APPIA - Improving irrigation performance in Africa

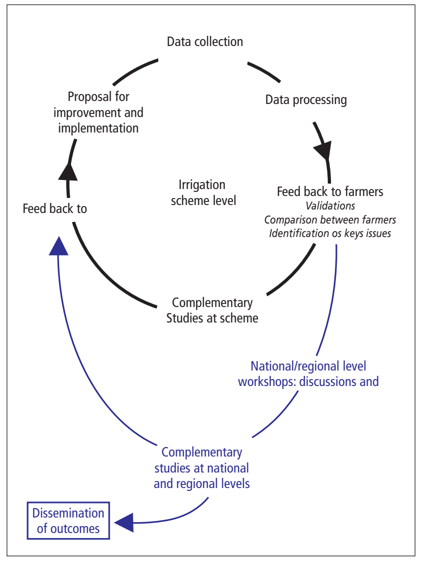
by Phillippe Lemperiere[1] and Ingrid Hermiteau[2]

Crop production in Sub-Saharan Africa is largely based on rain-fed agriculture, which increasingly depends upon unreliable and often insufficient rainfall. In response to an average annual population growth of 3%, and the fact that rain-fed agriculture productivity is limited, irrigation development is a major solution in terms of food security and alleviating rural poverty. However, only about 35% of potentially irrigable land in West Africa has been developed, and less than 10% in East Africa.

In response to the severe droughts that hit Sub Saharan Africa in the 1970's, many countries opted for irrigation development and made huge investments in government driven irrigation projects with the support of international donors. Change in world economic policy in the late 1980's, has led African governments to transfer, in some cases abruptly, irrigation management to farmers associations. At the same time donors have lost interest in irrigation, pointing out its lack of market competitiveness and cost effectiveness. Thus, improving irrigation performance (sustainability and profitability) is a crucial issue for bringing back investment to the irrigation sector.

In this difficult context, innovative and interesting initiatives have been carried out by various R&D projects, farmers organizations, irrigation authorities and NGOs. Unfortunately no information sharing mechanisms have been set up for these initiatives. More generally, the slackening of follow-up activities that accompanied irrigation management transfer no longer allows data-based assessment to be made of irrigation performance.

Due to their reduced level of preparedness, farmers associations have had a range of challenges to deal with: O&M; financial management; access to credit, inputs and market; diversification of crop production; and how to manage their natural resources. Consequently from the mid-1990's, extension services to farmers have started moving from a conventional approach, based on the dissemination of technical recommendations, toward a



Information sharing at scheme, national and regional levels

service that is more responsive to actual farmers' needs. These new forms of extension services, still very limited but growing in number, are characterized by innovative approaches:

Target: Farmers organizations (rather than individual farmers)

Theme: Support to organizational management (i.e.: negotiation of contract agreements with other stakeholders)

Tools and methods: Participative approach, comprehensive assessment, and tools to facilitate the decision-making process

Institutional set-up: involvement of the private sector, payment to extension services.

There is thus a need to assess the changes in the present transitional period, and to clarify the concept of "extension service modernization".

APPIA

The APPIA Project includes five countries in West Africa: Burkina Faso, Mali, Mauritania, Niger and Senegal, and two countries in East Africa: Ethiopia and Kenya. Extension to other countries is being considered.

In West Africa, the APPIA Project is building on the lessons identified in the "Best Practices" project implemented by IPTRID in the same five countries. The project has been extended to East Africa so that it is not limited to French speaking countries. Also it promotes comparison of, and transfer of, practices between East and West Africa where institutional structures have evolved in different ways.

The project is financed by the "Fonds de solidarité prioritaire" of the French Government until 2007. In West Africa, the project operator is ARID (Regional Association for Irrigation and Drainage) based in Ouagadougou, Burkina Faso. In East Africa IWMI (subregional office for Nile basin and East Africa) in Addis Ababa is the project operator. Two French technical assistants have been seconded to ARID and IWMI respectively.

The purpose of the APPIA Project is to improve irrigation performance in the region by setting up networks for irrigation professionals to share experience and information. Two types of activity are underway:

1. Assessing and comparing the performance of small to medium scale irrigation schemes, and disseminating useful information, including:
   - The development of a methodology to collect and share information about irrigation performance and to implement solutions to improve irrigation performance.
   - The collection and processing of information by irrigation professionals in each country, about irrigation performance on a limited number of schemes.
   - Discussion about the outcomes, and dissemination in French and English among irrigation professionals at regional level.
2. Capacity building to support new forms of extension services that respond better to farmers needs within the context of (i) irrigation management transfer to farmers associations and (ii) a market oriented economy, including:
   - Thematic and case studies on the modernization of extension service to farmers' organizations, discussions on the outcomes, and dissemination among

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Environmental conflicts in irrigated areas: impact assessment in the Tunuyán river basin, Mendoza, Argentina

By Jorge Chambouleyron[1], S. Salatino1 et al[2]

Tunuyán catchment

Recent agricultural development of Mendoza's central oasis region is strongly linked to the flows available from the Tunuyán River. The river catchment is divided into a 54,000ha lower sub-basin and a 81 000 ha upper sub-basin, each with registered irrigation rights. In the early 1990s, there was a boom in agricultural development in the Upper Tunuyán River command area. Large investment in quality grapevines for winemaking brought about a rapid growth of the cultivated area. It also brought about considerable use of groundwater due to the requirements of pressurized irrigation systems. This study has focused primarily on what happens as the groundwater withdrawal intensifies. The concern is that stream flows from the upper area will diminish and salinity will rise in the waters of the Lower Tunuyán River. This will impact adversely on crop yields in one of the most important agricultural areas of the province. This article describes a study, financed locally by ANPCYT and SECYT, to develop solutions to this problem.

Upper reaches area of Tunuyán watershed

Typical landscape from a Mendoza farm

The problem

The environmental impact of current and potential development in the upper sub-basin on the lower sub-basin of the Tunuyán River has been assessed in a recent study by INA and Cuyo University. The main scenario investigated comprised a 20,000 ha expansion of the groundwater irrigated area cultivated with quality grapevines. This will lower the water table, deplete streams (which are tributaries to the river downstream from the Valle de Uco diversion canal) and effectively transform them into drainage collectors. The quality of water, which is used to irrigate crops such as peach trees and vineyards that are "sensitive" to salinity, is expected to be degraded. Reduced irrigation water supply in the lower oasis and increased water salinity levels will lead to soil salinization and reduced crop yields. Pollution in the irrigation water may be further worsened due to inadequate treatment of municipal wastewater – if the treatment plant capacity is exceeded.

The study

A multi-disciplinary research group studied the physical and socio-economic characteristics of the area – in terms of salt-water balance, irrigation water pollution, socio-economic description of the area, administrative and management aspects, economic aspects, and characterization of production models. Water quality samples were taken from:- (i) inlets to the upper area, (ii) outlets from the upper area (iii) upstream of El Carrizal dam (which is the physical division between the upper and lower Tunuyán basins), and (iv) at the Tiburcio Benegas dam (where irrigation water flows into the lower basin).

The cultivated area of the upper sub-basin was surveyed to collect socio-economic and cultural information. The study also focused on agribusiness conditions and profitability, farmer profiles, social aspects, and irrigation water management. Environmental impacts were identified, linked and qualitatively valued by means of an "importance matrix" which enabled the more significant negative impacts to be identified and quantified. This lead to an economic impacts assessment from which mitigation and control measures for the area were proposed.

Results

The study found that a sustained increase in cultivated area as well as in the economic activity of the upper basin would lower groundwater, would raise the salt content in the Lower Tunuyán River and would affect crop yields there. Results showed that a potential 20 000 ha increase of viniculture area in the upper basin would increase irrigation water salinity (currently at 1.13 dS/m) to some 1.42 dS/m. The available water supply would be reduced (200 Hm3), so that only one third of the registered area could be sufficiently supplied, and crop yields (of grapes and peaches) would be reduced by between 12 and 22%.

The economic impact assessment identified that soil salinization and water pollution in the Lower Tunuyán River area would lead to increased water demand for leaching, and would affect the productivity of the irrigated areas. Unless adequate measures are taken, the current 4 500 ha of peach orchards would be lost and grape yields would drop. The financial impact of the losses is estimated to be $20 million per year.

Income lost by farmers (in terms of unemployment compensation) would be in the order of US$684 000 per year). Farmers' contribution to the maintenance and modernization of their irrigation and drainage system would be reduced; and urban migration from the area would increase.

On the basis of these assessments, mitigation measures were developed to control the impact of uncontrolled growth and development in the Upper Tunuyán River. The measures are divided into "infrastructure components" (improvement of the canal system, rehabilitation of the drainage system, wastewater treatment, aquifer recharge, etc.) and "management improvement components" (consolidated basin administration, integrated register of uses and users, training and technical assistance to managers, and strengthening of the control system of surface and groundwater uses and users).

Recommendations

The outcome of the study were recommendations: (i) that water management be consolidated at the basin level; (ii) that water be distributed in a proportional and equitable manner on the basis of quality and salt content (as is the case of the Murray-Darling Basin in Australia and the Colorado River in the Province of Mendoza); and (iii) that groundwater be integrated into decentralised water management (with users' organizations assuming responsibility for water management and pollution control).

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The search for productive bio-Saline crops

The search for plants that grow naturally in a saline environment and can be economically cultivated, is still in its early stages. Initially the focus is on indigenous plants from tidal land. There is a question as to what these plants can be used for. As a source of fibre, oil, cattle feed, and specialised vegetables, seems to be the most promising use. Some successes have already been achieved with commercial cultivation of bio-saline crops as vegetables. Other plants that grow naturally in saline habitat have potential uses in coastal protection, erosion control and the production of ornamental plants and shrubs.

Limitations of salt tolerant or bio-saline crops

All plants and crops have a limit to their salt tolerance. They maintain an optimal production below the threshold salinity. If the salinity rises above the threshold value, production declines and eventually the plant dies. Determining the threshold salinity and the rate of production decline at increasing salinities above the threshold value is complicated by the variation of these values with the growing stage of the plant. (For instance, the salt sensitivity of plants is higher during germination and seed-forming stages, and can vary between varieties of the same species.) The figure shows the threshold value for three wheat varieties varying from a soil salinity of ECe= 2.1 dS/m for Forage Durum, to 8.6 dS/m for the semi dwarf varieties of wheat for grain production. This shows that the rate of decline of production – see the different slopes above the threshold value for wheat. The lists of salt tolerance for crops that have been published in many reports and papers, although useful for general purposes, do not give sufficient guidance for specific situations.

The consequence of all this is that if reasonable productivity is to be achieved, then soil salinity levels have to be maintained below a certain value during the growing cycle – whether this be for traditional species, salt-tolerant varieties, or bio-saline crops. Since the values fluctuate during the different growing stages, this means that water management practices and engineering infrastructures have to be adjusted according to the local situation.

Conclusions

- The use of salt tolerant varieties will enable more efficient water use and the development of new areas for crop production (which requires engineering measures combined with water management), but will not in most cases eliminate the need for salinity control. The basics of the methodologies and techniques for salinity control are well known.
- For the production of bio-saline crops, conditions with a controlled but higher than traditional, salinity level must be created. If the cultivation of these crops takes place in areas that can be put under influence of the tides, the tidal movements of the sea water can be used to control the soil salinity.

A definition of what different crops require in terms of soil salinity and general growing conditions, is essential to determining where the (new) crops can be grown and what measures have to be taken to create optimal growing conditions.

News from ICID

New ICID Senior Appointments

At ICID's 54th International Executive Council meeting held in Montpellier (France), 14-19 September 2003, three new vice-presidents were elected all of whom have had significant interaction with IPTRID.

Dr. Alain Vidal, at present, Head of Cemagref's European and International Affairs Office, was formerly IPTRID Theme Manager for Water Conservation in the Mediterranean and North Africa region.

Mr. R. Jeyaseelan, Chairman of the Indian Government's Central Water Commission (CWC), was involved in discussions between IPTRID and organisations such as CWPRS in identifying research priorities.

Prof. Victor A. Dukhovny, Director of Scientific Information Centre of Interstate Coordination Water Commision of Central Asia for Aral Sea (SIC/ICWC) is a long-standing member of IPTRID's Consultative Group and SIC/ICWC is presently working with IPTRID in studies and consultations aimed at determining a rational investment strategy for land drainage in the region.

ICID also announced at the meeting that Mr. M. Gopalakrishnan will take over as its Secretary General from 1st January 2004. He currently holds the post of Coordinator of Task Force on Interlinking of Rivers (constituted by Government of India), and recently retired as Member (River Management) in Central Water Commission.

New ICID information service

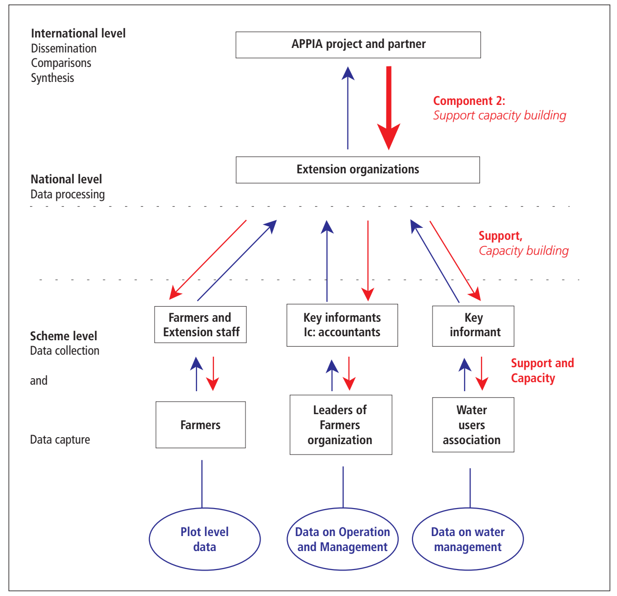
ICID's Text Delivery Service (TDS) has been running for 2 years, and now consists of almost 3,000 articles that can be viewed and downloaded online, as well as about 30,000 abstracts of ICID library holdings. Increasing numbers of users are making use of this online facility. 700 articles have been recently added to enrich the database, including:
- Transactions of 11th, 12th and 13th ICID Congresses, abstracts from ICID Irrigation and Drainage journal, and from many other journals and sources.

The system contains grey literature as well as the ICID library catalogue. These can all be searched through keywords, name of author, and (for books) title etc. Where a search shows that a document is available, it can be viewed/downloaded through "E-resource" button. If it is not available online, an "E-mail" button will enable users to get e-mail assistance in ordering on-line s that the document can be sent within two working days.

New software is being introduced at the ICID server to operate the text delivery service, which has several user-friendly features including open source standards. This means that the system can be freely customised as ICID sees fit, and it can link to similar databases (with Z39.50 protocol) on other servers. This means it will be possible for a user in one system to search and retrieve information from another computer without knowing the search syntax it uses.

Http://www.icid.org.

[1] See: Croon F.W. 1999 "Institutional aspects of drainage implementation", ICID Drainage Workshop, Penang, Malaysia



Capacity building for extension staff and farmers organisations

irrigation professionals.

- Building-up of capacity in extension organizations– so that they can offer new services to farmers, and can promote tools and methods adapted for local conditions.
- Technical and institutional support given to Extension modernization projects.

The priority target for the project is the small to medium scale irrigation schemes managed by farmers' organizations. These schemes are more sustainable than large state farms, and are more efficient in alleviating rural poverty than private agro-industrial schemes. Selection of the type of irrigation to be investigated has involved consultation with all stakeholders, and identification of how comparisons can be made between various countries.

Beneficiaries

- Extension organizations and farmers organizations – who are both beneficiaries of, and participants in, the project. They are the main target of information and training courses. They will play a major part in the collection and the dissemination of information from/to irrigation schemes. Information and training will help farmers organizations to improve practices and performance at irrigation scheme level.
- Other irrigation professionnals – who will have access to information and training courses.
- Senior government officials – who will have more information to help plan irrigation development and to negotiate with donors.

Drainage & sustainability

Capacity building workshop for the Aral Sea Basin drainage strategy

One of the main environmental problems in the Aral Sea Basin region is the increasing salinisation and waterlogging of irrigated lands fed by the 2 main rivers Syr Darya and Amu Darya. Currently over 50 % of these lands are affected. There is an urgent need to develop pragmatic solutions.

IPTRID's workshop in Tashkent brought together senior technical experts from land improvement authorities in 4 CAS republics, in order to assess current land drainage trends in the region. The objective was to develop an overview of the present situation and the main constraints in land drainage. This information is being fed into a number of IPTRID facilitated studies carried out by ICWC, which will lead later in the year to a 2nd event, in which the basis for a rational drain strategy will be developed. This will be a High Level Conference towards a strategy of sustainable irrigated agriculture with feasible investment in drainage, in the Aral Sea Basin.

The workshop yielded 13 reports summarising present land drainage situations in the main irrigated areas of the region. These areas are generally known as oblasts, and included: Kzylorda oblast, South Kazakhstan oblast (in Kazakhstan); Kyrgyz oblast, Batken oblast (in Kyrgyz Republic); Sogd oblast, Kulyab oblast, Khatlon oblast (in Tajikistan); and Hunger steppe, Karshi steppe, Buhara oblast, Ferghana oblast, Khorezm oblast, Karakalpakstan (in Uzbekistan).

The workshop was held at the Scientific Information Centre of ICWC, Tashkent, as one of a series of workshops organised by IPTRID with DFID support. As well as the technical contributions of the participants, inputs were made by HR Wallingford and McGill Univ. (Brace Cent.).

Controlled drainage to improve water use efficiency in semi-arid areas

Cath Abbott[1] and Shaden Abdel-Gawad[2]

Irrigated agriculture uses about two thirds of all water abstracted from rivers and underground aquifers in developing countries, and in many areas available water resources are nearly or fully utilised. If irrigated food production is to increase, irrigated agriculture must use water more efficiently.

Research has been undertaken by HR Wallingford and the Drainage Research Institute, Cairo, to develop and test controlled drainage strategies that improve water use efficiency of surface irrigated agriculture in semi-arid areas. Loss of excess water through drainage is a major cause of inefficiency in some systems. Integrating irrigation and drainage management through the use of controlled drainage opens up new opportunities for water savings. This work was funded by the Governments of Egypt and UK (DFID).

Controlled drainage is a practice that allows farmers to control drainage outflows, storing water in the soil profile for use by the crop and reducing losses from the system. Drainage flows are managed so that drainflow occurs only after the ground water level in a field has risen to the point where drainage is needed to prevent crop damage, or to provide salt leaching. Irrigation applications can thus be reduced, and the relatively good quality water that is "saved" becomes available for use by downstream irrigators.

Whilst improved water use efficiency is the principle benefit of controlled drainage in irrigated semi-arid areas, there are other benefits, including:

- improvements in crop yield
- an increased insurance against crop losses due to water shortage
- maintenance of soil nitrate and phosphate levels, so that soil fertility is not degraded in high irrigation or high rainfall areas
- reduced nitrate and phosphate losses to downstream water bodies, reducing eutrophication of, and ecological damage to, receiving surface water bodies
- conservation of wetlands and water–sensitive regions.

It is particularly applicable to areas that experience periodic water shortages, and suffer from limits to crop production and high costs for water application. In terms of the basin water balance, the benefits are greatest where rice forms a significant part of the crop rotation, and also in areas where reused water is of poor quality.

The link between improved water use efficiency at farm level and water saving at basin level is not always clear. A water saving at field level does not always translate to a water saving at basin level, especially if water is recycled or reused once it has passed through the drainage system, or if groundwater recharge is a significant component of the basin water balance. In areas where significant volumes of agricultural drainage water flow out of the basin, or to sinks, then any increase in field water use efficiency directly benefits the basin in terms of water saving.

It is also important to consider water quality as well as quantity. In areas where drainage water is reused for agriculture, or other purposes (e.g.

Flapgate used in Egyp to block drainpipes and control drainage outflows

fish farms), it is common to find that the lower the water quality the lower the productivity of the reused water. Drainage water is inherently of poorer quality, and lower productivity is inevitable. For this reason, water savings at field level resulting in reduced drainage flows nearly always result in water savings (in terms of productivity) at basin level.

The following set of prerequisites apply to identifying land suitable for application of controlled drainage:

- Relatively flat agricultural areas.
- Surface irrigation is the main method of water application.
- Artificial drainage systems comprising a network of open drains or horizontal sub-surface piped systems with suitable access points (such as manholes) in place or planned.
- There is an incentive for introducing controlled drainage (such as water supply being sporadic or unreliable in the area, or the need to pump/lift water from canals to the fields.
- Crop patterns can be consolidated with respect to drain lines. (This implies that landholdings need to be relatively large, or that farmers are able and willing to collaborate over crop rotations.)
- Farmer organisations are willing to take on the organisational tasks associated with controlled drainage, or can be formed.

Egypt

Egypt is one of the countries where controlled drainage is most applicable, and offers significant benefits to the farmer and the wider community. The vast majority of the agricultural land is irrigated (most of it by traditional surface methods) and over 90% is served by artificial drainage systems. The extensive drainage network comprises open drains and horizontal sub-surface pipes, with many suitable access points for operation of controlled drainage. There are certainly areas where the incentives for controlled drainage will be attractive to farmers – this includes areas where sporadic water shortages impact crop production, and rice areas where savings in water application translate to considerable savings in energy and manpower costs. Farmer groups also appear to be sufficiently developed to facilitate management of controlled drainage across farming areas.

Agricultural production in Egypt relies almost totally on irrigation, so controlled drainage management can be driven by local irrigation applications. Simple controlled drainage devices have been tested that enable farmers to use weirs to reduce drainage flows, or in rice growing areas to apply flow blocking devices.

Farmers testing controlled drainage under rice in a number of Nile Delta areas have already achieved water savings in the order of 40%. The main attraction to them was the reduction in irrigation application times. As the water requirements for rice are much higher than those for dry-foot crops, the potential savings in water application from controlled drainage are also higher. Areas with rice included in the rotation are the ones that will benefit most from controlled drainage.

The use of controlled drainage under other crops is expected to increase as water resources across Egypt become more limited. Farmer groups within the Nile Delta are sufficiently developed to provide the collaboration required. The necessary support for controlled drainage management across cropped areas would be provided by a strong farmer extension service.

Other countries of potential application include India, Pakistan, Northern China, Uzbekistan, Tajikistan, Turkmenistan, Israel, Syria, Iraq, Bahrain and Algeria.

Project outputs:
A number of reports on the technical testing and potential use of controlled drainage are available. Further details from the authors

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Salinity control needs for salt-tolerant and bio-saline crops

by Frank Croon[1]

The challenge for the future development of salt-tolerant and bio-saline crops is in creating soil salinity conditions that are stable and within the threshold levels for good production. What these levels are depends on the characteristics of the crops chosen, but the principles on which this approach can be based are already well known.

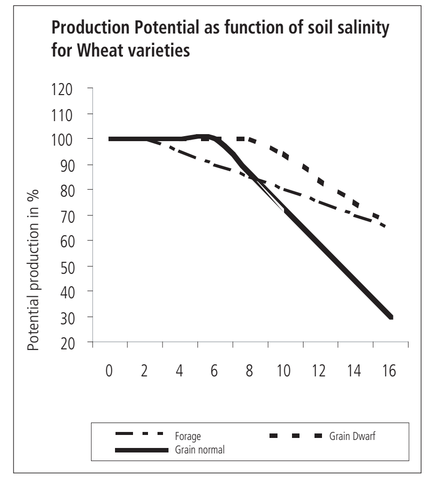
Bio-saline crops are generally selected from wild plants in tidal areas where the high, stable, soil salinity conditions are in balance with the salinity of seawater. Modifying tidal areas for agricultural production results in changes to the salinity of soil conditions, e.g. the exclusion of tidal inundation from coastal polders. Consequently soil salinity conditions will change and, if not properly controlled, can rise dramatically. The engineering challenge is to create an infrastructure that can maintain soils at an acceptable and stable salinity (such as making use of the stabilising capacity available from the adjacent seawater).

The agronomic challenge consists of (i) increasing the salt tolerance of the traditional crops while maintaining their productivity, (ii) selecting stable varieties of economically useful bio-saline crops and (iii) determining the condition under which they can thrive. This includes determining threshold salinity levels for new crops or new varieties as well as the environmental and climatic conditions.

Background

- Progressive salinisation of existing agricultural areas, especially the irrigated areas, is a major threat to agricultural production and has negative environmental consequences
- Salinity in coastal and delta areas, whether or not combined with the scarcity of fresh water, hampers agricultural productivity and development
- Soil salinity in areas adjacent to the sea are in balance with the salinity of sea water
- Considerable areas in arid regions cannot be brought into production not just because of water scarcity but also because of the potentially high soil salinities.
- Soil salinity is not static, but is a dynamic process that frequently results in progressive salinisation.

Halophyte plants – Salicornia.



The methodologies for solving salinity problems in reclaimed or irrigated areas are in principle well known and have been successfully applied to extensive areas on most continents, they comprise: leaching; increasing irrigation applications with a leaching fraction; and providing land drainage. In spite of this knowledge about how to use them, there are many institutional impediments1 and practical obstacles that limit their use, such as:- (i) scarcity of fresh water, (ii) high upfront costs of drainage, (iii) the requirement that large areas are dealt with in one go, (iv) the adverse impact on existing infrastructure, farming communities and agricultural customs, (v) the need for a consistent, disciplined water management and (vi) potential pollution of "downstream" areas by saline drainage effluent.

New approaches to dealing with these problems, and to making saline areas more productive, are starting to replace the more standard approaches:-

- Adjusting the crop to the existing environment (i.e. development of salt tolerant varieties)
- Productive cultivation of plants that grow naturally in saline environments i.e. bio-saline crops.

There is often an expectation that expensive and complicated engineering works (and related water and salinity management) can be avoided, and existing farming practices can be continued when salt-tolerant or bio-saline crops are grown. This is unfortunately not always the case - see below.

The search for salt-tolerant varieties of traditional crops

The creation of varieties of traditional crops that give moderately good yields under saline conditions in problem areas, is not simple. The threshold soil salinity values of most traditional crops vary in a narrow ECe range - from 4 to 8 dS/m. (The threshold value of a crop indicates the soil salinity value at which the crop starts to suffer yield reduction). The soil salinities occurring in coastal and salinised inland areas are often 4 to 6 times as high as these threshold values. Even barley, which is classified as one of the most salt-tolerant grain crops, has a threshold soil salinity (of 8 to 9 dS/m) which is considerably lower than the soil salinities of 20 to 40 dS/m that are often encountered.

Creating a suitable crop variety that can grow under the prevailing soil salinities in problem areas requires a huge jump in salt tolerance – something that is NOT just around the corner, if at all possible. So the use of salt-tolerant varieties is not going to be a universal solution for the large-scale salinity problems that are threatening world agriculture.

There are however important advantages to the cultivation of crops that have a higher salt tolerance than the traditional varieties. If crops can tolerate higher soil salinity levels, they will need less water, because leaching ratios can be reduced. Furthermore, the system would perhaps be less sensitive to occasional mishaps or seasonal fluctuations – so water and salt management could be less stringent than would otherwise be required.