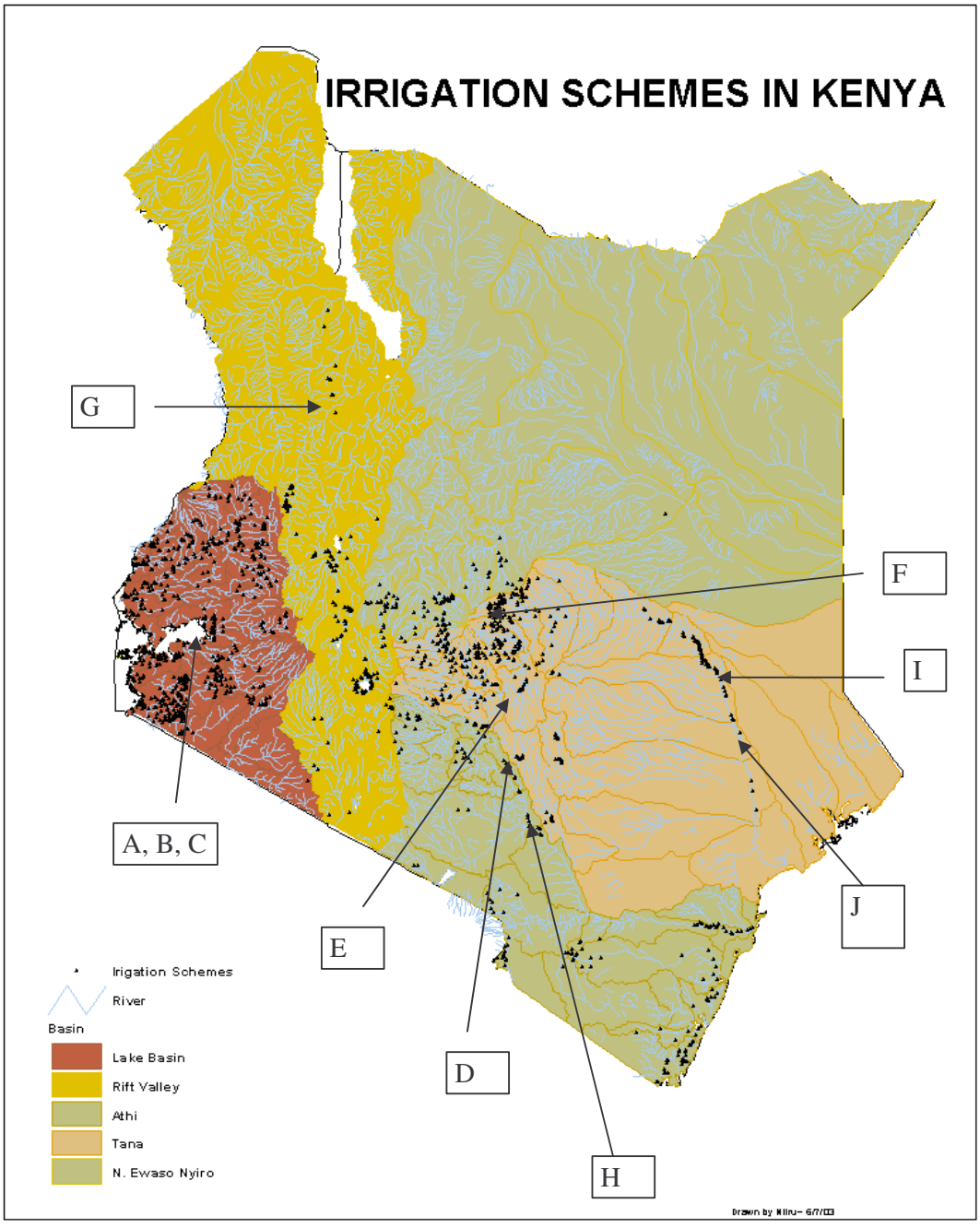
[1]Ethiopia and Kenya in East Africa, Burkina Faso, Mali, Mauritania, Niger and Senegal in West Africa.

The selection of these ten schemes was based on the irrigation typology as well as the location of the irrigated areas (see map on page 7). This activity made it possible to gather first hand information about the irrigation sector in Kenya. This note presents the principal lessons learnt in three points: water management, maintenance of irrigation schemes and productivity of irrigated agriculture.

*Table3: List of selected irrigation schemes*

| **Centrally managed schemes** | **Group-based schemes with a water undertaker** | **Group-based schemes with a water users association.** | **Cluster of individual private schemes** |
|---|---|---|---|
| Mwea (6,000 Ha)<br>Rice | Yatta furrow (900 Ha)<br>horticulture | Hewani (27 Ha)<br>Rice | Naromoru cluster<br>Horticulture |
| West Kano (900 Ha)<br>Rice | South West Kano (825 Ha)<br>Rice | Kibirigwi (110 Ha)<br>Horticulture / sprinklers | Awach cluster<br>Horticulture |
| | | Qahira (32 Ha)<br>horticulture | |
| | | Nakwamoru<br>Food crops | |

A- Awach, B- West Kano, C- South west Kano, D-Mwea, E-Kibirigwi, F-Naromoru, G-Nakwamoru, H-Yatta, I- Qahira, J-Hewani



## 1. Water management

The main objective of water management is the satisfaction of crops irrigation water requirements to increase and secure agricultural production. Water management is here approached according to three key issues. Firstly the technical design of irrigation schemes and the constraints that it implies for the users, secondly the amount of water used in relation to water requirement and the equity of water distribution taken as indicators of the capacity the organization in charge of irrigation management, and finally on-farm water management by individual farmers.

**Design of irrigation schemes implies constraints for the water users**

Scheme water supply (in l/s/Ha) as per design is the nominal discharge at intake (or of the pump) per unit of design command area. It is compared with peak irrigation water requirement expressed as the discharge that would meet irrigation water requirement if it was applied 24h/24h. Peak irrigation water requirement is calculated from the most demanding climatic condition (ET0 – P) as indicated by the services of the Ministry of Water and Irrigation or the National Irrigation Board, the cropping calendar as per design, and assuming irrigation efficiency is 50%. The ratio between scheme water supply and peak irrigation water requirement gives the theoretical daily duration of irrigation as imposed by the technical design to satisfy irrigation water requirement in the peak period.

*Table 4: Scheme water supply, peak irrigation water requirement and daily duration of irrigation of rice schemes*

| Schemes | Mwea | West Kano | South West Kano | Hewani |
|---|---|---|---|---|
| Peak irrigation water requirement | 1,4 l/s/Ha | 1,9 l/s/Ha | 1,2 l/s/Ha | 2,1 l/s/Ha |
| Command area | 6,000 Ha | 900 Ha | 825 Ha | 27 Ha |
| Discharge capacity at intake as per design | 10.000 l/s | 1660 l/s | 3000 l/s | 150 l/s |
| Scheme water supply | 1.7 l/s/Ha | 1,8 l/s/Ha | 3,6 l/s/Ha | 5.6 l/s/Ha |
| Theoretical daily irrigation duration in peak period | 20 h | 25 h | 8 h | 9 h |

*Table 5: Scheme water supply, peak irrigation water requirement and daily duration of irrigation of horticulture schemes*

| Schemes | Yatta furrow | Nakwamoru | Qahira | Kibirigwi |
|---|---|---|---|---|
| Peak irrigation water requirement | 1.4 | 2,1 l/s/Ha | 1,6 l/s/Ha | 1,2 l/s/Ha |
| Command area | 900 | 113 Ha | 32 Ha | 110 Ha |
| Discharge capacity at intake as per design | 1130 l/s | 668 l/s | 64 l/s | 150 l/s |
| Scheme water supply | 1.3 l/s/Ha | 5,9 l/s/Ha | 2 l/s/Ha | 1,4 l/s/Ha |
| Theoretical daily irrigation duration in peak period | 24 h | 8 h30 | 19 h | 21 h |

On several schemes, it is necessary to irrigate at night to satisfy the crops water needs in the peak period. This constraint is higher:

- On the horticulture schemes than rice schemes where plot irrigation simply consists in filling a basin.
- On pump-fed schemes (West Kano and Qahira) where crops may suffer of water stress in the event of pump break down.

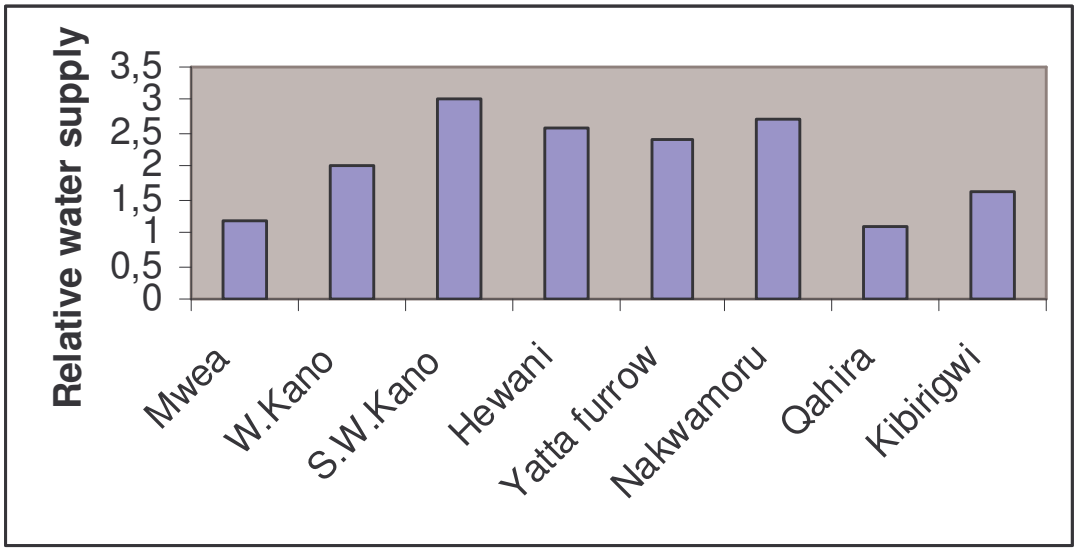
In South West Kano, the high scheme water supply is due to the possibility of future extension of the command area that was taken into account at design stage.

In addition and according to the Ministry of Water and Irrigation, cost of irrigation development varies between 100,000 and 150,000 Ksh /Ha, i.e. 1,300 and 2,000 US dollars/Ha at the current exchange rate. This is much lower than irrigation costs in West Africa: approximately 10,000 dollars/Ha. It seems that Kenya followed a policy aiming to maximize irrigated area within the available budget. Poor water control and distribution structures are often the consequence. Irrigation canals are earthen even where the nature of the soils would fully justify lined canals. This involves constraints for water users as irrigation technology and design has a strong influence on schemes manageability.

**Satisfaction of irrigation water requirement at scheme level and equity of water distribution.**

The relative water supply is defined as the ratio between water supply and demand. This indicator developed by IWMI gives information on abundance or scarcity in irrigation water and on the adequacy between water supply and demand. The data collected at the time of the rapid diagnoses make it possible to estimate the relative water supply for the peak period only. This estimation is based on crop water requirement, the cropped area in peak period and the discharge measured at intake. The last two parameters can largely differ from the initial design.

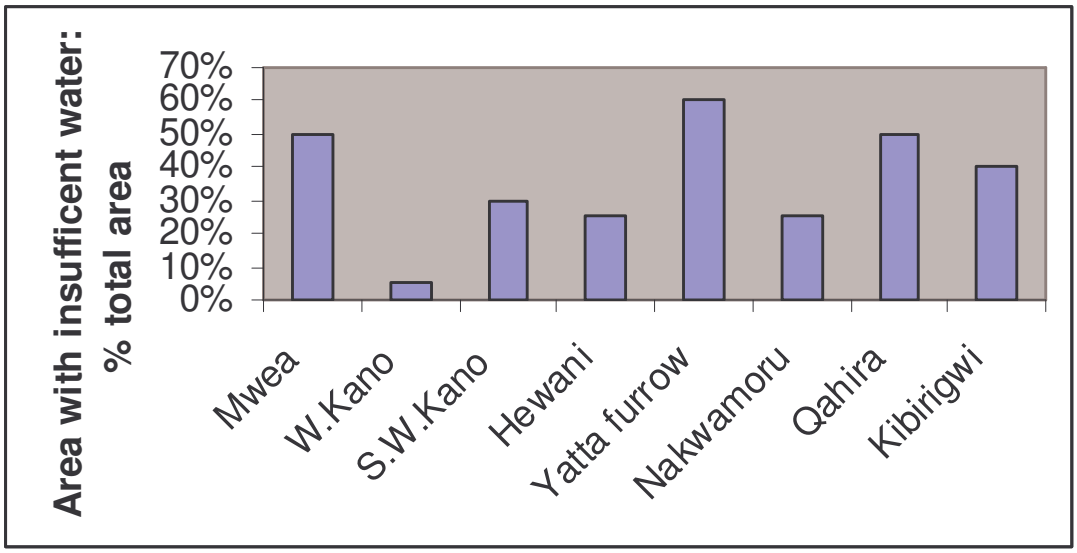
*Figure 2: Relative water supply of the selected schemes in the peak period.*



According to IWMI, benchmark values for the Relative Water Supply are respectively 2 for open canals irrigation schemes and 1.3 for sprinkler irrigation as in Kibirigwi. In West Kano, Hewani, Yatta Furrow, Nakwamoru and Kibirigwi, according to IWMI benchmarks, water consumption is high without being unreasonably excessive. Water supply can satisfy crop water needs of the peak period and therefore, a priori, in all the seasons.
In South West Kano where the Relative Water Supply is high, downstream water users irrigate their rice fields from the scheme drainage ditches therefore recommending a lower Relative Water Supply is probably not wise.
In Qahira, the pump discharge capacity is too low for the irrigated area, and water deficit is approximately 50%.
In Mwea irrigation water sources are the Nyamindi and Thiba rivers which flow from the Mount Kenya watershed. According to NIB engineers the flow of these rivers became more erratic due to deforestation of the slopes of Mount Kenya. The intake work no longer makes it possible to supply the scheme with sufficient water for the critical periods in January – February and September - October. Possible solutions are the construction of dams upstream to control rivers flow and/or construction of water reservoirs within the scheme. In addition irrigated area has been quickly increasing in the upper part of the watershed without real control by the Government authorities. Increase of irrigated acreage and water abstraction were not recorded for comparison with the available water resource. Conflicts between Mwea farmers and water users upstream seem inevitable if the Government pursues its "business as usual" policy or does not make investments aiming to increase the water resource.

Adequacy between water supply and demand at scheme level in South West Kano, Hewani, Yatta Furrow, Nakwamoru and Kibirigwi is not found at plot level. This indicates a poor water distribution within the scheme mainly due to unclear or badly complied rules for water distribution and/or poor maintenance. In West Kano, NIB staff closely supervises water distribution, this certainly explains the good equity.

*Figure 3: Insufficient water supply at plot level*



**On-farm water management**

In every scheme and at various degrees, the rapid diagnosis indicate water losses and wastages at plot level because of over-irrigation, excessive irrigation at too long intervals leading to percolation losses and poor land levelling. These difficulties have often negative effects on agricultural yields. Because of absence of sanction for non-observance of by-laws when they exist and insecure water access (insufficient resource, lack of equity, breakdown of pumps…), many farmers tend to irrigate their plots with as much water as possible when water is available, without considering actual crops water needs. This is a typical practice that is found in a large number of irrigation schemes worldwide.

**In conclusion**

WUAs' difficulties in managing irrigation are partially due to the irrigation scheme initial design which gives priority to low cost of irrigation development (i.e. five times less that in West Africa) over more flexible and potentially more performing irrigation schemes. This constraint combines with poor capacities within WUAs for managing and monitoring water distribution. The IPIA project has therefore identified possible solutions to improve irrigation water management.

A preliminary to efficient and sound water management is the establishment of clear **rules and clear sanctions acceptable by farmers** for effective application. On the majority of selected schemes, redefining and strictly enforcing by-laws is a necessity.

**The definition of water distribution schedules** based on simple straight forward assessment of crops water requirements should improve water management, increase equity and crops yields. Installing water measurement check structures would enable to better monitor water distribution.

**Improving of on-farm water management** is crucial to avoid water losses and wastages. IPIA interventions will cover the adoption of demonstration plots and training of farmers on good irrigation practices.

In irrigation canals, only water losses through seepage are unavoidable as long as canals are not lined. A considerable amount of water would be saved by **a better monitoring of water distribution** to limit water losses through over-toping and canal breakages.

## 2. Maintenance and irrigation schemes sustainability

Sustainability of irrigation schemes is closely linked to maintenance activities and provisions made for renewal of equipment. Operation & maintenance fee and farmers' participation to maintenance work are therefore key issues in current and future operation of irrigation schemes. Rapid diagnosis outcomes are here presented according to the type of organization in charge of maintenance.

**On small group-based schemes, capacity of WUAs for self management of irrigation is variable, but a insufficient maintenance has to be noted**

*Table : O & M fee management on small group-based schemes*

| | Qahira | Kibirigwi | Nakwamoru | Hewani |
|---|---|---|---|---|
| Type of organization | Water Users Association | | Vague informal committee | |
| First year operational | 1992 | 1977 | 1971 | 1984 |
| Initial design command area | 32 Ha | 110 Ha | 113 Ha | 27 Ha |
| Current irrigated area | 32 Ha | 140 Ha | 102 Ha | 27 ha |
| N° of farmers | 40 | 390 | 255 | 67 |
| Average plot size | 0,8 Ha | 0,4 Ha | 0,4 Ha | 0,4 |
| O & M fee / Ha/ year | 3000 Ksh | 3000 Ksh | 250 Ksh | 0 |
| Recovery rate | 100% | 60% | 45% | - |

Qahira and Kibirigwi WUAs are capable to guarantee some level of sustainability by mobilizing farmers for maintenance work and by collecting an O &M fee.

In Qahira, farmers' mobilization for maintenance work is good and canals are well maintained. On the other hand, the irrigation fee covers mainly the running costs of the pump; cash provision made for its renewal is definitely insufficient. It is a major threat on the sustainability of the scheme. More generally, in Kenya, the majority of the group-based pump-fed irrigation schemes are abandoned when the pumps reaches the end of its working life.

Kibirigwi has a gravity-fed pressurized water distribution system with sprinkler plot irrigation. The initial scheme investment cost was 12.6 million Shillings, i.e. 114,500 shillings per hectare (110 Ha). According to usually admitted standards[2] the annual maintenance costs of this type of irrigation system are estimated at 2% of the initial investment cost. Applied to Kibirigwi, the maintenance costs would amount to 2,300 Ksh per hectare. The current amount of the O & M fee is therefore satisfactory and even with a recovery rate of 60%, maintenance deficit would be only 20% of theoretical cost. According to field observations the general state of the irrigation system is good after 30 years of operation although some parts (valves, pressure regulators) and pipes need replacement. It is also worth mentioning that local craftsmen manufacture sprinklers for sales to farmers. Extension of irrigated area and multiplication of illegal connections on the irrigation network has significantly increased the risk of insufficient water supply. So far the WUA has been unable to stop this phenomenon. Scheme sustainability could be threatened if more and more farmers get insufficient water and therefore become reluctant to pay the O & M fee.

[2] Source: International Commission for Irrigation and Drainage

In Nakwamoru and Hewani the main share of the maintenance work has been so far been carried out by external organizations: the Catholic Mission of Nakwamoru for a symbolic fee actually paid by less than 50% of the farmers and in Hewani by TARDA free of charge. The programmed departure of the Catholic Mission and very likely to happen end of TARDA support leave little time for establishing on both schemes WUAs having a minimum of autonomy and capacity.

**In schemes with a Water Undertaker: Yatta Furrow and South West Kano, sustainability is quite poor.**

The Water Undertaker is the organization in charge of O & M of the main irrigation infrastructure. In Yatta furrow, the Water Undertaker is the Ministry of Water and Irrigation while it is a NGO in South West Kano. The absence of consultation with farmers and of strong association capable to represent them for negotiating the terms of contract for the service of the Water Undertaker has compromised the sustainability of both schemes.

**Case of Yatta Furrow.**

The 60 km long main canal of Yatta furrow was built in 1959 by the colonial government to irrigate the meadows of the Yatta plateau. Currently the canal is used for irrigation and serves a command area of 900 Ha, it also provides water for the town of Matuu.

After independence, the Ministry of Water and Irrigation took over the role the colonial government by providing the functions of water undertaker without consulting the community. The state of the canal has been continuously deteriorating due to insufficient maintenance and despite several rehabilitation works. The Ministry of Water and Irrigation is trying to operate a management transfer and, at its own initiative, a WUA has been recently established. This association is far from being operational and one may say it exists only on paper. Farmers seem quite reluctant to take in charge the tasks that have been provided by the Government since the construction of the canal. Operation and maintenance of irrigation schemes along the main canal is done by farmers organized in informal groups.

Currently, out of the 900 Ha irrigation command area, approximately 200 Ha at the tail of the scheme are completely abandoned and an additional 100 Ha do not bear crops in the dry season. On the other hand, in the upstream part of the scheme, the number of water users and the cropped areas has increased and illegal intakes were installed on the main canals creating conflicts amongst water users.

There is strong disproportion between the costs in cash and labour that involve the maintenance of a 60 Km long canal and the irrigated areas. Under these conditions the future distribution of tasks and responsibilities between the Government and the WUA will have to be clearly defined and applicable.

***Case of South West Kano***

This 825 Ha scheme started operation in 1993. Its water source is the Nyando River that carries a large amount of sediment. As soon as operation started, problems of sedimentation at intake and in the main canal occurred. In 1993, at the initiative of the Ministry of agriculture, a NGO "Smallholder Irrigation Support Organisation, (SISO)", was hastily established as

soon as 1993 to deal with operation and maintenance of the intake and main canal. SISO's responsibilities were:

- Water management and maintenance of the intake and main canal (length 4.5 Km)
- Ensuring equitable distribution of water between secondary canals
- Collecting the O & M fee to cover total cost of service provided

Water management and maintenance within the 19 secondary blocks remained of the farmers' responsibility.

SISO has never been able to collect the O & M fee and as a consequence the main canal was never properly maintained and its capacity declined over the years. Currently discharge capacity at head work is 900 l/s instead of 3,000 l/s as per design. During IPIA rapid diagnosis the cultivated area was 320 Ha out of the 825 ha command area.

SISO is no longer present in South West Kano but still claims for arrears of payment to the farmers. At the initiative of the Provincial Irrigation Unit, 19 WUAs (one for each secondary block) and an umbrella WUA has taken up SISO's functions. These associations are not operational: maintenance work is limited to manually removing vegetation in the canals leaving the sedimentation problem intact. Scheme sustainability depends primarily upon the capacity of the WUAs to mobilize farmers for collective maintenance work and/or to collect a sufficient O & M fee to pass on contract with a contractor that would clean the main canal. This condition being far from being met, the situation will continue deteriorating in the coming years if no change occurs.

**Collapse of centrally managed schemes of Mwea and West Kano was avoided but the situation remains fragile.**

Since its creation a Parliament act in 1967 and until 1998, the NIB has controlled the whole production process and the marketing of irrigated rice on these large schemes and the role of farmers was reduced to supplying labour.

As from the 1980s, pushed by economic and political reform winds, farmers demanded a greater say on irrigation management. The inflexible attitude of the NIB had only increased farmers' anger. In 1998, Mwea farmers revolted by refusing to deliver their paddy to the NIB considering the price offered by the NIB were far too low. As a result of Mwea events and the financial crisis that they caused, the NIB system collapsed.

In Mwea and West Kano, the NIB and the farming community eventually reached an agreement making it possible to start again operation of the schemes on new basis. The NIB ensures now the role of "Water undertaker" for operation and maintenance of the main infrastructure, while farmers and their organizations deal with all other functions related to production, marketing, and operation and maintenance within irrigation blocks.
In both schemes, the level of the O & M fee was the subject of negotiations between the NIB and the WUAs on the basis of the real costs of the services rendered by the NIB. This fee only deals with the direct maintenance costs: operation costs of machinery, wages of staff directly assigned to O & M and pumping running costs in West Kano. Therefore no provision is made to renew equipments (machines, pumps). Most of these equipments are ageing and should be replaced at short or medium term. Farmers have probably good reasons to believe that they have already paid for them in the previous period. The O & M fee is 5,000 Ksh/Ha/an in

Mwea, 9,100 Ksh/Ha/an in West Kano. The recovery rate in 2005 is close to 100% in both schemes.

The recent developments made it possible to avoid the abandon of these schemes but the current situation is probably only a stage in the process of irrigation management transfer. In Mwea, farmers wish in the long term to be fully in charge of irrigation management. In any case some capital injection in the next few years is necessary to guarantee the durability of the schemes. The 1967 Parliament Act defining NIB attributions is still in force even if it is no longer applied. It should therefore logically be revised or abrogated.

**In conclusion**

Maintenance, renewal of equipment and repair of irrigation infrastructures are major issues that are not properly addressed currently. On the long term they are a crucial condition of irrigation sustainability. Rapid diagnosis show for all schemes a maintenance deficit, the absence of provisions for renewal of equipment, difficulties of recovering O & M fee; even if on the majority of studied schemes, the current performance would enable farmers to bear fully the irrigation costs. The IPIA project developed tools and methods which will be tested on the ten pilot sites:

Development by Water users themselves of **maintenance plans** including their cost estimation in cash and labour. This is preliminary necessity for increasing irrigation sustainability.

Studying alternative options to maintenance work based on farmers' labour only which raises the problem of poor farmers' participation and bad quality of maintenance work. Possible alternative options are for example **payment for maintenance work,** or recourse to external labour force with invoicing in the O & M fee. Public or private organizations could supervise or control maintenance work.

## 3. Productivity of irrigated agriculture

The productivity of irrigated agriculture was analyzed in terms of crops yields, land productivity (gross margin/ Ha) and labour productivity for the two main cropping systems: horticulture and rice growing. The economic data and calculations were based on the information collected during the rapid diagnosis. However field data collection was cross checked between schemes and with data available in literature.

**The average crop yields indicate low input intensive agricultural practices except in centrally managed rice schemes.**

Horticultural yields are in general much lower than FAO benchmark for East Africa. Poor yields are first due to low inputs use (improved seeds, fertilizers, pesticides) which is explained by farmers low financial capacity and lack of access to credit, the risks related to access to water (insufficient resource, lack of equity) and the commercial risks. These factors often combine themselves and there is a high variation of yields between farmers. The variation is more important between farmers in one scheme than between schemes.

*Table 7 : Yields of main crops in horticulture schemes (t/Ha)*

| Schemes | Sweet potatoes | French beans | Kale | Cabbage | Tomatoes | Onions | Snow peas | Bananas |
|---|---|---|---|---|---|---|---|---|
| Kibirigwi | 11 | 6 | 11,3 | | | 11,1 | | |
| Qahira | | | | | 10 | | | 12 (per year) |
| Awach | | | 7 | | 5,2 | 8,3 | | |
| Naromoru | | | 7,1 | 14 | 7,5 | | 5 | |
| **FAO benchmark** | **15** | **9** | **25** | **25** | **30** | **25** | **8** | **40** (per year) |

On rice schemes, yields at Mwea centrally managed irrigation scheme are more or less 5 t/Ha of paddy rice; this is quite satisfactory for basmati rice. Yields are significantly lower in West Kano (3 t/Ha) and particularly Hewani (2 t/Ha) for a local cultivar which potential is 5 to 6 t/Ha.

In Mwea, farmers have a long experience of irrigated rice growing, a reasonably good access to credit through Saving and Credit Cooperative and furthermore they have beneficiated in the past of efficient extension service provided by NIB.

**Irrigated horticulture significantly alleviates rural poverty, but farmers' labour productivity remains quite low.**

On the 6 studied horticulture schemes, gross margins (not including labour remuneration and infrastructure economic depreciation are on average between 90,000 and 155,000 Ksh per Ha. The variability of yields between farmers is also found in the gross margins; for example gross margin of the best farmers in Kibirigwi is about 200,000 Ksh/Ha. Although yields are rather low, irrigated horticulture remains attractive for farmers if it is compared to rain-fed alternative option like maize where gross margins are about 40,000 Ksh/Ha.

Labour demand for irrigated horticulture is approximately 800 man-days/Ha[3], 1,200 man-days per Ha for farmers using treadle pumps and a farming family of four workers cannot cultivate more than 0.25 Ha without hiring casual waged workers. On this basis, the labour productivity varies between 110 Ksh per man-day (Nakwamoru, treadle pumps) and 200 Ksh per man-day (Kibirigwi) on average; it is about 250 Ksh/man-day for the most productive farmers of Kibirigwi. These figures can be compared with the opportunity cost of unskilled labour: 80 to 100 Ksh per day according to districts and to labour productivity for rain-fed maize: 250 Ksh/man-day assuming 160 man-days to cultivate 1 Ha of maize in entirely manual cultivation. Capacity of Kenyan farmers for working very hard is certainly the first reason for the rapid development of irrigated horticulture.

*Figure 4: Average gross margins of irrigated horticulture*

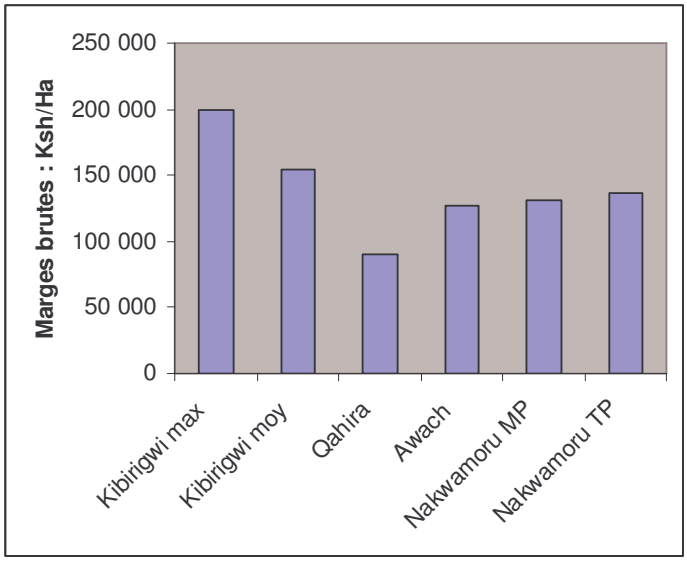
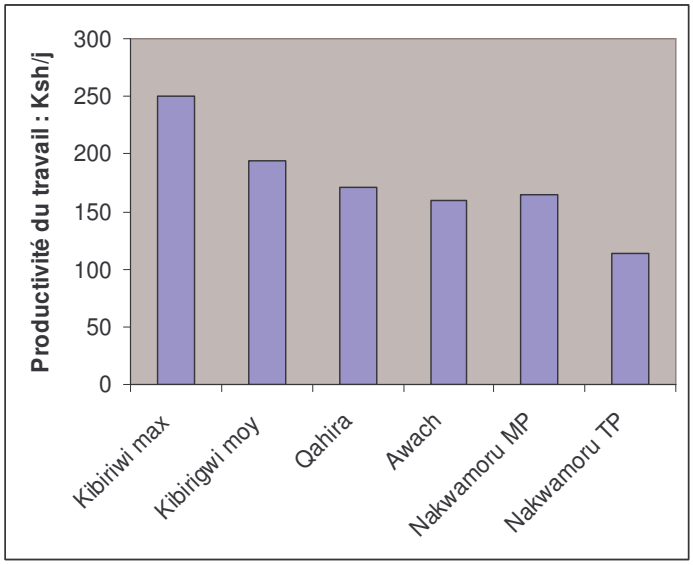



*Figure 5: Average labour productivity of irrigated horticulture*




[3]250 man-days per Ha and per year for bananas in Qahira. year for the banana trees to Qahira

**The case of Mwea shows that irrigated rice can prove to be productive in terms of farmers' income and labour productivity.**

Irrigated rice contributes obviously to food self-sufficiency. In Mwea, the gross margins/ Ha and labour productivity are twice higher than the alternative rain-fed maize, the main food crop in Kenya. Single rice cropping is the norm, but NIB research station tries out new crops (Soya, French beans "green grams") which would make it possible filling in more the agricultural calendar and increasing farmers' incomes. The NIB also implements tests of a new rice cultivar ("NERICA [4]") less demanding in water and which could enable managing better water scarcity and shortages. In Mwea many farmers do " a ratoon crop" which gives a second harvest of rice of about 2t/Ha not taken into account in table 8 below.

Rice productivity is definitely lower in South-West Kano and especially in Hewani. In this latest scheme, irrigated rice is competing with food aid distribution. On both of these schemes, farmers did not benefit from a sufficient extension support and/or haven't gained enough experience yet to implement the technical and organizational change that require irrigation management.

*Table 8 : Rice productivity*

| Irrigation schemes | Mwea | S.W. Kano | Hewani |
|---|---|---|---|
| Average farmer's plot size | 1,2 | 0,4 | 0,4 |
| Yield of paddy rice : t/Ha | 5 | 3,5 | 2 |
| Farm gate price of paddy Ksh/t | 26 000 | 20 000 | 22 000 |
| Value of production Ksh | 130 000 | 28 000 | 17 600 |
| Inputs: Ksh | 20 400 | 3 700 | 1 400 |
| O & M fee Ksh | 6 000 | 0 | 0 |
| Gross margin per farmer: Ksh | 103 600 | 24 600 | 16 200 |
| Gross margin/Ha: Ksh | 86 633 | 61 500 | 40 500 |
| Tractor land preparation: Ksh/Ha (man-day/Ha) | 7 500 (1) | 0 | 0 |
| Casual waged labour Ksh/Ha (man-day/Ha) | 3 000 (30) | N.A | N.A |
| Farming family labour: man-day/Ha | 150 | N.A | N.A |
| Total labour: man-day/Ha | 181 | N.A | N.A |
| Labour productivity: man-day/Ha | 479 | N.A | N.A |

**Marketing of horticulture products**

Alike in many parts of the world, Kenyan farmers complain about middlemen underpaying their products. However IPIA diagnoses indicate that farm gate prices of horticulture products have little variation between schemes and between farmers of one scheme; the number of middlemen seem to be sufficient for competition amongst themselves. The principal problem with contracts between brokers and farmers seem to be the lack of reliability of both parts. When the approved price is temporarily lower than the market price, farmers seek to sell to other purchasers than their contractor. Reciprocally there are cases of partial payment or even non payment of products by brokers.

The national market for horticulture products does not give any sign of saturation. No prospective market studies have been done to tell whether or not there is a risk of prices

[4]NERICA: New Rice cultivar for Africa

collapse if the horticulture development pursues its development in the next few years at the same rate as presently.
The horticultural export sector to the European Union is dominated about ten firms, which control approximately 85% of the market. In response to the ever-increasing E.U demand as regards traceability, products sanitary quality, maximum pesticide residues and others, the export firms tend to develop their own farms to the detriment of the small producers (or out growers). For the latter, the alternative option may be constituting groups of 30 to 50 farmers able to pass –on, with the exporters, contracts covering the quantity, quality and production planning of products.

**Conclusion**

The crucial issue of rural credit enabling farmers to increase agricultural inputs use should come within the framework of the National Irrigation of Agriculture Policy. At its lower level the IPIA project will test, with farmers and extension staff, solutions to increase cops yields as for example on-farm multiplication of improved seeds, increasing organic manure utilization and composting.

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Training and follow-up activities dealing with **farm financial management** and limiting market risk will aim providing farmers' guidance in terms of crop selection, planning of production, inputs use.

Improving cropping techniques through training and establishment of demonstration sites would also contribute to increasing irrigation productivity and farmers 'income.

## General conclusion

- **Summary of the present situation**

Currently, irrigation development is led by the horticulture private sector: investors in commercial farms for export and smallholders mainly supplying the national market the development of the irrigation is undertaken by the horticultural private sector: investors for the exporting commercial farms and small producers supplying primarily the national market. Due to lack of human and financial resources, the Government capacity for managing water resources and developing irrigation has declined since the 1990s.

While irrigated area developed on public funds has stagnated, the small private irrigation sector made a tremendous jump forward over the past 15 years. Investment costs: the surface of the installations built on public investments stagnated, the small private irrigation for horticultural productions made formidable great strides these the last fifteen years. Investment costs seem to be affordable by farmers: 60,000 Ksh for a motor-driven pump of 3.5 HP enabling to irrigate 4 Ha, 10,000 Ksh for a treadle pump that can irrigate 0.5 Ha or more according to the strength of the operator.

Irrigated horticulture provides an income to thousands of small farmers, its impact on social exclusion is considerable. On the other hand it is high labour demanding and rather badly pays for labour investment. The data collected in Mwea shows that rice can be a productive and attractive crop for farmers.

The irrigation potential and the water resources are very largely under used. It is probable that the current development will not by itself increase significantly the utilization of the irrigation potential. Furthermore, current irrigation development concentrates in high potential areas only with the risk of increasing and worsening conflicts over water.

The diagnoses led by the APPIA project enlightened a maintenance deficit and a defective water distribution. WUAs have still a limited capacity for self- irrigation management. In other words, irrigation management skills remain far away from farmers. In addition irrigation technology and design often gives priority to low irrigation development cost to the detriment of irrigation schemes facility and flexibility to use. The difficulties related to O & M combine with poor inputs access and commercial risks to limit irrigation productivity.

- **Some material for consideration for future development**

*Improving irrigation design and technology*

Irrigation design or rehabilitation of existing schemes should more focus on making WUAs life easier. Often the issue of irrigation management is tackled through its institutional aspects and training, far less from the engineering side. However **technology and design strongly determines the manageability of irrigation schemes.** There are various technical [5]solutions, not very sophisticated and therefore little expensive that enable simplifying water distribution.

[5]See reference work: Horst, l. 1998. *The dilemmas of water division: Considerations and criteria for irrigation system design.* Colombo, Sri Lanka. International Water Management Institute.

Research-development activities would allow trying these technologies in the socio-economic and institutional context of Kenya.

Small private irrigation, using small pumps, develops only easily accessible land and water resources. New forms of public investments and technology (i.e. construction buffer tanks) should to be sought in co-operation with all the users to tap more irrigation potential and to reduce the risks of conflict.

Access to the irrigation involves for the farmers technical and organizational change. A close follow-up is therefore necessary in the first years of operation of new schemes, its cost could be taken into account in the budgets of future irrigation development.

*Improving O & M.*

**Capacity building of WUAs** is an essential pre-condition which implies new forms of extension service helping farmers to define and implement the functions of their organization, its structure (organization chart), the right required skills and applicable by-laws.

**Towards public-private partnerships for better irrigation management?**

Does irrigation management transfer necessarily mean have to do everything on their own? Is it realistic (and morally acceptable) to transfer to farmers the large centrally irrigation schemes while their management proves complex from saying of irrigation agency engineers? Is delegating irrigation management to a Water undertaker an option to be ruled out definitively on the basis of the failed experiment missed in South-West Kano? Can training of WUAs members solve all problems? From the concrete experience of the IPIA project, the reply to all these questions is not.

In the Kenyan context, an efficient and sustainable irrigation management irrigation could partly rely on private sector involvement. **The intervention of qualified professionals** ("new NIB", NGO, private companies, consultants…) would enable the farmers to concentrate on crop production and would bring skills that irrigating farmers are missing on various aspects irrigation management: O & M of pumps, water distribution, maintenance, management of the O & M fee… Several forms of assistance are possible from specific punctual support until the total delegation of irrigation management.

**The financial management of irrigation** proves to be complex: recovery of O & M fee, cash provisions for exceptional events (breakdowns of the pumps, floods…) or fixed periodical cash deposits for the renewal of pumping equipment. Support to bookkeeping operation, advice for assessing actual maintenance costs, independent audit of WUAs bookkeeping systems, O & M fee recovery by an independent credible authority, etc … are as many services as financial **professionals can offer**.

**Governmental services** could re-orientate themselves towards training and licensing private sectors stakeholders, monitoring and evaluation of their activities and arbitration of conflicts they may have with farmers.

*Using better the national expertise*

At its level, the IPIA project tries to promote information and experience sharing between the various Kenyan institutions which bring it their competences for improving irrigation performance: Ministry of Water and Irrigation, Ministry of Agriculture, NIB, agronomic

Research (KARI), ApproTEC, universities. This approach could be extended well beyond IPIA activities for the implementation of the national irrigation policy.

*Other possible interventions*

The immense majority of Kenyan farmers have to rely on their own funds to finance their production costs. Consequences are often a low inputs use and limited bargaining power in their commercial transactions. The development of rural saving and credit organizations is a possible solution.

The construction of products storage capacities would enable farmers limiting the commercial risks and increasing their bargaining power.

Increasing labour productivity in irrigated horticulture also requires a change of production system: use of small motorized equipments and horticulture specific tools. A larger dissemination of KARI drip irrigation kits would present the double advantage of saving Labour and water.