On-Farm Systems : A Discussion on ICID Strategies*

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Abstract

This paper aims at discussing on-farm irrigation and drainage themes which could better respond to the ICID strategies in improving irrigation and drainage throughout the world. After defining the on-farm system and main components, a brief view of world irrigation is presented. The on-farm irrigation system is analysed with relative detail concerning the irrigation methods, irrigation scheduling, farm water supply, crop management, and different aspects which influence the on-farm performances. A similar but brief analysis is also provided for on-farm drainage. Social and environmental on-farm issues are also dealt, mainly for identification of existing concerns and gaps in the engineering practice. On the light of these analysis, the coverage of the different on-farm issues by the ICID working bodies is given and consequent themes are suggested for further consideration: improvement of traditional surface irrigation; issues in on-farm irrigation design; combined approaches on water application and irrigation scheduling practices; relationships between on-and off-farm systems; benefits from improving on-farm practices; good agricultural practices for water and soil conservation; issues in using low quality water in irrigation; environmental impacts assessment; new approaches to on-farm performance; and on-farm valuing the water.

Résumé

Cet article met en discussion plusieurs questions sur l'irrigation et le drainage au niveau de la parcelle dans la perspective d'aider à établir les stratégies de la CIID en vue de l'amélioration de l'irrigation et du drainage à travers le monde. On commence par définir les systèmes à la parcelle et leurs composants et par donner un aperçu sur l'irrigation dans le monde. Par la suite, on analyse le système "irrigation à la parcelle", avec référence spéciale aux méthodes d'irrigation, à la conduite et programmation des arrosages, aux modes de fourniture d'eau à l'exploitation agricole, à la gestion des cultures et à plusieurs questions tenant aux performances de l'irrigation. Des analyses similaires mais plus brèves sont aussi présentées concernant le drainage. Les aspects sociaux et environnementaux sont traités par la suite, avec identification de préoccupations, soucis et lacunes existants dans la pratique de l'ingénieur. A la lumière de ces analyses, on passe en revue la forme comment telles questions sont traitées par les organes de travail de la CIID. En conséquence, plusieurs thèmes sont suggérés pour leur considération, notamment en ce qui concerne l'amélioration de l'irrigation de surface traditionnelle, des solutions pour la conception et projet des systèmes d'irrigation à la parcelle, de nouvelles approches combinant la méthode d'irrigation et la conduite des arrosages, des innovations, visant mieux coupler les systèmes à la parcelle avec ceux de transport et distribution, l'évaluation des bénéfices dûs à l'amélioration des pratiques d'irrigation et de drainage à la parcelle, le développement de bonnes pratiques agricoles pour la conservation de l'eau et du sol, des améliorations dans l'utilisation des eaux de basse qualité en agriculture, l'évaluation des impacts sur l'environnement, de nouvelles approximations à l'évaluation et l'utilisation des performances de l'irrigation et, finalement, des approches innovatives sur la valeur de l'eau en agriculture irriguée.

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* **Les systèmes à la parcelle : une discussion sur les stratégies de la CIID**

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1. Introduction

By tradition, the ICID mainly works through working bodies, essentially working groups. These have a mandate with specific objectives and a limited duration. Recently, also work teams have been formed, with more precise objectives, shorter duration, and hopefully resulting from the collaboration of two or more working groups.

These work bodies produce written material, generally guidelines, due to the collaboration of their members. More recently, a large part of their activities is being oriented to organize Workshops on specific topics. Proceedings have been published through ICID publications, the National Committees, collaborative institutions or other publishers.
The ICID activity is primely expressed through Congresses and Regional Conferences. However, these meetings and respective publications are not directly supported by the current working bodies but the National Committees and the scientific and technical community relative to irrigation and drainage. Congresses and Conferences are periodic and respond to selected themes, namely those considered more relevant by the organizing national committees, while working groups and work teams have a continuous activity corresponding to the main strategies of the ICID.

The ICID recently grouped the working bodies into teams: Research, Policy, Systems, and On-farm. These deisgnations do not fully express the nature of activities of the working groups and work teams so grouped, but give only the respective main focus. Research activities and transfer of innovation definitely also interest the working bodies grouped under the title systems or on-farm, for example. However, aspects relative to research issues are the main preocuppation of the working groups and work teams grouped as the “research” team. The designation of teams “on-farm” and “systems”, the last referring to off-farm, creates some ambiguity. In the author’s view, on-farm irrigation and drainage has to be approached as a system: crop water requirements, irrigation scheduling, irrigation methods, drainage, and control of environmental impacts are not pieces of a puzzle but components of an organized system, the on-farm system. However, despite the importance terms may have, our discussion is oriented further to the strategies of ICID referring to the activities of the working bodies dealing with on-farm systems.

One main objective behind those teams is to provide for preferential horizontal links between the grouped working bodies and therefore facilitate cooperation and cooperative activities. Another is to help re-thinking the strategies of ICID relative to the themes covered by each team. Thus, since ICID mainly works through the working groups and work teams, it is important to openly discuss the respective orientations and support further improvements on their activities. This discussion should not be restricted to those members currently involved in the ICID working bodies but be open to the scienctific and technical community. This is the reason for this paper focusing on the “on-farm” theme.

2. The “On-farm” System

A farm is a complete system for producing food and fiber. This includes many components which are managed as an unit by the farmer. The characterization of this system is very different according to the discipline that approaches the farm. For an economist the components of the farm system are definitely different from those of an agronomist, as are again different when the farm is viewed from the irrigation, drainage and water management perspective. However, all disciplines view the farm as the basic unit for food and fiber production, for generating the farmer's income from the labour and managerial forces devoted to farming, and for contributing to the welfare of the society.

The irrigation and drainage (I&D) perspective views those aspects through the role played by the water and the water control activities, irrigation when water deficits are to be controlled, drainage when excess water has to be eliminated. However, the ICID view has to look further: on-farm water activities not only have positive impacts on yields but may have negative consequences on the labour and social issues relative to the farm, on the environment, and on the soil and water resources in particular. In other words, I&D engineering and management has to perform the best for the farm economic objectives and has to respond to social, labour improvements, and be environmentally friend, particularly concerning the use of water and soil resources.

Considering the aim of this discussion paper, it may be appropriate to represent the on-farm system as composed by the following :

- the **irrigation system**, including the engineering and management tools which provide for maximizing crop yields and farm incomes;
- the **drainage system**, relative to the engineering and maintenance tools which prevent waterlogging, water table and salinity detrimental impacts on crops, and contribute to the farm economy;
- the **labour and social system**, dealing with impacts of irrigation and drainage on the welfare of farmers, workers and the related rural communities;
- the **environmental system**, relative to the impacts of irrigation and drainage on natural resources, therefore also relative to the measures which are necessary to ensure that farm water management becomes environmentally friend and that the use of natural resources is sustainable.

The Box 1 evidences this system and the respective components, and their interactions as observed through the system performance.

For long time, the on-farm I&D performances have been limited to the physical ones. For irrigation, it is tipically the case of the application efficiency and the distribution uniformity. However, we need to further develop and use other innovative approaches to analyse the on-farm I&D performance. On-farm I&D systems shall perform well regarding :

- the economic return of water use and water control;
- the improvements in crop yield resulting from I&D practices;
- the labour requirements;
- the welfare provided by improvements relative to I&D;
- the water conservation, relative to control both water wastes and water quality degradation;
- the soil conservation, concerning the control of erosion, the avoidance of salinity and soil contamination, and the maintenance or restoration of soil fertility;
- the economy of energy, mainly when pressurized irrigation systems are utilized

Box 1. The "On-farm" System

ON FARM

Irrigation

- Irrigation Methods
- Irrigation Scheduling
- Farm Water Supply
- Crops and Crop Management

Drainage

- Design
- Construction and Maintenance
- Impacts

Environment and Natural Resources

- Water Resource Issues
- Soil Resource Issues
- Energy
- Biodiversity
- Landscape

Labour and Social Aspects

- Labour Requirements
- Economic and Social Issues

On-farm Performances

- Social
- Economic
- Environmental
- Water Management

or when water lifting is required to irrigation and/or drainage;

- the biodiversity and landscape conservation, which are of great importance when modernization or new land reclamation projects tend to modify the rural environment.

3. World's Irrigation

On-farm irrigation is often seen under a very simplified way: the irrigation method and the need to improve the respective irrigation efficiency, and the irrigation scheduling practices. Very often it is claimed that a definitive improvement can only be achieved when traditional methods will change into sprinkler or micro-irrigation. However the reality is more complex.

In Table 1 are given the most recent figures about world's irrigation as available from

AQUASTAT, a FAO initiative. It shows that near 70% of the irrigated areas in the world are in Asia. Most of these areas have been developed through centuries, some for more than thousand years. Many efforts have been employed to progressively modernize those systems. Many of the new projects have been established where irrigation was practiced before but with very different water supply. In large part of these areas surface drainage was already praticed and further improvements are being introduced recently. The long term irrigation in Asia is a part of the people's culture. The environment has been modified and maintained by the man. A large part of the Asian landscapes are a consequence of irrigated agriculture, namely the paddy rice basins.

Traditional irrigation, hundreds of years old, also exist in North Africa and Near East - for thousands of years in Egypt - and in Europe. Also there, irrigation contributed to build the landscapes, to create the overall environment, and is integrated in the cultural and social behaviour of rural populations. To modernise these traditional systems is a very demanding task, not only under the technical perspective, but also requiring innovative approaches to social, cultural and environmental issues.

Table 1. Irrigated areas in the world

Region	1000 ha	Percentage
Asia	174,300	68.9
Europe	25,200	10.0
Africa	11,500	4.5
South/Central America	17,600	7.0
North America	22,100	8.7
Australia	2,300	0.9
World	253,000	100.0

Source: AQUASTAT, FAO, 1997

In Table 2 is given the repartition of main irrigation methods in two world regions, Africa and Near East (FAO, 1995 and 1997). Data are only approximate because concerning less than half of the respective countries and irrigated areas. This Table 2 shows that surface irrigation is largely dominant. Very probably, given the importance of the irrigated rice systems in Asia, surface irrigation may largely exceed 90% of the total irrigated area.

Pressurized systems are more often utilized where irrigation is new, corresponding to

Table 2. Main irrigation methods in Africa and Near East

	Surface (%)	Sprinkle (%)	Micro (%)
Africa (1)	85.0	12.5	2.5
Near East (2)	87.6	11.0	1.4

(1) FAO Water Report 7, FAO, 1995

(2) FAO Water Report 9, FAO, 1997

irrigation expansion during the last decades, mainly in large or medium size farms. Surface irrigation predominantly corresponds to small farms. The largest proportion of irrigated areas in Asia is practiced in farms smaller than one hectare.

These aspects call for the need for ICID to define appropriate strategies which could support a progressive modernization of on-farm I&D, particularly in view of the areas where small farmers have limited access to new technologies. The discussion that follows takes these aspects in consideration.

4. On-farm Irrigation

On-farm irrigation faces an old problem: on the one hand, engineers considered the farm as a matter of the agronomists and farmers, and devoted their attention to the off-farm systems; on the other hand, agronomists payed attention to the plant, the crop, and the crop responses to water stress, limiting their approaches to define when to irrigate. The gap between the traditional engineering and agronomy disciplines was left to the farmer. More recently, bridges have been built and large developments relative to the on-farm irrigation systems are now available through research, manufacturers, dealers and support services. Unfortunately, these bridges only became effective to large farms and relatively few developments concern the small ones, the large majority throughout the world.

Irrigated agriculture is often blamed because wasting water, polluting the water bodies, provoking soil salinity, providing poor yields per unit of water used, achieving low economic returns for the investments in new projects or in the rehabilitation of the existing ones. These facts induced effective changes in the behaviour of the irrigation community, well evident in the last decade. One consequence of these changes is a new atitude concerning the on-farm irrigation system, namely the need to fill the traditional gap between engineers and agronomists to provide the farmer with better tools for the sustainability of irrigated agriculture.

The on-farm irrigation system is complex, as illustrated in Box 2. It comprises the water application to the fields, the irrigation scheduling, the constraints imposed by the water supply system, and the cropping system itself. Irrigation performances result from the combination of all these factors.

The water application sub-system concerns the irrigation method: surface, sprinkle and microirrigation. The respective performance can be measured through the uniformity of water distribution along the irrigated field. This performance mainly depends on design. For surface irrigation, this concerns the best combination of discharge rate, field length, slope, precision leveling, field supply system (field ditches, gated pipes) and, when applicable, automation equipments. For pressurized systems, design relates to the best selection of sprinklers or emitters and relative spacings on the laterals and between laterals, sizes of the pipe networks, pressure variation in the operating sets, system controllers and other equipments. In all cases, design discharges and irrigation timings have to be calculated from the foreseen crop demand.

Irrigation scheduling refers to when and how much water to apply, i.e. the irrigation depths and timings. These depend not only on the crops demand but also on the soil water reserve, climatic patterns, crop management, irrigation method and water

Box 2. The “On-farm” irrigation components

IRRIGATION DESIGN & MANAGEMENT

- Hydraulics
- Crops Demand
- Equipment
- Field Evaluation
- Management

IRRIGATION SCHEDULING

- Soil Water
- Climatic Demand
- Crops & Crop Management
- Constraints from Method
- Constraints from Delivery
- Water Conservation Constraints

FARM WATER SUPPLY

- System Constraints
- Drought
- Water Scarcity
- Water Quality, Wastewaters
- Water Price

CROPS & CROP MANAGEMENT

- Crop Demand
- Fertlizers, Fertigation
- Agrochemicals, Chemigation
- Salt and Drought Resistant Varieties

PERFORMANCE

- Distribution Uniformity
- Application Efficiency
- Agricultural Performance
- Economic Performance
- Environmental Performance
- Social Performance

availability. Small irrigation depths can not be applied when surface irrigation is practiced or when delivery schedules consist of several days rotation. The physical performance resulting from the combination of the irrigation method and the irrigation scheduling is the application efficiency. This performance results therefore from irrigation design and management.

Several tools sensing the soil water, the plant water stress or the climatic demand may be used for irrigation scheduling when appropriate tresholds are selected. Some of them are only effective at the scale of a single crop field. Others, namely providing imputs to crop-water simulation models, or using remote sensing facilities, can be used at a large scale. However, appropriate bridges between irrigation scheduling and water application systems are not yet available with exception of integrated systems for large farms, and for automated pressurized systems under non restrictive delivery schedules.

The farm water supply systems play a major role when selecting the water application and the irrigation scheduling systems. For rigid delivery schedules, usually with large time intervals between deliveries, and often with low reliability and low equity relative to water volumes supplied, there are few opportunities to improve the on-farm systems. As soon as flexibility may be introduced, and reliability and equity are increased, conditions are created to improved both water application and irrigation scheduling. This requires that off-farm and on-farm approaches be combined. Positive impacts on yields, on environmental impacts, and on economic returns may then be expected.

On-farm systems are particularly vulnerable to restrictions imposed during water scarcity periods, namely droughts. Restrictions affect not only the irrigation scheduling but crop management and, many times, the crop pattern. However, these restrictions to be effective, and have reduced impacts on the farm production and economics, should result from decisions considering the on-farm system, not only the off-farm supply. When the water application system is inefficient, water wastes may continue to occur. When supply restrictions consider the vulnerability of the crop to water stress, yield losses may be controlled. Enforcing restrictions through water price policies may be ineffective if farmers do not have control on volumes and timings of water application, or when farmers have no adequate procedures to improve field water application. These difficulties are increased when farms are supplied with low quality water.

Because water is scarce, the improvement of yields from irrigated crops is a priority. Agronomic research provided more performant crops and improved cropping techniques, including fertilizers and means to control diseases, pests and weeds. Irrigation scheduling tools, from the computation of crop water requirements to automated sensors and irrigation controllers, became also available. However, the full use of these developments is limited to farms where the irrigator is in full control of the irrigation process. Impacts are reduced when the water distribution uniformity is poor, when the farmer is not in control of volumes and timings of water application, or when the extension, credit facilities and other support services are not available to the farmer. Unfortunately, these less favorable conditions are common for the majority of irrigated areas, mainly for small farmers. Negative impacts on yields and on farmer incomes result, together with negative environmental impacts when runoff or excess water percolation carries agrochemicals and fertilizers out of the root zone.

This brings up the need for considering the performance of on-farm irrigation systems under multiple facets. Water application performances still are fundamental when based on field evaluations because they provide the required information to base advices to farmers for improving their irrigation systems, and they create the information necessary to improve design, extension and support services, off-farm systems management, and to formulate water and irrigation policies. However, it may be good to go further, developing and/or using other performance indicators for measuring: the agricultural performance, namely relative to yields, per unit of water, of land, of labour, or others; the economic performance, namely relative to the farmers income and to the public and private investments; the environmental performance, relative to the potential control of salinity, leaching of nitrates and agrochemicals, transport of fertilizers, erosion hasards, and the conservation of natural resources; the social performance, concerning labour consumption, working conditions and welfare of the small farmer family. Some performance indicators, when they are related with the irrigation practice, may be estimated when field evaluations are performed. Other may be obtained from follow-up surveys, which are often carried out in a regular basis in several irrigation projects throughout the world.

Issues developed above call for new approaches when looking to the on-farm irrigation systems. Some could be favoured when the ICID Working Groups would consider reinforcing or developing new themes. Others require combined competences of existing Working Groups. This is the case for developing new approaches on the inter-relationships between irrigation scheduling and irrigation methods, or between irrigation scheduling and water delivery schedules, about on-farm performances, or concerning the opportunities for improving the on-farm systems when the rehabilitation and modernization of off-farm systems provides for enhanced flexibility, reliability and equity.

5. On-farm Drainage

Drainage essentially acts at farm level. However, impacts of drainage, or the need for drainage, are often defined at the scale of the watertable area or at the basin scale. It results that the drainage design, with exception of large farms, is performed at a scale often much larger then the farm.

The on-farm drainage system (Box 3) has much less farmers intervention than the irrigation system. Enormous progress have been achieved on drainage design, construction and maintenance. However, further developments are required on the relationships between drainage and irrigation, particularly for areas where salinity is a problem or a potential problem, and where wastewater is reused for irrigation. Progress is required in including drainage requirements when irrigation is planned, and in considering specific irrigation requirements when defining drainage criteria.

There is an increased information on specific crop responses to waterlogging, watertable depths, and salinity, as well as about crop specific leaching requirements. Nevertheless, the on-farm water management changes with the irrigation method and the respective performances. Drainage for a drip irrigated crop, using very frequent and small irrigation volumes has different requirements from a basin irrigated crop, where irrigation depths are very large and wettings are unfrequent. Differences also exist between a precision level basin, where irrigation depths are controlled and the uniformity of distribution is high, and a traditional basin, where irrigation depths are not controlled and are uneven distributed. These differences may be less apparent when considered at a large scale in terms of yield or solutes transport out of the root zone.

Progress have been achieved in the evaluation of drainage impacts on yields and, at a larger scale, on the regional hydrology, landscape, water quality and health. Developments have also be attained in evaluating drainage performances. However, as pointed out before, it may be appropriate to put more effort in evaluating impacts and performances relative to the farm or the field scale, particularly under irrigation.

Box 3. The "On-farm" drainage components

DRAINAGE DESIGN

- Hydraulics
- Soil Media
- Hydrologic System
- Requirements
  - ® Waterlogging
  - ® Watertable
  - ® Salinity
  - ® Crops

DRAINAGE CONSTRUCTION AND MAINTENANCE

DRAINAGE IMPACTS

- Irrigated Agriculture
- Hydrology
- Landscape
- Water Quality
- Health

DRAINAGE PERFORMANCES

6. Social and Environmental Issues

The I&D community has been enriched during the last decades with contributions from social and environmental disciplines. The consequence is that engineers, agronomists and other irrigation professionals are integrating, step by step, economic, social, institutional, and environmental approaches into their respective activities. This is particularly evident in relation to economic and environmental issues.

Apparently, progress in social and environmental approaches to I&D are more evident when considering the project scale then when looking to the farm scale. However, economic and social issues directly interest the farmer (see Box 4) and, at project scale, success depends upon achievements at the farm level. Specific approaches to economic and social issues at farm level may contribute to a better understanding of success and failure of irrigation and drainage projects, and to better know, why and when improvements in on-farm water management are accepted and adopted by the farmers. This issue may be particularly relevant because there is a need for expanding improved farm practices which contribute to the sustainability of irrigated agriculture. Farmers only adopt innovative practices when these produce recognizable benefits. Similarly, a large part of the impacts of I&D occurs at farm (Box 4). Issues relative to water quantities - demand control and, particularly the control of water wastes - depend on the performances of water application and irrigation scheduling. Issues concerning water quality are also dictated by the performance of irrigation in combination with farming practices relative to fertilizers and agrochemicals applications. Fertigation may be applied with all irrrigation methods when distribution uniformity is high, and chemigation

Box 4. The social and environmental on-farm components

ECONOMIC AND SOCIAL ISSUES

- Labour Requirements
- Economics of On-farm Irrigation
- Family Incomes
- Health
- Welfare, Food Security

WATER RESOURCE ISSUES

- Demand Control
- Wastes Control
- Water Conservation
- Groundwater Contamination
- Surface Water Degradation
- Good Agricultural Practices
- Wastewater Reuse

SOIL RESOURCE ISSUES

- Salinity
- Erosion, Soil Conservation
- Soil Fertlity

ENERGY ISSUES

BIODIVERSITY

LANDSCAPE

can be practiced with pressurized systems when design is appropriate. Negative impacts from wastewater reuse in irrigation may be lessen when irrigation is highly performant and drainage is adequate. Farming practices, mainly tillage practices, also may play a role in water conservation at field scale.

Appropriate I&D farm practices are essential to keep the soil productivity under arid, saline conditions. Irrigation practices also influence erosion and soil fertility. Soil conservation practices are required when irrigation is practiced in sloping fields and fragile soils.

There is a good knowledge on processes and practices relative to I&D impacts on the water and soil resources, inclusive simulation models which permit to evaluate impacts of alternative practices on water demand, and on water and soil quality. However, there is a need for developing appropriate procedures and guidelines for environmental impact assessment (EIA) of farm I&D practices. Hopefully, on-farm EIA should include the evaluation of impacts on the energy resource base, which is important for pressurized systems, and on biodiversity and landscape.

7. Coverage of On-farm Issues by the ICID Working Bodies

Several ICID Working bodies deal with on-farm issues, but with different degrees of involvement. They are the following[1] :

(a) Specifically oriented to on-farm systems:

- the Working Group on Sustainable Use of Natural Resources for Crop Production (WG Natresource);
- the Working Group on On-Farm Irrigation Systems (WG Farmirrig);
- the Work Team on Use of Poor Quality Water for Irrigation (WT Watquality), which combines action from the above two Working Groups.

(b) Relevant to on-farm systems but also focusing on the off-farm systems:

- the Working Group on Drainage (WG Drainage);
- the new Working Groups on Highly Water Stressed Areas and on Impact of Drought on Irrigated Agriculture, to be merged (WG Watstress).

(c) Secondarily related to on-farm systems, dominantly related to the themes "Systems", "Policy", and "Research":

- the Working Group on Decision Systems for Water and Land Management;
- the Working Group on Environmental Impacts of Irrigation, Drainage and Flood Control Projects;
- the Working Group on Irrigation and Drainage Performance;
- the Working Group on Research and Development;
- the Working Group on Capacity Building, Training, and Education;
- the Work Team Watsave.

Our analysis focus only the first four Working Groups (WG). Future contributions from those under item c) are expected through collaborative actions with the first ones, since the respective mandates are marginal relative to on-farm aspects.

The present coverage of themes analysed above is indicated in Tables 3 and 4. Table 3 refers to the on-farm irrigation issues as these are identified in Box 2. It shows that the WG Natresource and Farmirrig very well complete each other. They already start working together on the use of low quality water for irrigation, and creating the WT Watquality. Both are reorienting their activities, mainly the WG Farmirrig because this one results from fusionming the former WG's on Mechanized Irrigation and Microirrigation. Information on coverage by the new WG Watstress is the intended one, or more likely to occur, because this WG is just being implemented.

The on-farm drainage issues as identified in Box 3 are generally well covered by the WG Drainage except for the aspects discussed above.

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[1] The names of the Working Bodies may have changed at time of publication

Social and environmental on-farm issues are less well covered than the technical aspects of the "on-farm systems". While most subjects are covered regarding the on-farm irrigation system (Table 3), only few aspects are presently dealt concerning the social, economic and environmental issues of on-farm irrigation and drainage (Table 4). This situation indicates that priorities have been given in past to technical engineering aspects, while social and environmental approaches are only now emerging. Conditions are now created to deal with those emerging subjects but keeping the appropriate interest on the technical, engineering ones.

Table 3. Coverage of the on-farm irrigation components by the ICID Working Bodies

	Working Group on Sustainable Use of Natural Resources	Working Group on On-Farm Irrigation Systems	Working Groups on Water Stress and Drought
Irrigation Design & Management			
Hydraulics		❏	
Crops Demand		❏	
Equipement		■	
Field Evaluation		❏	
Management		❏	❍
Irrigation Scheduling			
Soil Water	■		❍
Climatic Demand	■		
Crops & Crop Management	❏		❍
Constraints from Method	❏	❏	
Constraints from Delivery	❏	❏	❍
Water Conservation			❍
Farm Water Supply			
System Constraints			
Droughts	❏		❍
Water Scarcity	■		❍
Water Quality, Wastewater [(1)]	■	■	❍
Water Price			
Crops & Crop Management			
Crop Demand	■		❍
Fertilizers, Fertigation	■	❏	
Agrochemicals, Chemigation	■	❏	
Salt & Drought Resistant Varieties			❍

[(1)] Including the WT on Use of Poor Quality Water for Irrigation

■ Well covered, ❏ not fully covered, ❍ intended

Table 4. Coverage of social and environmental on-farm issues by the ICID Working Bodies

	W.G. on Sustainable Use of Natural Resources[(1)]	W.G. on On-Farm Irrigation Systems	W.G. on Drainage	W.G. on Stress and Drought
Economic and Social Issues				
Labour Requirements				
Economics of On-farm Irrigation	❑	❑		
Family Incomes				
Health			❑	
Welfare, Food Security				❍
Water Resource Issues				
Demand Control	■			❍
Wastes Control		❑		❍
Water Conservation				❍
Groundwater Contamination [(1)]	■	■	❑	
Surface Water Degradation	❍		❑	❍
Good Agricultural Practices				
Wastewater Reuse [(1)]	❑	❑		
Soil Resource Issues				
Salinity [(1)]	■	■	■	❍
Erosion, Soil Conservation				
Soil Fertility				
Energy Issues				
Biodiversity			❑	
Landscape			❑	

[(1)] Including the WT on Use of Poor Quality Water for Irrigation

■ Well covered, ❑ not fully covered, ❍ intended

8. Suggestions for the Future

The ICID is essentially an engineering society. The ICID welcomes multidisciplinarity and this is particularly relevant when dealing with the on-farm systems, where engineering has to to be necessarily complemented by the approaches specific to agronomists, agricultural economists, rural sociologists and other professional. In particular, ICID favours that the engineering profession be enriched when coupled with social, economic and mainly environmental approaches.

Themes suggested for consideration by the ICID working bodies as new approaches to the on-farm system are indicated in Box 5.

Box 5. Themes suggested for new approaches by the ICID Working Bodies

- SURFACE IRRIGATION
  - Improvements of Traditional Systems
  - Paddy Rice Systems
- DESIGN
  - Small Scale Irrigation
  - Design for Management
  - Quality Control of Design
  - Irrigation and Drainage Interactions
- COMBINED APPROACHES ON WATER APPLICATION AND IRRIGATION SCHEDULING PRACTICES
- RELATIONSHIPS BETWEEN OFF- AND ON-FARM SYSTEMS
  - Water Delivery and Irrigation Scheduling
  - Relating Off- and On-farm Improvements
- BENEFITS OF WATER APPLICATION AND IRRIGATION SCHEDULING
- GOOD AGRICULTURAL PRACTICES FOR WATER AND SOIL CONSERVATION
- USE OF LOW QUALITY AND WASTE WATERS
  - Irrigation, Drainage and Farming Practices
  - Evaluation of Long Term Impacts
- ENVIRONMENTAL IMPACTS ASSESSMENT FOR ON-FARM IRRIGATION, DRAINAGE, AND WATER MANAGEMENT
- NEW APPROACHES TO ON-FARM PERFORMANCE
  - Agricultural and Economic Performances
  - Social (Labour) Performances
  - Environmental Performances
- ON-FARM VALUE OF THE WATER

Surface irrigation is a theme requiring better attention because most of worlds irrigation is practiced by this method. Innovative approaches are required to improve traditional irrigation systems, including paddy rice irrigation, to provide conditions which permit to control water wastes, soil salinity and impacts on water quality, as well as to provide for social and/or economic benefits to the farmers.

Design of on-farm irrigation systems is another area of concern, mainly for small scale irrigation. Considering the influence of design on the irrigation performances, new approaches on design for management and on the quality control of design are necessary. The combined design of on-farm irrigation and drainage systems could also receive attention.

Combined approaches on water application and irrigation scheduling practices seem to constitute an area of multidisciplinary developments, important to modernize on-farm irrigation and favoring positive economic and environmental impacts. In relation to the above aspects is the consideration of the relationships between off- and on-farm systems, mainly concerning the mutual influences between water delivery scheduling and irrigation scheduling, and the possibilities for combining improvements in the on-farm systems when the off-farms systems are rehabilitated or modernized. Appropriate collaboration between existing working groups may favour developments in these areas.

Approaches to better evaluate the benefits from improvements in the irrigation method and in irrigation scheduling are also required because the adoption of innovation by farmers is only effective when they understand the respective benefits. New developments are also required in other farming practices which could lead to water and soil conservation.

The expanding use of low quality water, including drainage water reuse and wastewater reuse, calls for more deep approaches concerning irrigation and drainage, both design and management. The development of respective good agricultural practices could also be considered. Methods to evaluate the long term impacts from using low quality waters seem to be of high priority.

The control and evaluation of environmental impacts of on-farm irrigation and drainage practices is one facet of the issues referred above. However, there is the need for developing appropriate approaches for environmental impact assessment of on-farm irrigation and drainage practices, mainly focusing on the water, soil and energy resource. Complementary, new approaches in evaluating on-farm performances are necessary. These should include not only irrigation performances but also agricultural, economic, social (labour) and environmental performances. Finally, because water is scarce, also new approaches are required to value the water used on-farm.