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Issue Paper

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Foreword

The present Issue Paper has been prepared by the Food and Agriculture Organization of the United Nations (FAO) in collaboration with the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF), in support to the formulation of the Recommendations of the Ministerial Meeting on “Water for Food and Agriculture” at the Third World Water Forum, Kyoto, March 2003.

1. Agricultural water management is vital to sustain life

The world's growing population and changing consumption patterns will continue to *drive demand for food*. While the basic water needs of humans and animals are relatively small, it is the production of food and fibre crops that claims the dominant share of water abstractions. These abstractions are consumed through evapotranspiration from crops and soils or returned to watercourses and aquifers as drainage. The net result is that while the daily need of drinking water per person is 4 litres, the water required to produce our daily food is considerable higher, essential requirements are 1000 litres per day but depending on our dietary preferences can vary between 2000–5000 litres.

In addition, it should be remembered that that demands for food and potable water are non-negotiable, so that the primary opportunity for improving overall water management will hinge on the continued improvement of water productivity in existing agricultural systems (rainfed and irrigated).

Agriculture is by far the biggest user of freshwater, accounting for a global average of 70 percent of all water withdrawals. Irrigated agriculture today, occupies less than 20 percent of the cultivated land, but produces 40 percent of the world food supplies and almost 60 percent of cereal production in the developing world. In this sense improved agricultural water management remains the only option for achieving food security. FAO's recently published *World agriculture: towards 2015/30* (herein referred to as AT2030) projects that global food production will need to increase by 60 percent to close nutrition gaps, cope with the population growth and accommodate changes in diets. It is anticipated that agricultural water withdrawal will increase by some 14 percent from 2000 to 2030 in order to meet these food production needs. The report anticipates a net global expansion of arable irrigated land of some 45 million ha (a total of 242 million ha in 2030), with significant regional disparity). This reflects a projected annual growth rate, in water use, of 0.6 percent, compared with the 1.9 percent observed in the period 1963–1999.

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Abstract

The world's growing population and changing consumption patterns will continue to drive demand for food. Irrigated agriculture now claims the dominant share of freshwater abstractions. In the latter half of last century, significant public and private investment in agriculture has resulted in much needed productivity gains, and has closed food security gaps, particularly in areas otherwise vulnerable to climatic variability. Without this massive investment in agriculture, the world would have experienced devastating starvation. Providing enough water to produce food is an enormous challenge, especially in those regions and countries where water is scarce. Therefore a substantial increase in water productivity is needed. This will require both investment in the modernization of existing irrigation systems and the prudent development of new water resources. Irrigated agriculture will need to be carefully examined to discern where society can benefit most effectively from its application. Access to natural resources will have to be negotiated with other users in a transparent fashion in order to effect optimal use of limited water resources to deal with human welfare, food security and poverty reduction. Irrigation is under pressure to perform as a service to agriculture, not as an end in itself. This will involve a shift in approach from a supply-driven to a demand-responsive activity in which a much clearer rationale for the participation of users and the mobilisation of investment is established.

But global totals and averages mask reality since water management questions are generally addressed at local level. Data by country already give a better picture, although in large countries the national totals and averages still hide wide regional differences. The Near East, North Africa and parts of Asia are subject to water stress, when compared with the relative abundance of land and water resources in Latin America, and the low percentage of irrigated agriculture in sub-Saharan Africa. Indeed, lack of investment in productive agriculture can present as many limits as lack of natural resources.

For 93 developing countries, the water use efficiency in irrigation (the ratio between the consumptive use of water by crops and the total amount of water withdrawn) is expected to grow from 38 to 42 percent. However, there are major regional differences: higher efficiencies are reached in the water-scarce regions, while water-rich regions are not expected to make similar gains.

2. The need for continued investment in agricultural water management to make productivity gains

In the latter half of the 20th century, significant public and private investment in agriculture has resulted in much needed productivity gains, and has narrowed food security gaps, particularly in areas otherwise vulnerable to climatic variability. Without this massive investment in agriculture, the world would have experienced devastating starvation. Making these productivity gains will continue to be important. If gains in water productivity can be maintained, the pressure on resources can be decreased and the scope for transfers to other users increased.

The increase in agricultural water productivity has been the result of strategic investment in water development but also in research and development and in agricultural extension. The current investment trends in these components now show a sharp decline. The future of agricultural water management will depend on maintaining levels of investment in key areas of the production chain – not just water control infrastructure. In this respect it is the quality of the investment, rather than the quantity that will be critical.

Therefore investment needs to be a strategic package mixing geomorphology research, improved agricultural practice, trade initiatives and new resource development where required.

Contrary to a widely held view, returns on investments in irrigation are generally comparable to alternative investments. We should also note that many analyses fail to take account of the positive social and environmental benefits of irrigation. Future investments in irrigation will be channelled toward rehabilitation and upgrading. Such incremental investment will benefit from the large amount of sunk costs in existing schemes thereby enabling higher rates of return. A clear indication that irrigation yields adequate returns is the amount of private investment it attracts worldwide. Private investment is estimated to account for 20 percent of the total area currently irrigated (about 264 million ha in 1995/7). The share of private investment in the remaining 80 percent is approximately half of the total investment. Furthermore, there is an estimated additional 70 million ha of land under informal private irrigation that falls outside direct government control.

Having noted the importance of water in food production, we need to appreciate that *the real value of net aid disbursed to agriculture in the late 1990s was only 35 percent of its level in the late 1980s*. There has been a significant fall in the share of agricultural lending in the loan portfolio of the World Bank. This decline has been echoed in the national budgets of many developing countries.

The *downward trend in agricultural commodity prices* (particularly staple commodities) has compounded the effect of the drop in donor support to agriculture. World Bank data indicate that world prices for agricultural export commodities fell by 47 percent in real terms between 1965 and 1998. Low-income elasticity of demand for many such goods and depressed prices are likely to continue. At a time when the major wheat producing belts western United States of America, Ukraine, the Punjab and Australia have all been hit by drought (and wheat prices peaked in early September 2002), we are now seeing a fall in wheat prices as non-traditional exporters continued to shift more of their domestic surpluses onto the world market. Therefore global production and trade flows appears to be remarkably resilient to climatic shock. Water limited countries will continue to be able to substitute domestic production with imported grain – the ‘virtual water’ trade – with little risk if trading systems remain open. These systems of international trade in bulk commodities are becoming more sophisticated and transport costs more competitive.

But despite long term downward trends in commodity prices, developing countries still have to cope with the *high volatility of food commodity prices* against which the existing capacities for risk management and access to hedging instruments are inadequate. Such price fluctuations negatively affect the overall economy and the prospects for the successful design and implementation of sound fiscal, monetary, trade and development policies.

However, aggregate investment in irrigation may have not declined that drastically. During the past two decades, there has been a change in the pattern of investment with increased resources devoted to user participation and a revival in indigenous techniques and traditional knowledge. This has led to cheaper and more effective land development schemes with a shift from large-scale irrigation development to smaller scale initiatives adapted to local conditions and targeted at poor communities. Arguably, it is the *quality* of the investment, rather than the quantity that will be instrumental in making productivity gains, raising incomes and spreading the benefits of irrigated agriculture amongst those in need.

3. The multiple roles of water: the special character of agricultural water use

Management of water in agriculture goes beyond commodity production and addresses a broad spectrum of social, economic and environmental services. The specific objective of agricultural water management is to provide a more reliable and adequate water supply to the crop in question through capture, storage, transfer, distribution throughout the irrigation schemes, and application at field level. Equally rainfall can be harvested and shallow groundwater resources recharged from direct percolation of rainfall and seepage from watercourses. Such physical management will always modify the natural cascades and circulation of water in watercourses and aquifers, and consequently have significant impacts on economic activities, environmental process and people's health. These impacts are known as externalities in the sense that they impact things outside the immediate vicinity of the productive activity.

As with any other human activity, agriculture will always generates externalities which go beyond the primary objective of the activity and can be positive or negative. During the second half of the 20th century, the growing concerns of environmental impacts (pollution) and natural resource depletion have put pressure on industrial activities to eliminate or compensate for their negative externalities, that is, 'internalizing the externalities'. Agriculture is also under pressure to reduce the impact of its negative externalities, particularly those associated with the application of fertilizers and pesticides. But there is now a much wider recognition that agricultural water management has profound positive impacts going much beyond the strict economic systems of crop production. These externalities result from the multiple roles water plays in landscape processes and land management activities and are apparent in a wide array socio-economic and environmental settings.

Management of water for agriculture can result in quite tangible and visible results such as fisheries and tourist amenities in artificial lakes and streams, power production, enhanced recharge to shallow aquifers and augmentation of domestic water supply. The social values generated by agricultural water management may not be so apparent but are nonetheless

very important and include the wholesale socio-economic viability of rural areas, the development of social capital required to manage irrigation systems and the expansion of transport and marketing infrastructure to sell agricultural produce. The positive environmental values include the, creation of artificial wetland systems and associated biodiversity, the promotion of perennial vegetation and micro-climatic amelioration which, in some harsh climates, can make big improvements in the human environment. Equally, land management for rainfed agriculture can also yield positive impacts. Shaping the landscape for harvesting (dry areas) or storing water (rice paddy fields), have profound effect on diminishing erosion and protecting downstream areas from floods. Some irrigation practices can also contribute to the recharge of the groundwater with positive effects on the domestic supply of the near-by population.

Recognizing the diversity and the amplitude of these externalities is fundamental to sustainable development. In the context of the global institutional reform pushing towards more responsive management approaches, each use of water and each positive effect of agriculture practice needs to be recognized appropriately through both regulated allocations and market transactions. In many instances, multi-purposes projects (power production, flood control and irrigation) have proved an effective way to share the costs between several uses, despite the apparent management conflicts. The solution is to take into account all the services provided by such multi-purpose initiatives and share the cost of management in an equitable way.

What is seen by many as an almost unbearable challenge for the agriculture sector – internalizing the externalities – might in fact be seen as a major opportunity to promote a sustainable development in rural areas. By only focusing on crop production, agricultural water management will become unsustainable in economic and environmental terms. But a much more refined appreciation of positive and negative externalities will recognize and reward all water uses and can reduce pressure on the environment while paving the way to economically balanced management. It is in this sense that agriculture needs to draw attention to the multiple roles and effects of agricultural water management in rural and urban areas, and to internalize them in the local systems of land and water governance.

4. Improving the service to users: from supply to demand driven initiatives

Agricultural water management is shifting from a culture of supply management to that of demand management. Modernization of institutions and technology is required to adapt water management to local settings, improve social equity and system performance. Modernization aims to raise water productivity and improve water efficiency by generating water savings. This in turn gives resource 'space' for re-allocation to other competing uses with higher economic or social returns.

During the second half of the 20th century, the irrigation sector has been successful in generating large increases of food production and closing gaps in food security. Large national or state irrigation agencies have been able to put extensive agricultural areas under irrigation. However they have proved less successful in managing these systems after construction. Most of the time, conception and management of these irrigation systems were supply driven. Decision processes were rather a top-down and bureaucratic exercise, which leaves little flexibility to downstream users in choosing cropping patterns planting calendars and water delivery schedules. Furthermore, unreliable water deliveries have been one of the main drivers for the user to turn to groundwater, leading in many instances to over exploitation of shallow groundwater circulation.

This supply driven-model has shown its limits in the 1980s in terms of burden on national budgets and insufficient performance of agriculture, lack of maintenance of the irrigation systems and impacts on natural resource management. Consequently in the 1990's irrigation embarked in a thorough-going reform, a massive transfer of authority and responsibility to local organizations (Water User Associations, Fédération of WUAs, Local Public Agencies etc.). The objective was to create favourable conditions for both improving performance of irrigation systems and raising overall agricultural profitability in order to promote viable farming systems, alleviate poverty and ensure food security. Demand driven management strategies are now taking over, based on principles such as: subsidiarity, responsibility, transparency and responsiveness. Local actors, farmers and other users, are more and more involved in the decision process and in bearing the cost of operation and maintenance of the system.

One of the first priorities of modernization is to assess the physical conditions of the irrigation system and identify the practical options for moving towards more reliable and flexible water delivery service and accommodate a variable demand for water services. Ultimately this is the users who must decide about the level of service they need and are willing to pay for. Modernization programs must then clearly target enlarging technical and managerial options proposed to local users. Modernization is not limited to physical changes, but should be seen as a fundamental transformation in the management of water resources by changing rules, procedures and structures (physical and/or institutional), related to water rights, water delivery services, accountability mechanisms and incentives.

Therefore, modernizing irrigation water deliver is fundamental in reaching a cost-effective service for all users and in improving water productivity. This is a complex challenge for local organizations since water management needs to go beyond commodity production, and integrate all uses of water within the gross command area of a particular irrigation scheme. But it is clear that strategies for modernization should not be developed in isolation but pilot tested, coordinated at various level of organizations and interventions (project, agency, regional and national) and implemented when the requisite capacities are in place.

5. Alleviating the environmental impact: the search for alternatives

Agriculture, and particularly irrigated agriculture, has significant impacts on environment and people's health. Pursuing a narrow development goal of increased productivity has led, in many instances, to the breakdown of the resilience of natural eco-systems. But it is a mixed picture. In some settings there is an obvious need to relax the pressures on the ecosystems. In others, productivity is still low and can be improved while keeping within acceptable environmental limits. The negative externalities linked to agriculture and water management in agriculture, are fundamentally related to land and water uses, agricultural practices (application of pesticides and fertilizers), water quality management (health), drainage management (salinity, water logging). These externalities have to be accounted for explicitly if the long term productivity of the natural systems and their dependant populations is to be assured.

Where agricultural practice is stretching the limits of the land and water resource base and breaking down the integrity and value of the associated aquatic ecosystems, attaining a sustainable level of production will need agricultural practices to search for viable alternatives. Such alternatives, such as re-introducing natural flows, may enhance the overall productivity of the natural systems even if they foreclose on immediate, local economic gains.

The bulk of agricultural abstraction occurs in lowland areas where slack hydraulic gradients have produced extensive wetlands. Raw water extraction from rivers and lakes and the construction of irrigation infrastructure on these lowlands along river banks, invariably displaces the natural wetlands. These wetlands are in themselves highly productive as agricultural and ecological systems. While the application of water may expand extend the life of a wetland, the drainage and return of flows from irrigation often result in un-wanted impacts – loss of water quality, the spread of water related diseases and soil degradation through waterlogging and salinization. It is currently estimated that the lack of adequate drainage is threatening some 500 million hectares of agricultural land across the globe.

Finding alternative ways for agricultural water use and management to alleviate these impacts is therefore essential, not only to maintain the integrity and productivity of ecosystem, but more importantly to create conditions for agriculture to continue to contribute to food security, poverty alleviation and economic growth.

These complex issues depend very much on local conditions and available solutions. Therefore the search for alternatives can only be made a local, case by case basis. However, there are elements of a common approach in this search for alternatives. These technical and policy tools include;

- strategic environmental assessments,
- the application of broad-based cost-benefit analysis to new agricultural investment,
- application of simple and robust methods of environmental monitoring,
- setting of incentives to enhance environmental values,
- regulation of pollution externalities – making the polluter pay,
- consideration of non-structural (no-build) solutions, and
- the explicit integration of irrigated agro-ecosystems in the wider ecosystem frames.

These tools need to be based on clear principles of; shared and transparent information amongst water users, environmental regulators and agricultural producers; participation in the planning and investment process as a step-by-step learning process, and facilitation of local initiatives through national and regional policy-setting.

6. The challenge ahead: re-inventing agricultural water management

The challenges ahead include the elimination of under-nutrition, coping with continued and changing demand for food and reaching a sustainable level of natural resource development and management. It is clear that given current rates of progress in addressing food insecurity, both irrigated and rainfed agriculture will need to be rethought in order to close current and projected gaps in food needs. At the same time management approaches will need to make room for transfers to other competing uses, including municipal water supply and environmental flows. It is in this sense that irrigated agriculture is under pressure to perform as a service to agriculture, not as an end in itself. This will involve shift in approach from a supply, or input-driven activity, to a much more demand responsive activity.

The contribution of *rainfed agriculture* is equally important and a strategic balance between irrigated and rainfed production often needs to be found. This will involve improving and intensifying rainfed farming systems through conservation agriculture, including soil moisture management as fertilizer application.

Six areas of progressive change are emerging:

1. Strategic development of the available land and water resources in order to service effective demand for food products and agriculture commodities.
2. A re-adjustment in the balance between formal irrigation water management and pro-poor and affordable agricultural water management (low cost and small scale options in water harvesting, irrigation and drainage are gaining wide acceptance amongst rural communities)
3. A broader economic awareness of the efficiency and productivity gains that can be made in developing and conserving water for agriculture and sustaining rural livelihoods.
4. A strategy of irrigation modernization, transforming existing rigid command and control systems into much more flexible service delivery systems.

5. Structured and regulated participation of water users – individual farmers and farmer groups, and other interest groups – is proving important at local level in improving food security when it is negotiated on the basis of clear distribution of obligations and liabilities.
6. A realization that agriculture can shoulder its environmental responsibilities much more effectively by minimizing the negative environmental impacts of irrigated agriculture and looking for opportunities to restore the productivity of natural ecosystems.

In this sense there are positive opportunities for improved agricultural water use. In promoting better water use, the behaviour of the individual farmer is key, but water is only one of many farm inputs and its local economic and environmental significance needs to be put into perspective. Government agencies in developed and developing countries will need to develop into that of sophisticated economic and environmental regulators to overcome problems of food production and natural resource depletion. Therefore the continued use of water for agriculture has to be predicated on extracting the value from existing infrastructure and producing into effective markets. Agriculture and water policy have their respective roles to play here and but they need to be much more effectively 'joined up'.

However, certain institutional constraints can be expected to persist. The incentives to manage demand for irrigation services will remain weak (some subsidies to water and energy for pumping can be expected to remain in place) and water is only one of many micro-economic decisions that farmers have to take. The sheer scale of the asset base and the intensity of vested interests may well reinforce institutional rigidities for some time to come. Equally, the distorting effects of price support and input subsidies will continue to dampen private initiatives that might otherwise flourish.

With these considerations in mind, it is possible to identify three keys for unlocking the water potential in agriculture, modernization, governance and investment.

7. Key 1 – Water productivity gains: modernizing irrigation where there is comparative advantage

Water productivity gains are central for irrigated agriculture. Since agriculture will continue to be the main water user, improved agricultural water use in irrigated and rainfed agriculture will have a direct impact on local and regional water demands. Allocations of raw water out of agriculture to other higher utility uses – municipal supplies, environmental requirements and hydropower generation are already taking place, but there is still scope for these allocations to be optimized in economic and environmental terms.

Productivity gains will be obtained through a strategy of improved rainfed agriculture and the modernization of irrigated agriculture, especially the transformation of rigid irrigation schemes into much more flexible service delivery systems, with a much more structured and equitable participation of water users.

The modernization of irrigated agriculture through technological upgrading and institutional reform will be key. FAO has defined this as “*a process of technical and managerial upgrading of irrigation schemes combined with institutional reforms, if required, with the objective to improve resource utilization and water delivery service to farms*”. In this sense, modernization offers boosting water productivity but it also means taking on institutional reform with a purpose, not just reform for the sake of reform. It is systemic and practical without asking that all institutional elements change and it needs to be applied where irrigated agriculture has clear comparative advantage for producing into effective markets. Equally, a much more heightened appreciation of the water cascades and flows across landscapes and the circulation of groundwater within aquifers will lead to informed decisions on the use and re-use of agricultural water.

Therefore irrigation institutions need to adopt a service orientation and improve their performance in economic and environmental terms, including the adoption of new technologies, modernizing infrastructure, application of improved administrative principles and techniques and promotion of user participation.

8. Key 2 – Improving the governance of agricultural water management

Improvements in agricultural water management, such as modernization and conservation farming, can only succeed if strong commitment is given to the engagement and participation of users in planning and investment decisions and the flow of information. Participation is done for a purpose, to raise productivity and incomes and share benefits and while it is true that sharing the benefits of a common resource base may prove hard to negotiate at the outset, the economic outcomes of successful negotiation can be significant.

Access to natural resources is fundamental and here rights in use of land and water need to be stable, but they also need to be transferable if economic gains are to be made. Therefore clear legal and regulatory frameworks for water use rights and land tenure are essential. Sustainable management of water for agriculture also requires formulating effective systems of cost recovery that are socially acceptable and better reflect the value of water in food production. The shift from sector based planning to natural resource based planning is already taking place as economic sectors and their regulators realize that their performance can be improved by sharing a common approach to resource development and environmental protection.

Given the trends outlined in AT2030, positive policy and institutional shifts that have direct impact on the governance of agricultural water management are imperative. It is clear is that irrigation agencies will have to get into the habit of *adapting* within a natural resource planning framework. Within such a framework, adaptive management approaches may appear a little “clumsy” in relation to “comprehensive” or “integrated” approach, but they are systemic and responsive to both the scale of the investment and the institutional arrangements that determine the actual governance of irrigation schemes.

9. Key 3 – Pursue strategic investment in agriculture

Achieving a state of food security sustainable natural resource use will require innovative and strategic investment in order to sustain productivity gains and create new opportunities for water uses. Progress is being made with the application of technology to operational and managerial tasks to improve water use and scheme performance. These improvements are largely based on the principles of irrigator participation, financial autonomy, partial and progressive privatization and corresponding roll-back of direct government operation. The viability of future investments, destined to rehabilitate and upgrade existing schemes or to develop new ones, will continue be enhanced by the application of these principles.

The response of the private sector in generating finance for improved water control can be dynamic where it is not constrained by arbitrary limits or outdated legislation. The incentives for individuals and user groups to invest in water control will always be there when clear comparative advantage exists, both in servicing local markets in food staples and export markets in cash crops. In such cases, the financing mechanisms have to match the medium to long term nature of water control investment and also the sophistication of the market pull. In this respect a strategic mix of micro-credit for small holders, well regulated commercial credit for emergent and large-scale farmers and concessional finance for large scale public infrastructure needs to be aimed at. The inter-play between these types of investment in water control is vital in pulling the irrigated sub-sector out of its lacklustre performance. But it unwise to ignore one element at the expense of another. Equally it is also necessary to adjust these to investments to regional climate, hydrology and agricultural practice while also looking forward for a clearer identification of market opportunities and technology transfer.

The scope of policy intervention to improve agricultural water control and agricultural water use in general is broad. While globally, food production appears to have kept pace with demand (and shown an overall improvement) many problems of local food insecurity and vulnerability to drought persist. Overcoming these physical and socio-economic constraints and allowing

the poor marginalized populations to break out of poverty will continue to require investment in both rainfed and irrigated agriculture. In particular, conservation agriculture, small-scale irrigation, rural infrastructure and market access will be vital in the fight against hunger and poverty.

Three areas of policy and investment intervention can be identified.

- *At micro level, individual farmers and households* need to be assured stable engagement with land and water resources. Systems of land tenure and water use rights need to be flexible to promote the realization of comparative advantage in food staples and cash crops. But they also need to be matched by access to rural credit and finance that suits specific agricultural systems and are not just linked to annual repayment or harvest production, but allow longer term finance of farm inputs. Such initiatives will have to be complemented by the dissemination of technology and good practice in water control and productivity gains.
- *At irrigation scheme level, modernization*, that includes rehabilitation and management transfer, offers tangible scope for extracting the full value out of sunk costs and reducing pressure on public funds. Such programmes are essential before longer term investments in new-build can be evaluated.
- *At macro level, government policy and investments* need to be aligned to allow local markets for agricultural produce to become more effective in meeting local demands. This will require investment in the key public goods such as roads and storage but will also involve a more progressive role for large scale private investment. Creating these conditions while also guaranteeing allocation of sovereign resources through negotiation of shared water resources, for instance, are key considerations.

It is important to look at all three areas in parallel and stage investments as demands grow and the existing asset base is realized. Public and private finance will be required to make these advances. Not only will public finance be required to target poorer rural communities but the *enabling* functions of governments at micro and macro levels will be crucial in maintaining flows of private finance from individual farmers and commercial investors.

In conclusion, food, agriculture and water policies need to be much more effectively “joined up” and backed up with high quality investment into marginalized populations who have the capacity to break out of poverty and into markets where there is comparative advantage.

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