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IRRIGATION DEVELOPMENT AND WATER CHARGES

by

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TRENDS IN IRRIGATION DEVELOPMENT

1. Global Trends

At the end of the last decade 1.500 million hectares of land were under cultivation and, of these, 210 million hectares were under irrigation, which means that 14% were irrigated. It has been estimated that on this relatively small portion of the cultivated land, 37% of the total crop value was produced. If other measures for water control in agriculture, such as land reclamation, flood protection and drainage are included, the estimate would be that, for around 50% of the crop value produced, water was manipulated in one way or another.

In the last twenty years there has been a noticeable decline in the rate at which irrigation expanded in the world, and the average annual growth rate of irrigation development, which was at a level of 5% per annum during the decade 1965 - 1975, has dropped to 1.8% per annum for the subsequent decade. Until recently, these growth rates were still sufficient, as the part irrigated of the total cultivated area increased from 12% in 1970 to 14% in 1980, but thereafter the increase levelled off and the irrigated portion remained stagnant at about 14.5% during the first part of the 1980 decade.

This decline in irrigation development is also discernible for developed as well as developing countries. Whereas for the former the growthrate was 2.7% p.a., it was as low as 1.5% for the developing countries. The reason for this might be - in rather general terms - the increasing costs of water development schemes on the one side, and the declining prices of agricultural products on the other, which both tend to reduce the economic viability of new irrigation projects. It is obvious that in developed countries specializing in irrigation for high value crops and with a high degree of intensification these constraints can be absorbed more easily than in developing countries where irrigation is needed more for staple food production and where, moreover, in most cases, large-scale water development is dependent on external loans which have become so difficult to obtain. A more differentiated view of the role of irrigation in agriculture as a means for intensification of production and expansion of cultivation, could be obtained from an analysis of different regions or groups of countries as the requirements and constraints vary according to demographic, economic and social factors, availability of land and water resources and degrees of development of the rural infrastructure.

2. Europe, North America and Other Developed Countries

About 29% (61.5 million ha) of the irrigated area in the world is in developed countries, with the major shares being in the USSR, (19 million ha, with an average growth of 3.9% p.a.), USA (20 million ha, 2.6% growth) and Western Europe (10.6 million ha, 2.0% growth). In all three areas irrigation has been growing quite fast, whereas the total area under cultivation remained stagnant, or even declined, as in Europe. Therefore, the additional irrigation was provided tor compensate for areas lost to production, or for conversion of land so far under rainfed production to irrigation for intensification of production, higher input use, and eventually for higher value crops. In Russia, for example, the expansion and intensification of cotton production - in the Asian part of the country - has been made possible by the construction of large modern irrigation schemes designed for a high degree of mechanization and input use. In order to achieve the enormous expansion of irrigation (6 million ha during the last decade, according to statistics), large investments had to be made for water development works (canal diversions, pump-schemes, storage dams), and also for land reclamation and salinity control.

In contrast, for the expansion of irrigation in Western Europe and North America, existing infrastructures were used, thus high investments in water development schemes could be avoided. The conversion of rainfed to irrigated production has essentially been done by extended use of sprinkler irrigation because of its flexibility and adjustability to the particular requirements of supplementary irrigation in individual farms and schemes for small groups of farms with similar cropping schedules. The water supply for these sprinkler systems is often from groundwater through individual farm wells which have the advantage of short water conveyance. Complete rural electrification and the availability of efficient agricultural services have been an important prerequisite for this development, as have been the completion of land consolidation measures in areas of previously highland fragmentation.

This trend in developed countries to expand irrigation substantially against a reduction in the rainfed area is, however, not followed in Australia, where the total cultivated area in real terms grows much faster than irrigation for the obvious reason that large land resources are still available; but irrigation is also gaining importance in Australia as indicated by the high growth rate of 3.8% per annum during the past decade, which has brought the irrigated area to 1.75 million ha.

Japan should also be mentioned in this group of developed 'irrigation countries', because the share of irrigation is as high as 68%, but the irrigated area has been shrinking constantly during the past decade, as have the total cultivated area and the use of fertilizer. Therefore the agricultural production index has fallen to 94% of the 1973 level.

3. South East Asian Developing Countries

The developing countries have a share of 71.2% of world irrigation and two thirds of this (103.2 million ha) are in the region of South East Asian (excluding Pakistan, Japan and the Asian part of USSR). Two countries account for the bulk of this: China with 45.1 million ha and 21% of the world total, and India with 39.5 million ha and 18.5%. They are the two biggest 'irrigation countries' in the world, according to size of the irrigated area and also the pace of irrigation development - if it is counted in real terms (426 000 ha and 766 000 ha, respectively, of additional irrigation p.a. during the past decade). They both set the trend in irrigation development for this region, which is to use irrigation as a means for intensification of production, multiple cropping, use of high-yielding varieties of rice, and gradually increasing input use, as these become available (growth rates of fertilizer use are above 10% p.a. in almost all those countries with a high share and a high growth rate of irrigation). This is underlined by the fact that in the region, irrigation expanded at a higher rate in real terms (1.65 million ha p.a.) than the total cultivated area (1.0 million ha p.a.), which indicates that most of the additional irrigation facilities were used for the conversion of rainfed production to irrigated production.

The reason for this can be attributed to the low reserve of land resources in the monsoon areas of the region where irrigation is concentrated, and the high population density (125 persons per km^2). Moreover, irrigation has been used traditionally for paddy-rice, which is the staple food for the region. A staple food - even if it is a high-yielding multiple cropping rice - cannot easily pay for the high investments required for additional large-scale water development works and, consequently, the highest growth rates for irrigation are in areas where existing infrastructures allow for a further direct development of irrigation.

In China for example, the additional irrigation installations have been used entirely for the conversion of rainfed production to irrigation and reclamation of land with declining productivity. The total cultivated area has even decreased by half a million hectares during the past decade, because of losses of land due to salinity, waterlogging, flood damage and erosion, which could not be reclaimed or compensated by new land coming under cultivation. The installation of additional irrigation at a magnitude of 4.3 million ha (about 10% of the total irrigated area) in one decade, has been done within the existing infrastructure, with small and medium-scale water development works, pump schemes and groundwater use, and in many places in combination with measures for flood protection or erosion control. With this increase, irrigation has been provided for 45% of the cultivated area, and this has greatly supported the enormous rise in intensification of production, expansion of multiple cropping and increase in the use of inputs (the growth rate of fertilizer use is 13.6% p.a.). As a result, the production index reached 155% of the 1974-76 level, and rice yields - almost entirely from irrigation - are now amongst the highest in the world.

The trend in India is quite similar, as irrigation growth has been about triple that of the total cultivated area during the past decade. With an average of 0.77 million ha p.a. of new irrigation facilities, India, in real terms, has the fastest irrigation rate in the developing world. The expansion of irrigation to land so far under rainfed production or partially irrigated is done in India, in most cases, through the special Command Area Development Programme. This provides for the district and farm-level distribution systems and their connection to the existing main canal systems, by which efficient irrigation can be rapidly carried through to the field at relatively low investment costs, as existing irrigation infrastructures can be used. This trend to connect the expansion of irrigation to existing infrastructures, which reduces costs and increases the efficiency of the system, is the same in India and China. In addition, both countries have the capacity through their trained personnel and available construction facilities, to implement this type of project with their own means, and in most cases the required capital investment can be generated locally and with the help of government resources. Both these factors explain the high rate at which irrigation has been able to expand in both countries.

Bangladesh should be added to this group because it has a high growth rate of 3.6% p.a. for irrigation development, essentially for conversion or reclamation of land previously under rainfed production. But the total amount of available land resources is insufficient, and much of the land is under constant threat of flooding. Therefore there has been no expansion of the total cultivated area, and the intensification of production which has been obtained so far by improvement of irrigation and a high growth rate of fertilizer use, has not been enough to compensate the increase in population so that Bangladesh is the only one of the large countries in Asia's monsoon zone where per caput agricultural production is declining, now at 0.1% p.a.

Three smaller countries also belong to this category with a high share of irrigation: the Republic of Korea 55%, the Korean DPR with 46%, and Sri Lanka with 25%; in there irrigation is growing quite fast, even faster than total cultivated area. In the cases of South Korea and Sri Lanka the fast irrigation expansion has been influenced decisively by the progress in the major water development projects, e.g. Naktong and Mahawelli Ganga. Thus, the countries mentioned under this category have been able to base irrigation development on existing infrastructure and on some which are now developing. Irrigation itself continues according to standing practice and experience, particularly with regard to the main crop of paddy-rice, for which there is a long tradition. This trend to expand irrigation to land so far under rainfed production has been further caused by lack of land resources suitable for expansion of non-irrigated production. The demographic and economic pressures have forced production to be intensified on existing cultivated areas through multiple cropping and high input use, and these are both possible for paddy-rice.

Indonesia and the Philippines do not follow exactly the same trend, irrigation growth is substantially below that of the non-irrigated cultivated area. Indonesia, for example, is quite dependent on irrigation, which covers 28% of the cultivated area. However, the country has achieved self-sufficiency in rice and has started to export some surplus; therefore it is less necessary to extend the paddy area, and moreover sufficient land resources are available to expand non-irrigated production in Sumatra and the outer islands. Irrigation has been concentrated in Java, for demographic reasons, and further expansion on the island, although very much needed for the same reasons, is extremely hindered by the high costs of the development of additional water and land resources. The short and steep catchments of islands cause a very unfavourable ratio of cost-effectiveness for water storage and diversion, terracing of land, access roads, etc. Therefore, besides some expansion of irrigation in Sumatra and the other islands, investments for irrigation are directed towards improvement of existing schemes for better water control and management for intensification of production, but also for protection of the catchment areas, soil conservation and measures for the preservation of the value of the schemes.

Similar tendencies have been observed in the Philippines and Thailand.

The common trend in all these countries in the monsoon zone of the Far East, is the expansion of irrigation for intensification of production, essentially for rice. The growth rates are above world average, and irrigation development comprehends extension of existing systems and conversion of rainfed land, in cases where the infrastructure for water development and supply is already sufficient for this. In countries which do not have the water and land resources ready for irrigation development, improvement of existing schemes for intensification is becoming the new trend. The prevailing irrigation technique used in both cases remains the traditional surface method, mainly for paddy. The particular problem of this development is the conversion of rainfed or partially irrigated cropping into a highly efficient, fully irrigated system for two or more crops with high input use. Special concepts have been introduced for such schemes, typified in the Command Area Development Projects in India.

4. South West Asia, Developing Countries

The region comprising South West Asia and the Near East (from Pakistan to the Mediterranean, excluding the USSR and North Africa) is the most extensive arid area in the world, but its irrigated part is only 12.6% of the world total, being 26.8 million ha, only one quarter of that of East Asia. However, because of its aridity, irrigation might be considered even more important in the region. As has been estimated, 70% of the crop value is produced under irrigation, although only 31% of the total cultivated area is provided with irrigation facilities.

As a general trend, irrigation is decreasing in this region, but so is the total cultivated area; during the last decade, the area irrigated was reduced by about 500 000 ha, and the total cultivated area lost about 4 million ha. These losses have partly been caused by increasing salinity, waterlogging and soil degradation due to erosion and desertification, and have not been compensated by expansion of irrigation and other reclamation measures. Neither were the results of intensification by better irrigation management and higher input use (average fertilizer use is about 50 kg/ha p.a.) sufficient to compensate the losses of productivity; consequently the production index remained far below the world average, and agricultural production per caput remained stagnant or even declined in some of the countries of this region.

Pakistan, with 72% of its cultivated area under irrigation, and the third highest share of irrigation in the world, is an exception in this region, as its irrigation has been growing at a rate of 100 000 ha. p.a. Progress which is quite remarkable as it has not only compensated high losses due to salinization, but even led to a steady increase in the total area under cultivation. Apparently, this has been made possible by earlier investments for the Tarbela Dam, for canal improvement and for groundwater development on a large scale. Now the effects of these investments have been absorbed and a reduction in the growth rate of irrigation can be expected for the first half of this decade. Therefore the trend for the remainder of this decade will have to direct efforts toward further intensification of irrigated production - for which some room exists. Possibilities are: the introduction of water-saving techniques and practises on a large scale (e.g. the ditch lining programme), the prevention of losses of irrigated land or its reclamation through drainage for control of salinity and waterlogging, and the further development of groundwater for medium and small size farms or farming areas with the introduction of piped distribution, and, eventually, sprinkler systems as a long-term goal. Research will be needed on all these subjects for adaptation of methods and techniques and generation of local know-how.

Most of the countries between Pakistan and the Mediterranean suffer particularly from waterlogging and the increasing spread of salinization; as a result, investments in drainage and water control will call for more attention than expansion of irrigation as such. This reclamation of land requires, besides the high investments, a lot of time as positive results in the form of increasing production are only noticeable after a long gestation period. In this way, Syria and Jordan show a high production index as a result of large previous investments for reclamation, whereas for Iran and Iraq the production index remained below average for lack of corresponding investments during the past decade.

The same zone of this region is also known for its traditional technique for groundwater development through hand-dug underground collector galleries. Most of these areas still have untapped groundwater resources (e.g. Afghanistan, Iran, Iraq, Turkey), but there has not yet been a break-through in the application of modern techniques of groundwater development which, combined with sprinkler or other

piped irrigation systems, could provide a basis for rapid expansion of high value production, higher input use, more efficient use of the scarce water and reduction of the danger of salinization. If there were such a move for the introduction of modern groundwater development techniques and irrigation methods, it could be well supported by a regional cooperative research and support organization.

In the southern areas of the Arabian peninsula the age-old technique of water-spreading, often referred to as spate irrigation, is still in use. Although the area under this technique is has hardly more than half a million hectares, it has provided the lifeline for the Wadis which would otherwise have been uninhabitable because of extreme aridity. The method provides for the diversion of flash-floods into bunded fields to store soil-water for one crop and excess water to replenish the underground aquifers. The modernization of these systems for better production and greater security against sometimes devastating floods (as occurred recently in South Yemen) must be done with full respect to the function of the system as a regulator of the water household of the Wadi. One task during this decade should be to provide the technical and financial means for this modernization.

Common to all countries in the South West Asian region is the high dependence on irrigation on the one hand, and the stagnation of further irrigation development on the other, this is due to physical and financial constraints to the development of additional water resources. In many countries, the productivity of land has declined due to salinization and waterlogging; therefore, investments should first be directed towards the reclamation of such lands rather than to expansion of irrigation. Modern techniques for groundwater development, water distribution and irrigation have not found a substantial application so far in this region, but are promising - together with the introduction of better water management - for expansion of irrigation and reduction of the spread of salinization. Research must be conducted for these aspects.

5. Africa, Developing Countries

The African region (i.e. the 51 developing countries of the continent) has the lowest share of world irrigation, and 9 million hectares under irrigation represent only 5% of the total cultivated area; yet the value of the production from irrigation (without fodder crops) is about 20% of the total crop value. Irrigation in Africa refers to a wide range of conditions for major water supply to fields from sophisticated formal irrigation schemes with extensive permanent infrastructural facilities, to traditional peasant irrigation with simple local techniques, as well as traditional flood recession practices under limited water control systems. For climatic and demographic reasons irrigation has been concentrated in the Mediterranean and arid North African zone, which accounts for 47% of all irrigation in Africa, and the Sudano-Sahelian zone with another 25%, leaving just 2.5 million ha for sub-Sahelian African, of which Nigeria and Madagascar have the major share.

In the Mediterranean and arid North African zone, Egypt occupies the most prominent place, because almost all cultivated land is under irrigation, and all agricultural production comes from irrigation. The additional water from the Nile - the life-line of the whole country - which has been made available through increased storage behind the Aswan dam, has been used more for intensification of irrigation than for its horizontal expansion, and irrigation intensity has reached an average above 150%. This has allowed a high input use, which is evident by the high rate of fertilizer use at an average of 360 kg/ha p.a., and yields are amongst the highest in the world. However, during the past decade, irrigation expansion to new areas was only marginal; in some areas production declined and land was lost due to increasing salinity, so that the total cultivated area was in a continuing decline, and an average of about 40 000 ha are being lost annually. Consequently, and as production per land unit is already at a high level, growth of production has been and is very slow, only 1.3% p.a. during the last decade, and insufficient to match the population growth. Thus per caput agricultural production is declining, now at a rate of 1.2% p.a., and food imports are increasing at the alarming rate of 20% p.a. As water resources from the Nile are insufficient for a rapid increase in the irrigated area in order to change this trend, the country's efforts have been directed towards prevention of land losses and to reclamation of land with declining productivity. This requires substantive investments in new drainage installations, and improvement and maintenance of such existing systems. Moreover, prevention of salinization and waterlogging calls for efficient water use and management, and improvement and maintenance of the irrigation systems, which would also save water. It is obvious that the traditional surface flow method will continue to be the irrigation method in Egypt, but in marginal areas (i.e. Sinai and oases) a tendency has been noticed to install water-saving irrigation techniques, such as drip irrigation, on small farms, because of the high cost of supplying water and the scarcity of this resource.

In the Magreb countries - a part of this zone - the irrigated portion in contrast to Egypt, is only about 5%, but irrigation growth rates are high, and apparently there has been a break-through in the use of sprinkler irrigation, as most of the new installations are of this technology. Water supply in most cases is from groundwater, and if this trend continues, special measures will be needed to protect the aquifers against over-exploitation or eventual degradation through salinization (as is already the case in Libya). In all these countries the production index is at a very low level, and agricultural production per caput is declining at an unacceptably high rate. But all three countries have a chance to change this situation by further expansion of modern irrigation together with much higher degrees of intensification. The research for developing additional water resources, better water management and eventual re-use of waste water should be accorded a high priority.

In the Sudano-Sahelian zone, the Sudan itself has the largest irrigated area with about 1.8 million ha and 14% share of the cultivated land. This could make a substantial contribution to the

national economy, but agricultural production is low, per caput even declining, and input use is low (less than 50 kg/ha of fertilizer on irrigated land, against the 350 kg/ha in Egypt). It is very obvious that irrigation has not met the requirements for intensifying production, which might have been due to a set of constraints which are typical for Sahelian and Sub-Sahelian Africa. There are deficiencies in the rural infrastructure, transport, markets, supply systems, support services and policies. The effects of this are shown in the Gezira scheme which is of a size to be typical for large-scale projects. The scheme, which was originally built for cotton as an export crop, has neither the technical facilities to be adjusted to the requirements of an intensified and diversifie production, nor the capacity and organizational structure for appropriate operation and maintenance. The spread of waterborne diseases, changes in the structure of the rural society, lack of support services and obsolescence of the infrastructure have added to the increasing deterioration of the viability of the scheme. The necessary and, in fact, already initiated programme for rehabilitation, which is typing to control these factors, should reverse the negative trend; and it could then be an example of am approach to rehabilitation of large schemes.

Somalia, regarded as a part of the Sudano-Sahelian zone because of its aridity, has such limited resources for rainfed or irrigated production that it, at present, cannot provide the food for its population, and production per caput is declining at the very high rate of 4.6% p.a. The irrigation systems in the two river valleys of the country cannot provide the basis for intensification, and input use is almost nil. To obtain a substantive expansion in river irrigation, large-scale water development works have been planned, but their implementation has not yet been started due to lack of financial resources (large external loans are needed), and benefits will not materialize for one or two decades to come. Therefore, to alleviate the country's dependence on food imports, all irrigation efforts should be directed to the modernization and improvement of existing schemes for intensification of production to higher input use, and to the expansion of irrigation through the development of so far untapped groundwater resources and their appropriate management.

In contrast to this is Madagascar, which is more similar to the Asian islands than to Africa. By tradition the staple food in Madagascar is rice, and experience from Asia has proven that rice yields are best under irrigation (full water control) even at low input use. In mountainous islands, water development for large-scale irrigation schemes is costly, if not impossible. Hence, small-scale development of water resources (stream diversion and small storage, although not low-cost are suitable for construction and maintenance by local means) has made possible a large number of small irrigation developments which together provide 80% of the rice land with water. With this average, rice yields are relatively high and stable (1 800 kg/ha) even with a low use of mineral fertilizers (average about 10 kg/ha). In view of this, it is understandable that this type of irrigation has still been expanding at an average rate of 10 000 ha p. . (9.2%) during the past decade.

Some countries which have a minimal share of irrigation in the sub-Sahelian zone must be mentioned because they are representative of a particular trend in irrigation in Africa:

- Nigeria has about 850 000 ha under irrigation, most of it locally managed minor small-scale irrigation in the more marginal northern areas. This type of irrigation has some importance for the local production of high value perishables, and eventually could be expanded for some rice or export crops. Irrigation, however, represents less than 3% of the total cultivated area, and at national level Nigeria has sufficient resources to eliminate the present and predicted food deficits by intensification of rainfed production.

- Senegal is environmentally marginal, and present performance of the agricultural sector gives cause for grave concern (production index 74% of 1974-76 level, per caput production is minus 3.7% p.a., and fertilizer use; minus 5.6% p.a.). Therefore, much hope has been placed on harnessing the resources of the Senegal river. Once the investments for the large storage dam and salt-water barrage have been completed, irrigation could indeed be modernized and extended, if the additional investments needed for this can be made available. However, types of irrigation, production and management systems first have to be determined, and present irrigation development should be used as a pilot activity to conduct the studies and research and to build the required cadres.

- Mali has achieved a remarkable expansion in irrigation which is now 160 000 ha or 7.8% of the cultivated area. This certainly has been a major contribution to the high growth rate of 4.8% p.a. in agricultural production in this country, which is an exception in all Africa.

- In all these countries, water resources planning is done through river basin commissions (Senegal, Niger, Chad) which have been established for most international basins in Africa. Their influence on irrigation development is, however, is rather limited as agricultural planning and corresponding investments are the privileges of national governments.

The continent presents a variety of conditions and constraints which result in quite a diversity of trends in irrigation development in the different zones; for the North and the Sahel these are:

- the aridity of the climate causes a high dependence on irrigation, but a further substantive expansion in irrigation is blocked practically by the non-availability of additional water resources of large potential (Egypt, Libya), or high costs and long gestation periods for their development (Somalia, Senegal);

- as a consequence, most attention has been given to intensification of production (Egypt), but it also needs to be given to better water use in those areas where production is low (Sudan, Somalia).

- where performance of irrigation is low, measures for the increase of productivity must be introduced, such as improved irrigation methods, better management, higher input use and appropriate support services (Somalia, Senegal, Sudan);

  This may entail complete rehabilitation and modernization of the entire scheme, such as for the Gezirna in Sudan;

- where irrigated production per land unit is high, because of high degrees of input use and irrigation intensity (Egypt), more attention needs to be maximizing production per unit of water by judicious water management, minimum leaching, reduction of water losses and, eventually, introduction of water-saving techniques;

- waterlogging and salinization, often induced by irrigation, place a constraint on production and require appropriate prevention measures, or reclamation of affected lands, which requires additional investments for installation of drainage, its operation and maintenance;

- modest expansions in irrigation could be made possible through development of groundwater or re-use of low quality water from effluents, which - combined with piped distribution and sprinkler or drip irrigation - could be quite effective in marginal areas.

By contrast, in the sub-Sahelian part of the continent, trends in irrigation development have been conditioned not so much by a given physical environment, but rather by a set of external and internal factors which can change over a period of time. Factors promoting irrigation development have been:

- experience with traditional irrigation, based on local technology which has been practised in suitable locations by peasant communities for self-sufficient farming (i.e. Northern Nigeria), or for rice as a market crop where the market has existed traditionally (Madagascar);

- growing urban demands which have promoted small irrigation developments for production of perishable crops around urban centres;

- increasing consumption of rice in place of traditional staple foods which lead to the construction of medium and large-size irrigation schemes, specifically for rice;

- demand for agro-industrial production (sugar, milk, fibre) for which a commercial type of irrigated agriculture has been introduced often with substantial foreign investments and under foreign management;

- the socio-economic stabilizing effect of irrigation, which can help to settle the population, improve standards of living and satisfy demand for food and employment;

- and last but not least the demand for an adequate food supply for the whole population, and also for stabilization of food supplies in drought-prone areas.

These last two are the major reason for which the role that irrigation can play in Africa must be redefined.

Factors impeding irrigation development have been:

- the disproportionately high costs of water development and irrigation projects where the appropriate local infrastructure does not exist or is insufficient for the required works (capacity for construction, transport, power supply, settlement, planning and services);

- the sometimes low performance of new irrigation schemes which do not reach the expected level of benefits owing to shortcomings in design, management and services, and also to lack of incentives for the irrigators;

- the discouraging effect of an economic depression, deterioration of the country's balance of trade, or reduction in foreign aid;

- the absence of a consistant national policy for irrigation development as part of agricultural and rural development, also with regard to investment and pricing policies.

In the light of the African food crisis and from an analysis of the situation described above, a recent FAO consultation with irrigation experts from African government services has developed an African concept for irrigation development which provides a definition of the role of irrigation and guide-lines for its further development.

- Large irrigation perimeters can be justified for a viable agro-industrial production where irrigated production is in a competitive position compared to non-irrigated production.

- Irrigation as the sole form of farming is suitable where no cultivation is possible without (arid zones).

- Irrigation can be complementary to rainfed farming when irrigation makes it possible to intensify crop production, to introduce new crops or to open new markets (semi-arid areas).

- Supplementary irrigation can be of interest for particular crops (humid and semi-humid zones).

- Irrigation, as well as other forms of land reclamation, may also be used as a socio-economically stabilizing factor in rural development to help settle the population, improve its standard of living and satisfy its food requirements.

- Irrigation should be developed preferably as part of a wide-ranging area development programme, which must take account of the need to overcome those constraints to irrigation which are of an economic, social and institutional nature.

- Farmers' involvement in all stages of irrigation development and management, and transfer of responsibilities to farmers and water users associations are indispensable for success.

Furthermore, a series of measures are needed to place irrigation development on a sound basis:

- provide a reliable resources data base and broaden it to include socio-economic information;

- establish national policies for irrigation development;

- develop national/local capacities for irrigation planning, implementation, management and irrigation training down to the farmers' level;

- include social parameters in project appraisals;

- include rehabilitation of old schemes in the programmes of irrigation development.

In summary, irrigation should be able to play a more important role than at present to increase and intensify agricultural production if and when the above guidelines are converted into direct action.

6. Latin America

A review of the trends in irrigation development in Latin America can be brief, as most of its elements are the same as in other continents. Latin America has only the small share of 7% of world irrigation, and most of the irrigated area is in five countries.

- Peru is rather dependent on irrigation which is practised on 35% of the total cultivated land. The aridity of the western slopes of the Andes, together with the difficult topography causes new irrigation developments to be very expensive. In addition, measures for the reclamation of salt-affected land needs to be extended in the lower coastal strip. The growth rate of irrigation is only marginal and production is declining. The present financial crisis will lead to a complete halt of investments in irrigation and reclamation and will probably also seriously hinder the necessary maintenance work for the more sophisticated schemes.

- Brazil has the second largest irrigated area of the region, but as this is only 3% of the cultivated land, its dependence on irrigation is low. It is mentioned here because of a very high growth rate for irrigation emanating from a fast expanding

irrigation development programme for the North East. An interesting part of this is the government programme which provides support for the introduction of irrigation on small and medium farms as a means to intensify production and reduce the risk of failure of high value crops.

- Mexico has 23% of its cultivated area irrigated, and is well known for its efficient systems under good management and high productivity. Irrigation is still growing fast as the country has been able to provide some financial resources for hydraulic works which formed the basis for the present expansion.

- In Chile, although in real terms the irrigated area is the smallest among these five countries, it represents 22% of the total cultivated area. However, there was practically no expansion of irrigation in the past decade, fertilizer application was low and declined, and the little rise in total production probably came from an increase in cultivation on non-irrigated areas. Salinity problems in the north could have contributed to the decline in productivity under irrigation.

- Argentina has a long tradition of irrigation development in Mendoza, where irrigation is still being expanded by introducing sprinkler irrigation from groundwater wells.

One particular aspect of irrigation in this region should also be mentioned, these are the ancient small irrigation plants in the higher Andes. They have been of great value for the viability of rural settlements in the high mountain valleys, but are now tending to fall into ruin as a result of the economic depression in those areas. Some support should be provided by all the Andean countries to save these little schemes which are the basis for survival of these rural mountain populations.

7. Summing Up

From this review of the trends in irrigation development in the world, it is possible to identify problems which are of relevance to questions such as how to recover the cost of irrigation, and how much can be charged to the direct or indirect beneficiaries. Following the sequence of this review, the problem areas can be listed as follows.

1. The problem of really global concern is the high investment costs for the development of additional water resources, if irrigation is to be extended on a large scale to new areas. This problem have been approached in different ways.

   i) In developed market economies, there has been a change towards decentralized irrigation which has been made possible by sprinkler irrigation and groundwater development. Both have low investment costs, but high costs for operation, thus shifting the burden of costs from the public to private sector.

ii) In the developing countries of South East Asia, it was not only the high costs but also lack of opportunity for water development on a large scale which caused a change in trend towards the expansion of irrigation within the existing infrastructure where ever possible and needed. Alternatively, the expansion of non-irrigated production and the better use of water through improved management received priority over new projects.

iii) In the arid zone of Western Asia and North Africa, expansion of irrigation is blocked in both directions by high costs and low availability of resources. Thus greater efficiency in the use of water appeared to be the only way to obtain the necessary increase in production; however, this had not often, met with success. The introduction of water-saving irrigation techniques and cost-effective groundwater development could ease the tense situation to some extent.

iv) In Africa the high cost of water development - as experienced in Senegal - might cause a change of priority towards small scale, effective schemes.

2. The second area of interest was the change from horizontal expansion of cultivation to a vertical increase in production per Land and Water Unit. This has been rather successful in irrigated rice production in the Far East and must therefore become the new move in the Near East and North Africa. It affects the irrigators directly as they become more dependent on an exact water supply by the system, as well as on the supply of inputs by the agricultural services.

3. The third problem is the decline in production and degradation of the rural environment caused by salinization, erosion, flooding, diseases etc. It requires countermeasures for which appropriate funding is difficult as investments are not directly productive. The positive role of irrigation for the improvement of the rural environment, as shown for Africa, can be listed under this area.

4. As the last item, the problem of rehabilitation and modernization of irrigation and drainage schemes is mentioned, because it is more the task of the future than an identified trend. It concerns the farmers directly and forces the authorities to arrange for their participation in all phases of improvement, and of course, also in sharing the cost. It is understood that this latter point may be the reason why rehabilitation has been neglected so far; a successful attack on the problem in a few cases, however, might open this important subject to more support.

WATER PRICING POLICIES

The trends of irrigation development have confirmed the important role irrigation has to play for the increase of agricultural production and the improvement of the rural environment. At the same time, however, the trend of increasing costs of irrigation development calls in question the economic viability of irrigation projects. Both tend to demand an enlargement of the involvement of the public sector for financing irrigation in order to attain the agricultural and social objectives on the one side and to ease the burden of costs to make irrigated farming attractive on the other. But public financing of development projects is finding its limits by an unprecedented decline of the availability of funds in the developing countries. This resulted in the strongest competition between the sectors, and subsectors of the national economies, and the allocation of public funds to development projects will ultimately be decided on the basis of the cost/effectiveness by which the objectives (also the socio-political ones) can be attained. This need to reach a high level of cost (effectiveness has lead to the two main lines of present trends in irrigation:

- Reduction of the costs and the public share of investments in irrigation development and

- Intensification of production under irrigation.

It is the purpose of this consultation to discuss the influence which water pricing policies can have on the achievement of these two objectives.

The present trends of regional and national irrigation developments show a logical reaction to raising costs; only those opportunities have been selected for the horizontal expansion of irrigation which avoid too heavy a burden of investments; where such opportunities do not exist, priority has been given to the vertical expansion of irrigated production through intensification, instead of an increase of the irrigated area at all costs.

Both trends are mutually complementary and do overlap, thus a component of each can be found in every project to a varying degree. Water pricing policies have a direct influence on vertical increase of irrigated production where they can provide incentives and disincentives for good water management and production practices: their influence on lowering investment cost is more indirect as they can, for example, provide the incentives for saving water which then could be used for the horizontal expansion of irrigation at low investment cost for water.

In view of this, the Consultation will have to examine the role of water pricing policies in relation to the essential elements of both trends. For their essential elements the following check-list can be provided.

It should be recalled that irrigation water charges could reflect:

i) the cost of delivery of water to the field which can be subdivided in:

- cost of permanent installations and

- cost of operation and maintenance.

ii) The price the farmer can afford to pay for water as a production input.

A water-pricing policy can, through a manipulation of the water charges, encourage or discourage water use, as well as appropriate operation and maintenance, and indirectly subsidize irrigation by transfer of funding from other sources.

With this in mind, it is to be accepted that the enormous costs for large and super-large water development structures or systems must remain outside these considerations.

For the normal size new irrigation development water pricing policy can play an important role in determining the rate of recovery of investment costs through water charges. Moreover, and perhaps even more important, is the determination of the share of the water charge which goes for operation and maintenance of the system, because here the basis will be layed for the proper functioning of the system and the preservation of its value for the future. This part of the water charge can provide one of the desidered links between the individual irrigator and "his" irrigation system.

Water pricing policies have an equally important role for providing incentives and support to improvement and expansion of existing irrigation parameters. Here it is the incentive for judicious water use and introduction of measures for saving water which can come from an appropriate fixing of the price of water. At the same time the introduction of a change for the irrigation water - which previously might have been free and now might be necessary to cover additional investments for the tertiary system and on the farm can be an element to help the establishment of water-user associations.

The same applies to the role of water-pricing policies with regard to the rehabilitation of old irrigation systems. But, quite often, those schemes which now need rehabilitation have deteriorated to this degree by the fact that no organization was in charge of maintenance, and no collection means were available to pay for the necessary repair work, which in some cases even might have been neglected by purpose to obtain subsidies for the rehabilitation.

The water pricing policy for irrigation should also take account of the related measures for maintaining the productivity of the land, such as drainage for salinity control, erosion control and others. Their operation and maintenance should be included in the water charges and administratively under the scheme management.

Finally, the whole question of water-pricing policies within the context of the existing legal framework for land and water property and rights must be given appropriate consideration also with regard to eventually necessary legislative action.