Australian Government

Australian Centre for
International Agricultural Research

Project proposal

project	**Soil salinity management in central and southern Iraq**
project number	LWR/2009/034
proposal phase	Full
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1 Project outline

Project number	LWR/2009/034
Project title	Soil salinity management in central and southern Iraq
ACIAR program area	Land and Water Resources
Proposal stage	Full
Commissioned organisation	ICARDA
Project type	Multi-lateral; Large
Geographic region(s)	Middle East
Country(s)	Iraq
Project duration	24 months
Proposed start date	October 2010
Proposed finish date	September 2012
Time to impact	5 years

1.1 Funding request

		Amounts	Totals
Year 1 2010-2011	Pay 1	1,171,952	1,950,330
	Pay 2	778,378	
Year 2 2011-2012	Pay 3	953,631	1,744,181
	Pay 4	790,550	
Total			3,694,511

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1.3 Project summary

Iraq's agricultural sector is a vital component of Iraq's economy as it is the largest employer (25 per cent of the labour force) and the second largest contributor to GDP behind the oil industry. Iraq is divided into a rain-fed northern winter grain-producing zone and a central-southern irrigated zone that produces vegetables and fruit as well as rice and cereals. In the central and southern part of the country, salinity has long been identified as a major threat to agriculture and has led in the past to policies aimed at improving irrigation and drainage practices, but these were halted in the early 1980's.

Since then, Iraq's extensive irrigation infrastructure has fallen into disrepair and soil salinity has spread across much of the irrigated areas of central and southern Iraq. According to the FAO estimates, more than 2 million hectares are irrigated and it is estimated that approximately 75 per cent are moderately saline and another 25 per cent have levels of salinity that prevent farming.

The issue of salt-induced land degradation is compounded by the increasing levels of salinity in the irrigation water from both the Euphrates and Tigris rivers due to changed water regimes. These changes are a combination of upstream damming of the rivers and subsidiaries in Turkey and Syria, and recent events of climate change/variability.

Australian salinity management experience has demonstrated that solutions to salinity and water management need to be long term, based on integrated resource management and underpinned by robust baseline assessments. The overarching aim of the project is to develop baseline data and information for central and southern Iraq to provide a robust framework for the development of long term sustainable salinity management strategies. Iraqi farmer livelihoods, food supply and environmental outcomes will be improved through the sustainable use of available water and soil resources in central and southern Iraq. The project will assess salt distribution and its drivers and irrigation water salinity at different scales, and develop methodologies for salinity control and productivity enhancement. Research will be undertaken into soils, water, plants and socio-economics across three scales (basin-, irrigation district- and farm-scale) to develop options that enhance the agricultural productivity of saline soil and water resources to the benefit of farmers and the wider community.

The long term success of this project critically hinges on its ability to attract and partner with other major donors to contribute to a long term effort in salinity research and management. Therefore, communication is an overarching component of the project from the outset, targeting major donors and institutions.

An initial project workshop was held in Aleppo (Syria) at the ICARDA headquarters from the 13th to the 16th of June 2009, and its outcomes provided the architecture of this proposal. In addition to representatives from Iraqi and Australian institutions, researchers from three international organizations (ICARDA, IWMI, and ICBA) participated in the workshop.

2 Justification

The irrigated areas in central and southern Iraq (the Mesopotamian Plain) have a long history of development. These areas were the birthplace of civilisation and have relied on the waters of the Tigris and Euphrates River system for their ongoing viability. The area is very flat and lies at the down-stream end of the large river basin that includes Turkey and Syria. There are also regional groundwater aquifers that flow towards the coast under the Plain and discharge over most of the lower Plain. As a consequence, shallow watertables of varying salinities and depths underlie the area. Over the long history of irrigation, these shallow groundwater levels have risen closer to the surface and salinities have been further exacerbated. It is estimated that Iraq is losing about 25,000 ha per year of agricultural cropping land as a result of salinity.

The irrigated areas experience a very arid climate with average annual rainfall below 250 mm and annual evaporation rates being extremely high, around 2000mm/yr. As a consequence the crop water requirement is also very high, probably approaching 20 to 25 ML/ha. This is 10-fold higher than annual rainfall, therefore necessitating intensive irrigation to sustain crop production.

Irrigation throughout the region occurs as long thin strips adjacent to the rivers that takes advantage of the better soils and minimises the transport of water. All irrigated areas are serviced by delivery infrastructure and all have some form of drainage. Previously the drainage from irrigation was either returned to the river, or seeped into the regional groundwater system - in most cases eventually returning to the river over the long term. Today the drainage infrastructure has fallen into disrepair, rendering the system ineffective and contributing extensively to the current salinity crisis.

Recently the demand for water in the Tigris Euphrates river basin has increased dramatically in Turkey and Syria. This has caused a reduction in flow at the downstream end of the Basin, though the exact reduction is unknown. Greater water withdrawal and return of saline drainage water back into the rivers in up-stream countries has reduced the quality of water that moves into the Iraqi part of the basin. This apparent water scarcity and water quality deterioration, together with inefficient delivery and drainage systems combine to present the current problems of increasing salinisation of irrigated fields and reduction in productivity. The deterioration of drainage infrastructure and lack of maintenance in the recent past has further compounded the situation. The recent events of climate change may have affected water availability and quality in the Tigris Euphrates river basin, although data on climate change effects on the water balance in Iraq are not yet available to quantify the possible implications of climate change.

Much work is currently being undertaken within Iraq to explore production gains from saline soil and water management and saline agronomy. However, it is recognised that this work, at the farm scale, must be complemented with work at the basin and irrigation district scale so that the broad strategic policy options can be made to ensure that farm scale change is made within a framework for a sustainable future.

These issues mirror the situation that confronted Australian natural resources managers in the Murray Darling Basin where severe soil salinity and increased stream salinisation presented a significant threat to agriculture. Australia also has a major dryland salinity problem across southern states, and researchers within State Government agencies, universities and two Cooperative Research Centres have been assisting farmers to develop saline agricultural solutions for salt-affected land. The actions taken by Australian bureaucrats and researchers, both at the policy and strategic level as well as the farming systems changes at the local level are particularly relevant to the Iraqi situation.

Australian experience suggests that it is possible to live in a salinised environment, and that there are three substantial avenues for salinity management: (a) the development of engineering solutions, (b) the development of better biophysical solutions, and (c) the increased use in agriculture of salt tolerant crops and other plants. As an example of the former approach, one of the most successful strategies to reduce stream salinisation in Australia was the Murray Darling Basin Commission Salinity Management Strategy under which salt accounting (salt credits) and salt interception schemes were implemented. It is anticipated that similar initiatives will be needed in Iraq.

Other geographical areas with conditions similar to those prevailing in the salt-affected areas in Iraq are irrigation-based agricultural production systems in the Aral Sea Basin, which is fed by two main rivers, Amu-Darya and Syr-Darya. Recent estimates reveal that more than 50% of irrigated soils in the basin are salt-affected and/or waterlogged. While working in the salt-affected area of this basin, ICARDA, IWMI, and ICBA have developed biophysical interventions to improve agricultural productivity. This experience is expected to complement the efforts of Australian institutions in partnership with Iraqi researchers in project planning and implementation.

To address the salinity issues in Iraq, in consultation with AusAID, ACIAR has developed a partnership between Australian researchers from CSIRO and the University of Western Australia (UWA), the State Board for Agricultural Research in Iraq's Ministry of Agriculture, Iraq's Ministry of Water Resources, the International Centre for Agricultural Research in Dry Areas (ICARDA), the International Centre for Biosaline Agriculture (ICBA) and the International Water Management Institute (IWMI).

2.1 Partner country and Australian research and development issues and priorities

With about 8 per cent of GDP and 25 per cent of the labour force, Iraq's agricultural sector represents a vital component of its economy. About 28 million acres in Iraq are cultivable (26 per cent of the total area of the country). The country is divided into a rain-fed northern winter grain-producing zone and a central-southern irrigated zone that produces vegetables and fruit as well as rice and cereals. The central and southern irrigated areas of Iraq (the Mesopotamian Plain) have a long history of irrigation development. These areas were the birthplace of civilisation and have relied on the waters of the Tigris and Euphrates River systems for their ongoing viability but are now seriously affected by salinity issues. In addition to soil salinization, the unstable political situation has also affected the pattern of land use in Iraq. It is estimated that only 7 to 12 million acres are actually cultivated annually. In 1993, the area cultivated was estimated at about 9.2 million acres, of which 8.5 million acres consisted of annual crops and 0.66 million acres consisted of permanent crops.

Past evaluations of Iraqi agricultural production systems reveal an overall decline in agricultural production by about 1.1 per cent annually over the past 20 years. Salinisation of water and land resources in the central and southern part of the country is considered as a major driver leading to agricultural productivity decline. At present, about 70% of the irrigated area in Iraq is subject to varying levels of salinity. Past policies aimed at improving irrigation and drainage practices were halted in the early 1980s. Since then, Iraq's extensive irrigation infrastructure has fallen into disrepair and salt-induced water quality deterioration and land degradation have spread across much of the irrigated areas of central and southern Iraq.

In recent years, redevelopment of the agricultural production sector has been given a high priority by the Iraqi Government to improve the livelihoods of rural communities, enhance food security, and decrease dependence on importation of agricultural commodities. Because salt-affected soils occupy most of the irrigated 'bread basket' of Iraq, the Iraqi Government has revisited its approach for agricultural productivity enhancement from available resources and focussed again productivity enhancement of salt-affected soils through salinity management at different scales.

The overarching objective of this project is to develop baseline data and information to provide a robust framework for the development of long-term sustainable salinity management strategies in Iraq from basin to farm scale. In addition, the project will come up with best-bet adaptation and mitigation strategies at irrigation district and farm scale levels through the selection and implementation of various interventions at demonstration sites. The success of this project critically hinges on its ability to attract and partner with other major donors to contribute to a long-term effort in salinity research and management in Iraq.

2.2 Research and/or development strategy and relationship to other ACIAR investments and other donor activities

The strategy adopted in this project is to initially diagnose the issues and then to develop long term remediation and management strategies at the three scales relevant to the problem – regional (or basin-wide), irrigation district and farm – informed by proven and high level international salinity science and management.

The initial step will be to gain an understanding of how the river basin operates as well as an understanding of how individual irrigation districts fit into this broader hydrological context. This will be critical for the development of an accurate and reliable problem statement that will underpin future investment in irrigation and drainage systems in the region. It will also be crucial to develop farming techniques that adapt agricultural practices to the current and future water supply/salinity and soil quality/salinity conditions. The research strategy will need to address the causes by looking at the overall hydrological processes of the problem as well as the symptoms which require farmers be successful in managing saline soil and water resources.

The salinity issues in the irrigation areas of central and southern Iraq are complex, and are not well described at the current time. It will be critical to understand these complex processes and frame future salinity management options within this context to ensure that farming becomes and remains sustainable.

There will be many impediments to adoption of management solutions related to the political, historical and cultural context of the project. For instance, the areas' complex political and cultural environment, and the long tradition of irrigation practices will challenge the project through potential resistance to change. At irrigation district and farm scale, the research strategy will rely on close collaboration with the farming community and the use of demonstration sites.

Thematic workshops organized at ICARDA and visits of Iraqi researchers to the mirror trial sites in Syria will help in technology transfer to and uptake in salt-affected areas in Iraq.

USAID is currently supporting Iraq's agricultural sector through its Inma Agribusiness Program (2007-2010, US$343 million). Inma means 'growth' in Arabic and its mandate is broad, covering agribusiness and value-adding processing. A component of Inma will support farmers as they restore poorly functioning drainage facilities and improve irrigation practices. This project will complement the engineering work of the USAID program by providing research-based approaches to better irrigation water management and the production of suitable crops in bio-saline environments. In addition, other potential donors such as World Bank are working on improving the quantity and quality of water in four high priority governorates through the rehabilitation and upgrade of the water supply and distribution infrastructure, and are engaging the Iraqi government to develop a sustainable water sector policy. The new strategy of the European Union for Iraq (2011-1013) has already identified water as a priority area for intervention. In addition, ICARDA has already communicated with the Ministry of Foreign Affairs of Italy for potential funding to complement this ACIAR-funded project.

There is also a large program of work being delivered into the Iraqi irrigation sector via the Inma agribusiness project of USAID in Iraq. For example, Inma provides funds for irrigation renovation and soil reclamation programs. Therefore, the proposed research program outlined in this proposal complements the US program already in place in Iraq. Exchange of communication between the Inma project implementation staff in Iraq and the proposed project is expected to greatly assist in achieving the goals of the project.

3 Objectives

With the goal of better livelihoods through improved and sustainable use of available water and soil resources in central and southern Iraq, the proposed project aims to assess the drivers of salt distribution and soil and irrigation water salinity at different scales, and develop methodologies for salinity control and productivity enhancement.

There are four project objectives:

1) Develop a robust conceptualisation of salinisation processes in central and southern Iraq and quantify salt and water fluxes and areas affected by salinity;
2) Determine appropriate strategic approaches to manage salinity that suit local environmental and socio-economic conditions;
3) Assessment of key productivity limitations and opportunities to wheat-based irrigated agricultural systems;
4) Develop investment options for ongoing salinity management in Iraq.

The project objectives will be addressed by undertaking research across three scales (i.e. regional, irrigation district, and farm). These objectives will be met through 7 research components (A to G) and 4 project process components (H to K). The components are:

At regional scale:

1. Quantify the spatial distribution of soil salinity and its causes in central and southern Iraq (Component A);
2. Describe the qualitative and quantitative trends in river and drainage water for central and southern Iraq (Component B);

At irrigation district scale:

1. Quantify and describe the relationship between groundwater levels, groundwater salinity and irrigation activity (Component C);
2. Assess the current state of irrigation and drainage infrastructure (Component D)

At farm scale:

1. Demonstrate best bet practices for different salt tolerant crops, crop varieties and fodders (Component E);
2. Develop methodologies to improve soil, agronomic, irrigation water and drainage management for salinity control (Component F).

All scales:

1. Socio-economic and policy constraints to the effective use and remediation of saline land and water resources in central and southern Iraq at the basin-, irrigation-district and farm-scales (Component G).

The four “project process” components are:

1. Training: Capacity building of Iraqi researchers involved in the project (Component H).
2. Investment options: Supporting continued salinity management in Iraq and linking with other potential donors (Component I).
3. Integration: To deliver on project objectives, outputs (Component J).
4. Communication: Building the teams; building the network in Iraq/with Iraq; ensuring 'sustainability' of the activities in the post–project phase (Component K).

4 Planned impacts and adoption pathways

4.1 Scientific impacts

The project will develop/determine/demonstrate at three scales:

Regional scale:

- A statement of the size and scope of the problem of salinisation of the irrigated areas of central and southern Iraq, and its causes, at the river basin level and at the irrigation district level (Component A).
- A statement of the trends in river and drainage water quality and availability and agricultural production trends in central and southern Iraq (Component B).

Irrigation district scale:

- Quantified relationships between groundwater level, groundwater salinity and irrigation activity, and groundwater management practices that prevent excessive salt accumulation under various climatic, soil and cropping conditions (Component C).
- An assessment of the current state of Iraq's irrigation and drainage infrastructure, in central and southern Iraq (Component D)

Farm scale:

- Farm-level best bet practices based on different salt tolerant crops, crop varieties and fodders (Component E).
- Methodologies to improve soil, agronomic, irrigation water and drainage management for salinity control (Component F)

All scales:

- Socio-economic and policy constraints to the effective use and remediation of saline land and water resources in central and southern Iraq at the basin-, irrigation-district and farm-scales (Component G).

The development of this information will allow clear investment options to be developed for further research, and for other potential donors to become involved in the solutions to address salinity management in central and southern Iraq.

4.2 Capacity impacts

Capacity development for Iraqi scientists from participating institutions and ministries is required to implement the project and to sustain activities after the project. The Iraqi ministries and institutions participating in the project will be the Ministry of Water Resources (responsible for regional-scale activities); the Ministry of Agriculture (responsible for district and farm scale activities); the Universities of Baghdad, Basra and Wasit under the Ministry of Higher Education (responsible for regional, irrigation district, and farm scale activities); and the Ministry of Environment (responsible for farm scale activities).

The project will train Iraqi scientists and technicians from the participating ministries and institutions in skills such as:

- Mapping the spatial distribution of salt-affected lands
- Soil-plant-water modelling
- Regional scale assessment of agricultural production by remote sensing
- Crop screening methods for tolerance to salinity and the other soil constraints operating in saline landscapes.
- Irrigation water requirements
- Soil analysis
- Socio-economics – quantifying effects of salinity on livelihood patterns and poverty of rural households.

Iraqi scientists interacting and working with researchers from Australia and international institutions will update their knowledge with regard to the best management practices in soil and irrigation, farming saline lands, and policy and institutional aspects for integrated natural resource management in salt-affected environments.

4.3 Community impacts

Due to its limited duration (2 years) and the magnitude of the problem the project is primarily about setting baselines (data, information) and identifying the key issues to be addressed. As such, it is unlikely to have direct and measureable farming community impacts within its timeframe.

Provided the communication and dissemination activities (see below) have the expected impact, other donors will engage in the issues identified in the project and community impacts should be long term and significant. This increased capacity will be reflected in both mitigation and adaptation management strategies at irrigation district and farm level.

More immediate impacts will flow from capacity building at the irrigation district and farm scales, whereas the more lasting impacts will eventually flow from managing basin scale issues over a much longer time frame.

The project has major components that focus on:

- The development of further investment by other donors, i.e. supporting continued salinity management in Iraq (Component I),
- The integration of all the outputs of the project into communication packages (Component J),
- Communication to the network of salinity researchers developed in Iraq that will have continuing carriage of the project's theme areas after the current project finishes (Component K).

4.3.1 Economic impacts

It is estimated that 28 million acres in Iraq are cultivable, i.e. 26 percent of the total area of the country. The total area estimated to be currently used for agriculture is 19 million acres. However, due to soil salinity and fallow practices, and the unstable political situation, it is estimated that only 7 to 12 million acres are actually cultivated annually. In 1993, the area actually cultivated was estimated at about 9.2 million acres, of which 8.5 million acres consisted of annual crops and 0.66 million acres consisted of permanent crops.

Salinity has always been a major issue in this area -- it was recorded as a cause of crop yield reductions some 3800 years ago. It was estimated that in 1970 half of the irrigated areas in central and southern Iraq were degraded due to waterlogging and salinity. The absence of drainage facilities and the irrigation practices used (flooding) were the major causes of these problems.

It is anticipated this research project and subsequent initiatives will develop methodologies to improve irrigation water management for salinity control and demonstrate best bet practices for different salt tolerant crops/varieties and soil management approaches. Adoption of these interventions is expected to reduce the area lost to salinity degradation. Iraq is losing about 25,000 ha per year as a result of salinity. In addition, these interventions are expected to slow down the rate of land degradation and contribute to reclamation of saline land.

At the farm level, adoption of interventions to improve irrigation water management for salinity control is expected to improve crop yields. It has been estimated that adoption of salinity control measures in India increases crop yields by 21-32%. Similar gains could represent a substantial contribution to food security and farm income of poor farmers in Iraq.

4.3.2 Social impacts

Adoption of salinity control measures is expected to reverse or reduce many of the social impacts of low productivity, low income and poverty associated with salinity. One of the most important consequences of low profitability resulting from salinity and loss of land is rural migration. Therefore, by improving crop yields and reduction of loss of land to degradation, the project can contribute to reducing migration and the associated cost to rural communities resulting from the declining population associated with migration. Similarly, adoption of salinity control measures may reduce health problems due to stress on families suffering from the impact of salinity on their livelihoods.

4.3.3 Environmental impacts

A summary of priority needs by the Ministry of Agriculture in Iraq suggests that significant savings in water use and avoidance of salinity problems can be made through adoption of drip and under tree sprinkler techniques, as well as other salinity control measures. A key concern in Iraq is the reduced flows and increased salinity of the rivers from Iraq and Iran. Water already is short in Iraq, so further reduction in available water supplies will have a serious impact. Improving on-farm efficiencies from the low current levels assumed to be 30 to 40% but likely nearer 20% or less, to a much more appropriate level through adoption of interventions developed and promoted by the project would have positive impacts on the water supply. Increased salinity makes the return flow unsuitable for re-use in most areas without large amounts of dilution. Water for irrigation needs to be pumped in many cases and also drainage in many cases relies upon pumps. This water lifting consumes a major proportion of energy in an energy-limited country. Thus, programs to improve on-farm efficiency have a high priority because the country could realise potential benefits in both water supply and energy. This project is expected to promote and foster these environmental impacts.

4.4 Communication and dissemination activities

Background

This project will focus on identifying the key drivers of salinity in Iraq and their impact, and suggest management strategies adapted from Australian and other international experience. The success of this project hinges on its ability to attract other major donors to contribute to a long standing effort in managing salinity in Iraq.

Issues

The key communication-related challenges to address in this project are as follows:

- The primary communication need focuses around ensuring the “hooks” are there for long-term engagement of future donors and competent networks of researchers. This project will form the foundation (and the science) for a much larger and longer-term implementation project. Good communication planning will be important to ensure that a) these “hooks” or links are created early and maintained, and b) that expectations about what this particular project will deliver are managed across a wide range of stakeholders.
- The second key area is ensuring emphasis on a basin-wide approach to water and salinity management: good communication around this area will be key to staying “on message” given the range of water management issues across three or four countries in the Tigris-Euphrates basin. Staying on message will be very important given the wide range of stakeholders with which the project team will need to communicate (across national boundaries) and the ultimate focus on improved agricultural production.
- In addition, ensuring good data capture and information management will be key to ensuring that the basis for the longer-term work is captured effectively and passed on.
- Ensuring good communication across the range of project participants, given the challenges of working in Iraq. Communication planning and delivery will be a key part of this. For example, delivering good online tools for collaborative work online (including team forums and data capture and sharing) would be just one example.

Objectives

On the basis of the key issues identified above, the communication objectives are:

- Build stakeholder support and engagement for the longer-term large-scale salinity management project.
- Create focused messages and communication channels to communicate the outcomes of the project.
- Develop and implement an information management strategy and information management infrastructure and practices across relevant stakeholder groups.
- Build and maintain effective communication within the project team including through online tools.

Key audiences/stakeholders

Potential donors adding funds to complement the project-led activities include World Bank, UN organisations (including FAO and IFAD), USAID, EU aid organisations, and AusAID. The project results will be shared with the neighbouring countries with trans-boundary Euphrates and/or Tigris rivers.

The national agricultural research systems and organisations involved in the communication and dissemination activities in Iraq will include the Ministry of Water Resources; the Ministry of Agriculture; the universities of Baghdad, Basra and Wasit under the Ministry of Higher Education; and the Ministry of Environment. In addition, the project results will be shared with other relevant Iraqi scientific organizations and universities, agriculture extension workers, farmers and farmer groups, and key individuals.

Key messages

Key messages will include (but will not be restricted to): Importance of managing salinity on a catchment-wide basis; management of salinity on-farm; project progress and outcomes; collaborative approach; and need for long-term infrastructure and management programs.

5 Operations

The project has 7 components that will work across three scales (i.e. regional, irrigation district, and farm), and 4 project process components. The components are:

1. Research components (7):

Regional scale:

A = Quantify the spatial distribution of salt land

B = Qualitative and quantitative trends in river/drainage water and agricultural productivity

District scale:

C = Quantify and describe the relation between groundwater level, groundwater salinity and irrigation

D = Assess the current state of irrigation and drainage infrastructure

Farm scale:

E = Demonstrate the best bet practices for different salt tolerant crops, crop varieties and fodders

F = Develop methodologies to improve soil, agronomic, irrigation water and drainage management for salinity control

All scales:

G = Socio-economic and policy

2. Project process components (4):

H =Training

I = Develop investment options for continued salinity management in Iraq/linking with donors.

J = Integration (To deliver on project objectives, outputs)

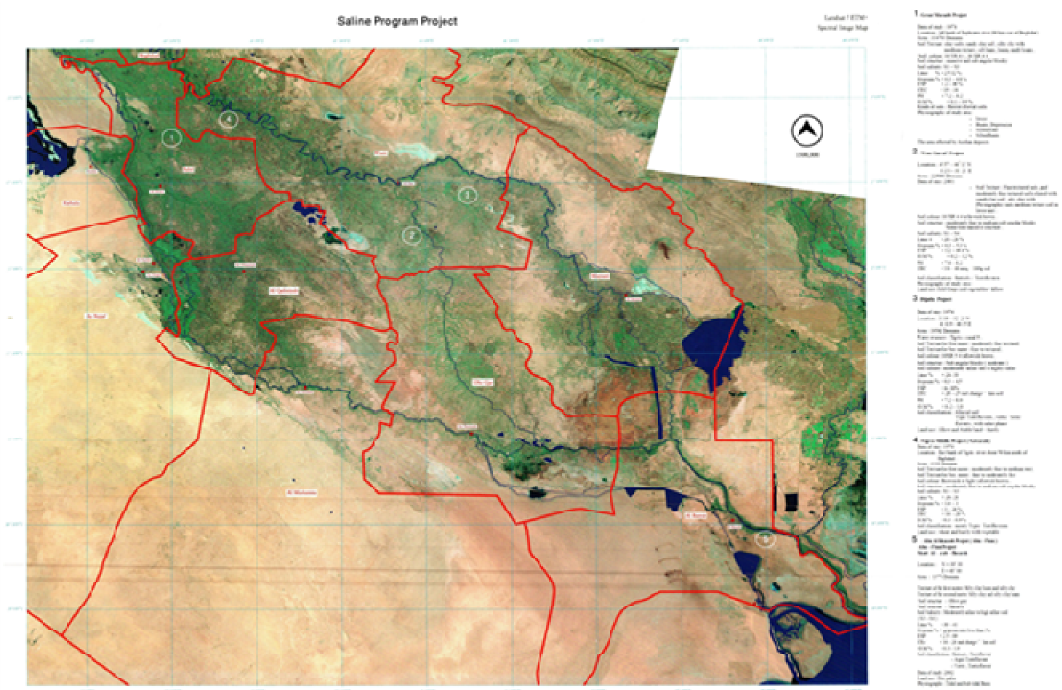
K = Communication strategy (building the teams; building the network in Iraq/with Iraq; ensuring 'sustainability' of the activities post project)

5.1 Methodology

For all project components a critical first step is to collate all existing data and knowledge on the biophysical, economic and social conditions in our area of interest. This will be undertaken in a co-ordinated manner with the Iraqi collaborators to ensure that data gathering is efficient and avoids replication of requests. The data will be managed by the ICARDA communications/IT staff in a searchable database. A full literature search will be undertaken (ICARDA library services) and provided to all the project scientists through the project web portal to ensure they are fully aware of published literature. Grey literature will be collated through personal contacts and shared with the project staff through the project web portal.

5.1.1 – Research Activities

At irrigation district and farm scales the research will have close collaboration with the farming community and the use of demonstration sites in the following locations: Al-Sawera (Wasit Province); Al-Dujeala Project (Wasit Province); Al-Mussiyab Project (Babylon Province); Al-Khraf Project (Al-Nasreia Province); and Abu Alkhasub (Basra Province). The following map provides details of the study area. The final site selections will be subject to discussions at the project inception workshop.



Regional Scale

Quantify the spatial distribution of soil salinity and its causes (Component A)

Rationale

According to recent studies on soil salinity in Iraq (Inma Report: Irrigation, Water Management and Soil Reclamation), there is uncertainty about the extent and severity in irrigated areas. Sources are not backed up by hard evidence (recent surveys) and are contradictory. Moreover, evidence from nearby southern Iran, with similar irrigated areas, points to severe salinity problems depressing crop yields. These points underscore the need for a comprehensive assessment of the spatial distribution of soil salinity.

Objectives

- Quantify spatial distribution of soil salinity, its causes and socio-economic and environmental impacts
- Develop multi-temporal maps of spatial distribution of soil salinity

Methodology

The methodology for regional-scale salinity assessment will be based on the following: (1) secondary data compilation; (2) remote sensing; (3) multi-scale/multi-temporal analysis; (4) field mapping;

1. Secondary data compilation and review: There is an obvious need to compile earlier salinity assessment studies and maps undertaken in Iraq. Considerable work in this area was undertaken by consulting firms before the 1991 Gulf War. Although these studies and maps may be partly outdated, as they do not contain information on salinity reclamation works or salinity increase that may have occurred over the last 20 years, such work is useful in identifying areas of greatest concern and assessing causes of salinisation. Acquisition of recent work on salinity mapping in parts of Iraq, undertaken by RTI consulting, is of even more interest, both from a situation assessment and from a methodological perspective.

2. Remote sensing: two approaches are envisaged for soil salinity assessment: - the direct method by analysis of bare soil reflectance spectra, and indirect - by analysis of vegetation stress.

   By using these methods maps of soil salinity over a range of years will be created and spatial and temporal trends quantified. Trend analysis will locate areas, where vegetation conditions are stable, deteriorating, or improving. Through a process of ground truthing, calibration and verification, the effectiveness of this approach in assessing soil salinity will be verified (see below).

3. Multi-scale assessment will establish models coupling the soil and salinisation features (soil and salinisation types, salt percentage) with remote sensing spectral signatures (e.g., soil brightness, the middle infrared indices and some new kinds of Soil-Adjusted Vegetation Indices (namely SASI) derived from hyperspectral data for croplands). For this spectral characterisation and salinisation mapping, field sampling using EM38 and AccuPAR (LP-80) and soil chemical analysis will be undertaken.

   Once the models are developed from local-scale studies using multi-temporal Landsat images (high resolution), they will be used to differentiate salinisation types and salt percentage to provide a country-level assessment using time-series moderate or even coarse resolution remote sensing data such as MODIS (250 m - 1.0 km), SPOT-Vegetation (1.0 km) and SeaWiFS (1.1-4.5 km) images.

4. Field mapping: Field mapping will be undertaken to link salinity indicators derived from remote sensing with the chemical composition of soils, and spectral measurement (PAR and fAPAR) to build up spectral models of different types of salinisation. This will require a comprehensive soil sampling and field assessment campaign to be undertaken to verify and calibrate the output from the remote sensing activities. A sampling strategy will be developed to account for differences in salinity in both the vegetated and non-vegetated states of the main farming systems, in major soil types, distance to irrigation canals, and quality of canal maintenance.

   Field mapping will also be undertaken over irrigated areas using an electromagnetic survey technique using the Geonics EM38 instrument. This technique is rapid and inexpensive. This will provide detailed data at a farm level for management and planning and enable tracking of changes in salinity over time. At the same time assessment will be made of the depth to watertable.

   Concepts of soils databases and a basic database infrastructure will be developed. This will enable the results of ongoing work to be stored safely and be accessible to planners and researchers.

   Note that the field mapping survey will be linked with component G which will undertake socio-economic surveys.

Outputs

- Quantification of the spatial distribution of soil salinity
- Multi-temporal maps of spatial distribution of soil salinity

- Remote sensing salinisation models that can be disseminated to other regions with similar conditions
- Database of field mapped soil salinity, and possibly a soil archive.

Qualitative and quantitative trends in river/drainage water and agricultural productivity for central and southern Iraq (Component B)

Rationale

Agriculture is the dominant user of water in Iraq and the Euphrates and Tigris rivers are the main sources of irrigation water. Declining water availability and quality (salt and other contaminants) is a major concern. Drainage water generated from agricultural fields in the upstream areas of these rivers is often discharged directly into the river systems resulting in declining water quality that has both direct and indirect implications for all downstream users - irrigators, cities and environmental assets. As available water supplies decrease the reuse of saline drainage and the conjunctive use of fresh and marginal waters is becoming increasingly common in Iraq. This leads to much reduced water availability and increased salinity at the tail end of the river systems, critically impacting these areas. As such determining spatial and temporal trends in water quantity and quality is critical and the development of a framework for the monitoring and management of water quality, especially salt, at a basin scale is required. Determination of the current agricultural productivity levels in comparison to past levels and potential levels is required to demonstrate the impacts of current water availability and quality on agricultural production.

Objectives

- Assess river and drainage waters in central and southern Iraq and the availability of water for agriculture with respect to quality, quantity and requirements for other uses.
- Determine impacts of water availability and quality on current and future agricultural productivity
- Policy and institutional arrangement constraints to sustainable resource management identified
- Develop a draft salinity management framework that provides for basin wide accountability

Methodology

1. Assess quantity and quality of river and drainage waters in Central and Southern Iraq.

- A literature review will be carried out using published and grey literature on the flow regime, water quality status of the river and the biophysical characteristics of the catchment. Water quality and catchment biophysical databases that may be available from research or state government type organisations will be evaluated and where possible analysed for trends in relation to cropping, land use change, flow regime and climate change. The data will be captured into a water and salt balance of the regional flow system showing variability over time. The understanding of the surface water flow routing will be interfaced with knowledge of the underlying groundwater system. The rationale surrounding existing monitoring programmes, data quality and analysis and end use of data will be evaluated. The information will be compiled into a single document.
- A programme of consultative and networking activity will be undertaken to make contact with the key organisations holding historical water quality data and/or those organisations currently monitoring the river and drainage system.

- Gain cultural understanding and identify what the priority values and assets of the river are to a range of stakeholders, what the risks are to those values and assets and the level of knowledge and capacity within the catchment.
- Taking into account existing and historical monitoring programmes and technical capacity, river flow, salinity, pH, turbidity and nutrient monitoring arrangements will be advised at key strategic points (e.g. tributary and end of valley) that may provide baseline data necessary for the setting of targets and the implementation of a future management water salinity strategy. The water quality monitoring will be conducted at an appropriate level depending upon objectives and requirements determined by Iraqi requirements, and guided by the available resources, skills and security. In the first instance this will be a grab sample. The exact suite of analysis will again depend upon the local circumstances; however, the analysis will be conducted at a high level, and specific solutes (such as nutrients) and turbidity will not be a major focus. The monitoring system may be transformed into a permanent framework for water quality and quantity monitoring in consultation with our Iraqi partners. Where possible, the sampling will be aligned with existing monitoring efforts in Iraq. In particular, observations at key gauging points will be undertaken.
- Historical groundwater monitoring programmes and groundwater monitoring networks will be evaluated for the possible inclusion of groundwater quality and dynamics into a river and irrigation water salinity management framework. The approach will be to provide an understanding of the distribution of groundwater and it's salinity. This will lead to a simple water and salt balance model based on a spreadsheet approach. This would be interfaced with a similar level of understanding of the surface water system. It is not intended to develop a groundwater model as it is assessed as not being appropriate investment for the level of data available.
- An assessment of the mix of land management, drainage, river flow and living with salt options will be made to understand historical, current and future tradeoffs between water available for agricultural water use, potential productivity gains and environmental requirements and status.
- Scenario analysis will be conducted for future agricultural production that promote increased water use productivity, reduce soil salinisation and decreased downstream water salinity. The analysis will include the use of saline waters in conjunction with freshwater resources. The approach will be to undertake a scenario analysis development component of work. This will involve liaising with key agricultural and water management and research stakeholders to develop a number of possible scenarios. The analysis will not be to predict what will occur, but rather to understand the possible range of scenarios and how responses to each may be formulated. In this way, a broad pathway of possible approaches is developed and considered, and this will lead to a better understanding of how migration strategies may be formulated.

2. Determine impacts of water availability on current and future agricultural productivity

- Analysis by remote sensing of agricultural areas, crop water use and biomass using:
    - Landsat data to identify major agricultural areas and development in 10 year increments (1980's, 1990's, 2000, and 2010),

    - Time-series MODIS images to analyse growing seasons and annual changes in agricultural activity from 2000-2010 and map large-scale actual agricultural farming systems
    -
    - TRMM to identify rainfall distribution in time and space
- Analysis of potential agricultural production across regions according to water quantity and quality available, soil salinity and groundwater levels and potential downstream impacts, including a ‘do nothing’ scenario.
- Assessment of economic impacts of changing water availability and water quality.
- Analysis of different options for the management of marginal-quality waters, including conjunctive use with freshwater resources. The approach will be to analyse the approach within the context of the resource descriptions available. Earlier tasks will provide a more comprehensive picture of the distribution of both surface water and groundwater resources. This understanding, together with an understanding of what agricultural systems are possible (or a more explicit statement of what objectives are required to be met by agricultural systems) will provide a framework within which the various options can be considered. Essentially, the issue will be to balance the water quality of the water resources available against the desired objectives of the agricultural systems.

3. Review current water and salinity policy and institutional arrangements
    - Collate background material from relevant Iraqi ministries
    - Undertake interviews with key staff in the Ministries to assess the success or otherwise of government policies
    - Workshop the identification of policy failure and possible alternatives

4. Develop a draft salinity management framework that provides for basin wide accountability:
    - Compare and contrast current arrangements in Iraq with integrated approaches used to manage water and salinity in Australia
    - Develop draft framework to provide integrated basin wide management that provides accountability across temporal and spatial scales

Outputs

- Report on historical changes and current status in terms of quality and quantity of river and drainage water, and sources of salt
- Determination of the impact of water availability on current and future agricultural productivity
- Draft water quality framework for basin wide management

Irrigation District Scale

Quantify and describe the relationship between groundwater levels, groundwater salinity, and irrigation activity (Component C)

Rationale

The sustainability of irrigated agriculture is often threatened by high watertables and soil salinisation. These two factors can interact with root-zone waterlogging substantially increasing salt uptake by plants. The elevated watertables in irrigated areas are a consequence of high seepage losses from canals and irrigated fields. Since the drainage needs of these areas are heavily dependent on the irrigation component, groundwater levels should be optimised to guarantee maximum groundwater contribution to the crops through capillary rise without permanently accumulating salts in the root zone. Therefore optimal groundwater table management and irrigation scheduling will be critical in maximising crop yield and maintaining soil salinisation at an acceptable level. However, where high watertables and salinity cannot be addressed merely by changed irrigation practice then subsurface drainage will need to be investigated.

Objectives

- Assess the current state of groundwater levels, groundwater and soil salinity, irrigation infrastructure and practices, drainage infrastructure and its management and their combined impact on crop production and the ‘do nothing’ scenario.
- Determine groundwater management that prevents excessive salt accumulation whilst minimising irrigation water use and drainage requirement under a variety of climatic, soil and cropping conditions

Methodology

We will survey various districts with varying levels of soil salinity, informed by the outcomes of the regional scale soil salinity assessments. In these areas we will survey soil salinity, groundwater levels and crop production. We will survey farmers to understand current farmer adaptations to the degree of salinity and its impact on their cropping, yields and incomes. The survey will include assessing irrigation and drainage infrastructure.

The complex interaction between irrigation, crop evapotranspiration, groundwater level, and soil salinisation can be investigated using simulation models that are able to simulate soil water and solute fluxes under a variety of climatic and physical conditions. Models are also useful tools for estimating the effects of various irrigation management practices on crop production and other water balance parameters. In this study, Soil-Water-Atmosphere-Plant (SWAP) relationship models will be used to determine optimal groundwater table depth and irrigation requirements for maximising crop production.

The model(s) will be calibrated for the prevailing conditions in the study area, which will be established as described in the section below. The calibrated model(s) will then be used to assess different scenarios involving the determination of the effect of different groundwater levels on the salinity status of the soil and its consequent impact on crop production. Simulations will be performed for different groundwater salinity levels under different groundwater table depths, and variations in soil type, land use, drainage infrastructure condition and its management. Based on these simulations, optimal groundwater table depth and irrigation requirements for maximising crop yields whilst managing soil salinity will be determined.

The following activities will be implemented in partnership with Iraqi scientists and research and management organisations (the accomplishment of these tasks will be challenging, but of high importance to the project; they will be heavily dependent on the availability and accessibility of data):

- Collection and analysis of current status of groundwater levels, groundwater salinity, irrigation practices, crop production, incomes and drainage and irrigation infrastructure and its management.
- Calibration of models to existing soil, crop and climatic conditions of the project area.
- Development of different scenarios for evaluating the impact of different groundwater depths, salinity levels and irrigation and drainage practices on crop production and soil salinisation.

Outputs

- Information on current status of groundwater levels, groundwater salinity, irrigation practices and their impact on crop production and environmental degradation.
- Guidelines for farmers on irrigation requirements of different crops under different groundwater depths and soil salinity levels.
- Information on optimal groundwater table depth that needs to be maintained in order to ensure sustainable agricultural production in the project area and the irrigation and drainage infrastructure required to do so.

Assess the current state of irrigation and drainage infrastructure (Component D)

Rationale

Performance assessment of irrigation and drainage infrastructure involves the systematic observation, documentation, and interpretation of the management of an irrigation and drainage system, with the objective of ensuring that the infrastructure provides the basic needs of irrigation (to meet crop water requirements and leaching of salts to maintain appropriate salt balance in the root zone) and drainage (to remove the leaching effluent from the system through a drainage network). This assessment is needed both at the larger scale (district scale) to monitor the overall performance of the system as well as at the local scale (farm scale) to evaluate the efficiency of the system in terms of sustainability of the cropping system.

Regardless of the efficiency of farm-level irrigation practices, adequate collection and disposal/reuse of drainage effluent is crucial to ensuring the sustainability of crop production systems. Considering the fragmented information on irrigation and drainage infrastructure in Iraq, there is a need to assess the current status of the infrastructure to determine key limitations influencing irrigation delivery, irrigation management, and disposal of the drainage effluent.

Objectives

- Document the current state of irrigation and drainage infrastructure
- Assess the factors influencing irrigation delivery, irrigation management, and disposal of the drainage effluent

Methodology

This study will be undertaken through interaction with the irrigation and water management departments and agricultural extension services in Iraq, and farm level surveys and assessments. Data will be collected on the irrigation network at the irrigation district and farm level (irrigation channels/outlets, current irrigation systems such as surface, furrow, drip, and sprinklers and their extent), quality of irrigation water at the farm, irrigation practices, depth of groundwater, quality of groundwater, features of drainage systems (structures, depth of drainage network, efficiency, drainage type, expected life, and drainage maintenance system), collection of drainage effluent, quality of the drainage water, disposal and/or reuse options of the drainage effluent, and cropping system.

The following activities will be undertaken (the accomplishment of these tasks will be dependent on the availability and accessibility of the required information and data):

- Survey of districts with varying levels of soil salinity, informed by the outcomes of the regional scale soil salinity assessments. In these areas we will undertake detailed surveys of irrigation and drainage infrastructure and depth to watertable. This data will tie in with the regional scale assessments of soil salinity.
- Farmer interviews and workshops will be undertaken to determine issues regarding water availability and infrastructure condition and the interaction of these factors.
- Using the regional scale data on water availability and historical productivity combined with the farmer information, assessment will be made of the relative contributions of irrigation management and cropping patterns, poor irrigation infrastructure and ineffective or non-existent drainage infrastructure in causing high water tables in different regions.
- Using farmer and community input develop scenarios for investment in different regions aimed at reducing soil salinity

Outputs

- Description of state of irrigation and drainage infrastructure and its condition across different regions
- Investment plans for pilot scale investments developed

Farm Scale

Demonstrate best bet practices for different salt tolerant crops/varieties and fodder species (Component E)

Rationale

Plant growth in salt-affected soils is decreased because of soil salinity (which may vary in time, space, and depth in the soil profile), and a range of other associated soil constraints (water logging, inundation, micronutrient toxicities). Improving agricultural production in salt-affected areas of Iraq requires plant production systems suited to the range of soil constraints and appropriate soil management practices. Appropriate management technology in combination with the planting of salt tolerant cultivars and halophytes in cropping systems may be an effective strategy to mitigate salt stress and bring salt affected areas under cultivation. Therefore, the provision of salt tolerant germplasm, associated suitable soil management technologies and their dissemination through demonstrations would contribute to increased agricultural production in the salt-prone areas of central and southern Iraq.

According to FAO statistics, livestock production comprises about one third of Iraq's agricultural value with an estimated 6.2 million sheep, 1.7 million goats and 1.5 million cattle. Furthermore, of the area (2 million hectares) of land irrigated for crops, 25% has levels of salinity that prevent farming. This land that has become too saline for crops represents an opportunity for the growth of salt-tolerant fodder plants to complement livestock production systems. However, salt tolerant forage plants are variable in biomass production and nutritive value. Salt-tolerant forages used around the world tend to be wild-type species that have not been selected or managed for improved livestock production. Because of this, there are real opportunities to use research to improve: (a) edible biomass production (kg/ha/year), (b) nutritive value of edible biomass (i.e. the response in animal production per unit of voluntary feeding intake), and (c) the use of micronutrients and nutraceutical properties.

Objectives

- Establish relationships between plant growth and soil conditions for the major crops grown (bread wheat, durum, barley, chickpea, and lentil) and forage species for salt-affected land in Iraq.
- Assess improved salt tolerant germplasm (bread wheat, durum, barley, chickpea, and lentil) to be used for establishing on-farm demonstrations in salt-affected areas of Iraq
- Assess salt-tolerant / halophyte species suitable for economically-feasible fodder and biomass production and demonstrations in salt-affected areas of Iraq

Methodology

This component contains two field research activities (E1 and E2) and a survey and desktop analysis (E3). The trial activities in this component will occur at two locations – one in the project area in Iraq and other in Deir-ez-Zor in the Euphrates Basin within Syria where the conditions are similar to those in the project area in Iraq. Similar trials will be carried out at both of these locations.

The two trials to be conducted are:

E1. Soil conditions and plant growth

This trial will focus on the critical question of which soil constraints most limit plant growth and when they have greatest adverse effects on growth. Detailed measurements will be made of the growth of a small number of typical crops along a salt land transect, with plant growth along these transects being related to a detailed assessment of soil conditions with time and depth in the soil profile. Plant growth and ion concentrations in leaves will be measured at 4 weekly intervals during the growing season and related to regular measurements of soil constraints at a range of depths. Soil factors to be regularly assessed will include: soil salinity, water content, pH, depth to watertable, and salinity of groundwater. Some composite soil and water samples will be taken to assess soil texture and detailed ion composition.

E2. Comparisons of salt-tolerant crops and halophytes for fodder and biomass

Comparisons will be made between the growth and productivity of a range of salt tolerant germplasm of bread wheat, durum, barley, chickpea, and lentil (provided by ICARDA/ICBA) and a range of halophyte species suitable for economically-feasible fodder and biomass production (provided by ICBA). The project team will jointly select and implement the best soil management strategies for salinity management at farm level. In addition, a trial will also be established at ICBA headquarter based on similar highly saline conditions in Iraq and testing production systems that can be introduced in Iraq during the implementation phase, as ‘technology transfer’.

Field-scale plantations will be commissioned that allow hypothesis-driven research to demonstrate benefits/limitations of incorporating salt-tolerant fodder plants in the system. An opportunity exists to examine wider environmental and social benefits if that is of interest to the project leaders. The trial sites will be chosen using an EM38 or through the careful assessment of existing site variation using soil surface visual indicators (e.g. growth of prior crop, presence of salt tolerant weeds, salt visible at soil surface). The plots in E1 will be orientated along a transect so that each species runs from slightly to more highly affected land. The plots in E2 will be orientated in an area with relatively uniform moderate salinity.

The desktop analysis activity (E3) will assess three questions: (1) Are crop residues used for livestock production and what are the major nutritional constraints for livestock? This question will be answered by surveying existing data on ruminant production systems, the feed base and times of feed shortage in the target area. (2) Are the nutritive values of fodders related to the soil conditions? During the course of activities associated with the other project components, representative samples of fodder will be collected and analysed in the laboratory for relevant nutritive value traits: nutritive value will be related to the salinity of the soil, degree of water logging and other relevant soil constraints. (3) Can the growth of fodder plants on salt affected land fill seasonal feed gaps? This issue will be assessed by examining synergies between the times of feed or nutrient shortage (from 1) and biomass production/nutritive value (from 2). The analysis will assess systems where the synergies between potential fodder supply and demand can be tested in a future research proposal.

Outputs

Activities E1 and E2 will provide us with an understanding of which soil factors most affect plant growth and when the effects of those stresses are most significant. This knowledge will increase the production of crops (cereals and legumes) and halophytic fodder species on slightly to moderately affected salt land, potentially the most productive saline soils in Iraq. Activity E3 will determine the degree to which salt-tolerant fodder plants can be matched to local animal production systems in more highly to severely affected salt land. The outputs will be:

- Identification of the major factors responsible for the decreased growth of crop and fodder plants on salt affected soils in Iraq and development of relationships between the intensity of these factors (and their interactions) and plant growth and yield/productivity.
- Identification of salt-tolerant plants that can produce biomass on land that is too saline and/or waterlogged for cropping
- An understanding of how forage can be used to optimise and complement local livestock production systems (for use in a subsequent livestock focused project).

Develop methodologies to improve soil, agronomic, irrigation water and drainage management for salinity control (Component F)

Rationale

Salt management or salinity control is a critical component of irrigated agriculture in arid and semi-arid regions. Successful crop production cannot be sustained without maintaining an acceptable level of salts in the root zone. This component will examine the package of strategies (soil management, agronomic management, and the management of irrigation and drainage) that can be used to manipulate and reduce the salt concentrations in the root-zone of annual crops. A number of approaches could be considered, including:

- Appropriate irrigation water management; this is a key means for leaching salt out of the root-zone and minimising the input of salt into farming systems.
- Suitable drainage and the safe disposal of saline drainage water, which can degrade the quality of receiving water bodies.
- Soil reclamation strategies such as the scraping and removal of surface soil, proper use of ridges or beds for planting, the use of mulches and soil ameliorants.
- The use of pre-sowing irrigation with good quality water to reduce the salt load affecting seed germination and seedling establishment.

Objectives

- Determine the best current soil, agronomic and irrigation practices to manage salinity in different regions.
- Communicate best practice in the areas of soil, agronomic and irrigation water management to farmers.

Methodology

This component contains a survey and desktop analysis (F1), a communication activity to demonstrate best practice (F2) and a research identification activity (F3). The communication activity will occur at two locations – one in the project area in Iraq and other in Deir-ez-Zor in the Euphrates Basin within Syria where the conditions are similar to those in the project area in Iraq.

F1. Survey and desktop analysis

Although the short project timeframe does not allow for extensive investigation, this methodology will allow the project to survey and assess current best soil, agronomic and irrigation management practices for salinity control, and identify the farmers using these techniques. The activity will: (a) identify which are the outstanding farmers in each region, and/or in differing salinity affected areas, (b) determine what makes these farmers outstanding (eg. use of soil, agronomic or irrigation techniques or use of social/physical/economic capital), (c) monitor the fields of outstanding farmers to understand what is occurring, (d) benchmark these farmers with surrounding farmers (using other survey data), and (e) determine what aspects of the outstanding farmers can be usefully promoted in the same and other regions. The field survey will be linked with component G which will undertake socio-economic surveys.

F2. Communication of best practice

This activity will demonstrate different “best-bet” soil, agronomic and irrigation water management strategies. Using the understanding developed in F1 the current best practice will be communicated to farmers in an extension program that will use the current best practice farmers as models. This extension program will use the best farmers as models and advocates whilst supporting this with a quantitative understanding of the approach these farmers are using and the benefits they derive compared to surrounding ‘traditional’ practice. Measurements will be continued at the best practice farms to demonstrate salt management, water management and yield of wheat.

F3. Research identification

Based upon the understanding developed in F1 of current best practice the research team will assess the research requirements to further refine these best practices and research required to adapt theses best practices to other regions. This will lead to the development of research plans for implementation by Iraqi agencies with donor agencies. Where applicable and feasible the project may undertake some pilot one year trials to provide an initial assessment of some of the research ideas. If this is possible it will provide substantiation for the proposed research making it more attractive for funding.

Outputs

- Identification of the best soil, agronomic, irrigation and drainage management strategies for salinity management at farm level.
- Extension and adoption plans to promote these best practice techniques
- Research plans to further develop these best practice techniques for future funding

All Scales

Socio-economics and policy (Component G)

Rationale

The nature and extent of salinity at the regional and district level and the impact of salinity at the farm-level are not well documented. In addition, no credible assessment has been undertaken in recent years of the cost to Iraqi agriculture, the livelihood patterns of farm families and the policy environment affecting water and salinity management. Iraqi agriculture is in need of modernisation of its irrigation systems, but also in need of farm level water management strategies, salinity control, irrigation management, and enabling water policy structures and institutions to enable the country's agriculture to cope with or mitigate the effects of salinity. Previous attempts to cope with or mitigate the effects of salinity have focused almost exclusively on field drainage, which is a highly expensive proposition that may not have been appropriately prioritised. Future activities to mitigate or cope with the effects of salinity through the auspices of this project will focus on development, evaluation and extension of efficient and cost-effective farm-level technologies, and appropriate basin scale salt and water management strategies, policies, and institutions. In order to improve farm water productivity under saline agriculture, it will be necessary to address rehabilitation priorities as they relate to soil and water salinity problems, create mechanisms for direct farmer participation in the development, evaluation, extension and monitoring of technologies for saline agriculture, and highlight livelihood-enhancing and employment-generating opportunities for farm families.

Component objectives:

Regional scale (in conjunction with components A and B)

- Review the existing agreements, policies and institutions and assess their influence on water allocation and hence cropping patterns at the district and farm levels.
- Determine strengths and weaknesses of current institutional and policy arrangements for water and salt management in Iraq
- Estimate the economic impact of salinity at the regional level and the future 'do nothing' scenario.

Irrigation district scale (In conjunction with components A, C and D)

- Identify and assess land use policy measures that can be implemented based on experience at farm and district level
- Determine the effects of salinity on livelihoods patterns, poverty and vulnerability of rural farm households within irrigation district.
- Estimate the economic impact of salinity at the irrigation district level.

Farm scale (In conjunction with components E and F)

- Determine the effects of salinity on livelihoods patterns, poverty and vulnerability of rural farm households.
- Develop a typology of farm household farming systems, agricultural productivity of irrigated areas, and the types and current levels of technology use for mitigating the effects of salinity.
- Estimate the private (farm-level) and social impacts of salinity in Iraq

- Identify and evaluate efficient and cost-effective technologies for saline agriculture.
- Identify policy and institutional constraints to the adoption of efficient technologies for saline agriculture and to identify policy options to overcome these constraints.

Methods:

A review of existing policies and institutions will be conducted based on government policy documents, previous reviews and meetings with policy makers and government officials. The information collected will include the institutional arrangements, prices of outputs and inputs, specific policies in relation to prices, subsidies, water allocation and distribution policies and investments, specific development programs, and strength of extension. This will establish the history of institutions, salinity policies, lessons learned in successes and setbacks in policy making and implementation; current policies, the impacts of these policies on farmers behaviour and on the adoption of more efficient and sustainable practices and cropping patterns, and the degree to which the policy-making process is amenable to dialogue in land use policies and their impacts.

A baseline survey of farm households will be undertaken in the first year, aligned with component A which will map the physical distribution of soil salinity. The data will form a reference for monitoring changes in farmers' perceptions, practices, and technology adoption in future. Information collected will include farming systems under salt-affected environments, the incidence and extent of salinity, crop yields, types and costs of technologies available, current levels of saline agriculture technology use by farmers, other livelihoods, asset status of farming households, and market prices for both inputs and outputs. The data will be disaggregated by gender to ensure that gender aspects are fully considered. Farmer perceptions and knowledge of options for sustainable management of saline agriculture will be documented and options developed by the project will be evaluated for profitability, risk-reduction capabilities, farmer acceptance and potential for uptake.

These analyses will utilise econometric techniques for estimating technical relations between crop productivity, input use, level of salinity and production technology, and will identify causes of inefficiency in the production system and the extent of productivity reduction due to salinity. For technology options and policy analysis, minimum data modelling and trade-off analysis will be applied.

Outputs:

- Farm household characterisation in the target areas
- The impact of salinity on livelihood patterns analysed and economic costs of salinity estimated.
- Socio-economic benefits of technology options for saline agriculture assessed
- Documentation of current institutional and policy arrangements and their strengths and weaknesses for management of salt and water
- Options to overcome policy and institutional constraints identified.

5.1.2 – Project Process Components (cutting across Components A–G)

Component H

Training

Throughout the project implementation Iraqi partners will be involved and given formal training courses on data collection, data management, survey methods, and economic and environmental economics methods. Specific training will be determined according to the needs of the research team, currently identified training outcomes include:

1. Training in Syria in soil salinity mapping and use of EM38
2. Training on the use of SWAP model hosted by ICARDA
3. Training on salinity management through saline agriculture techniques, led by ICBA
4. Training of Iraqi scientists for experimental planning and implementation at the project demonstration sites in Syria and Iraq
5. Training of Iraqi researchers for socio-economic research, led by ICARDA

In the process of selecting suitable candidates for the above-mentioned training and capacity building activities, emphasis will be given to the selection of qualified female scientists.

Component I

Developing investment options for continued salinity management in Iraq

The overarching objective of the project is to develop baseline data and information to provide a robust framework for the development of long-term sustainable salinity management strategies in Iraq from basin to farm scale. In addition, the project will come up with best-bet adaptation and mitigation strategies at irrigation district and farm scale levels through the selection and implementation of project-led interventions at various demonstration sites. The success of this project critically hinges on its ability to attract and partner with other major donors to contribute to a long-term effort in salinity research and management in Iraq.

Objective

Develop investment options for continued salinity management in Iraq

Methods

- At inception workshop identify key stakeholders. Then develop tailored communication strategy appropriate to each stakeholder. This will require development of communication/meeting strategies between the Project Team and future donors to ensure baseline data and 'best bet' amelioration techniques align with donor's strategic plans for the region. This will probably include: an initial workshop with donors soon after project inception, regular updates and meetings, sharing draft reports, end of project workshop. Where appropriate the project will encourage donor staff to become involved in data collection and analysis with the project team
- Engage with donors to test the project assumption that potential donors currently have inadequate levels of quality baseline data and information on the status of salt affected agriculture in Iraq which is restricting their confidence to fund projects

- Investigate donors preferred investment strategies e.g. socio economic aspects of irrigation water management (farmer water user groups etc), physical infrastructure, governance issues etc and assess the best investment mix in mitigation and adaptation at the various scales.
- Align 'best fit investments' of potential donors in the region with the baseline research to ensure the data collected will align with their overarching strategies.
- In collaboration with donors develop a matrix of potential solutions of both mitigation and adaptation for rehabilitating degraded irrigation systems with the following categories:
    - Agronomic based solutions;
    - Governance based solutions;
    - Engineering based solutions;
    - Social or culturally based solutions.
    - Economic or value chain solutions

Outputs

- Communication programme for donors and Iraqi government to engage with this project as a tool for developing investment options in irrigation and salinity control in Iraq
- Investment options developed that align with donors strategic plans for the region and Iraq government requirements

Component J

Integration activities

The above activities and targeted achievements will be synthesised by a multi-disciplinary team to provide the following outputs:

1. A report on the spatial distribution of soil salinity, its causes and socio-economic and environmental impacts in central and southern Iraq
2. Preliminary definition of strategic approaches to manage soil salinity that suit local environmental and socio-economic conditions
3. A matrix of key productivity limitations and investment requirements to improve irrigated agriculture.

Component K

Communication strategy

The communication strategy will consist of building the teams and networks in Iraq to ensure 'sustainability' of the activities in the post-project phase. A first step will be to collate all information on current research and development activities being undertaken in the agriculture and water sectors. This will be used to determine research partnerships/collaboration/synergies and input to the communication strategy as to the stakeholders already involved in the sector. Therefore, the main features of the communication strategy will be:

- On-going communication of the outputs of the project

- Building the research teams/research network in Iraq
- Ensuring 'sustainability' of the activities post-project phase

There will be a number of aspects to the communication strategy:

- A web portal for communication within the project team
- A website for public communication of the project aims and progress
- Meetings/workshops with project collaborators and key stakeholders such as the Ministry of Water resources; the Ministry of Agriculture; the Universities of Baghdad, Basra and Wasit under the Ministry of Higher Education; and the Ministry of Environment.
- Meetings with agriculture extension workers, farmers and farmer groups, and key individuals.
- Meetings/workshops with donor agencies such as World Bank, UN organisations (including FAO and IFAD), USAID, EU aid organisations, and AusAID.

Key messages of the communication strategy will include importance of managing salinity on a catchment-wide basis; management of salinity on-farm; project progress and outcomes; collaborative approach; and need for long-term infrastructure and management programs.

5.2 Activities and outputs (assumes start date of 1 September 2010, end 31 August 2012)

No.	Activity (Component)	Outputs	Due date of output	Risks / assumptions	Applications of outputs
	Regional Scale				
1 (A)	Quantify the spatial distribution of soil salinity and its causes in central and southern Iraq	1. Relevant RS-Salinisation models that can be disseminated to other regions with similar conditions 2. Multi-temporal maps of spatial distribution of soil salinity 3. Database of field mapped soil salinity, and possibly a soil archive.	1. Feb 2011 2. May 2011 3. May 2012	Data availability Adequate security to access relevant areas in Iraq	1. Benchmark data for future comparison 2. Problem definition for stakeholders and donors/investors 3. Problem definition for stakeholders and donors/investors
2 (B)	Qualitative and quantitative trends in river/drainage water and agricultural productivity	1. Report on historical changes and current status in terms of quality and quantity of river and drainage water, and sources of salt 2. Determination of the impact of water availability on current and future agricultural productivity 3. Policy and institutional arrangement constraints to sustainable resource management identified 4. Draft water quality framework for basin wide management	1. Feb 2011 2. May 2012 3. May 2012 4. May 2012	Data availability Adequate security to access relevant areas in Iraq	1. Benchmark data for future comparison 2. Problem definition for stakeholders and donors/investors 3. Iraqi ministries and donors use as initial assessment of policy and institutional hurdles to sustainable development 4. Framework for initial implementation in Iraqi institutions and for donor investment for further development

	Irrigation District Scale				
3 (C)	Quantify and describe the relation between groundwater level, salinity and irrigation	1. Information on current status of the groundwater levels, groundwater salinity, irrigation practices and their impact on crop production and environmental degradation. 2. Guidelines for farmers on irrigation requirements of different crops under different groundwater depths and soil salinity levels. 3. Information on optimal groundwater table depth that needs to be maintained in order to ensure sustainable agricultural production in the project area and recommendations on irrigation and drainage infrastructure to do so.	1. May 2011 2. Dec 2011 3. May 2012	Data availability Adequate security to access relevant areas in Iraq	1. Benchmark data for future comparison 2. Irrigation extension staff 3. Input to investment decisions by Iraq government and donors
4 (D)	Assess the current state of irrigation and drainage infrastructure	1. Description of state of irrigation and drainage infrastructure and its condition across different regions 2. Investment plans for pilot scale investments developed	1. Aug 2011 2. May 2012	Data availability Adequate security to access relevant areas in Iraq	1. Benchmark data and problem definition 2. Input to investment decisions by Iraq government and donors

	Farm Scale				
5 (E)	Demonstrate the best bet practices for different salt tolerant crops, crop varieties and fodders	1. Identification of the major factors responsible for the decreased growth of crop and fodder plants on salt affected soils in Iraq and development of relationships between the intensity of these factors (and their interactions) and plant growth and yield/productivity. 2. Identification of salt tolerant crops and varieties for saltland 3. Identification of salt-tolerant crops and varieties. 4. Identification of forages that can produce grazable biomass on land that is too saline and/or waterlogged for cropping 5. Develop understanding of how forage can be used to optimise and complement local livestock production systems (for use in a subsequent livestock focused project). 6. Research plans to further develop cropping techniques for future funding 7. Extension and adoption plans to promote these best practice techniques	1. Aug 2011 2. May 2012 3. May 2012 4. May 2012 5. May 2012 6. Jul 2012 7. Aug 2012	Data availability Adequate security to access relevant areas in Iraq	1. Research and extension organisations 2. Research and extension organisations 3. Problem definition for future investment

6 (F)		1. Identification of best soil, agronomic, irrigation and drainage management strategies for salinity management at farm level 2. Demonstration of some of these best bet strategies 3. Research plans to further develop these best practice techniques for future funding 4. Extension and adoption plans to promote these best practice techniques	1. May 2011 2. Jul 2012 3. Jul 2012 4. Aug 2012	Data availability Adequate security to access relevant areas in Iraq	1. Benchmark data and problem definition 2. Agriculture and extension services 3. Agriculture and extension services 4. Research organisations and funders 5. Extension services
	All Scales				
7 (G)	Socio-economic and policy	1. Farm household characterisation in the target areas 2. The impact of salinity on livelihood patterns analysed and economic costs of salinity estimated. 3. Socio-economic benefits of technology options for saline agriculture assessed 4. Documentation of current water management, institutional arrangements and policy, their strengths and weaknesses and options to overcome policy and institutional constraints identified (with component B).	1. Feb 2011 2. Jun 2011 3. Feb 2012 4. May 2012	Data availability Adequate security to access relevant areas in Iraq	1. Benchmark data for future comparison 2. Problem definition for stakeholders and donors/govt 3. Investment benefits defined for donors/govt 4. Options for initial implementation in Iraqi institutions and for donor investment for further development
8 (H)	Training	1. Training in Syria in soil salinity mapping and use of EM38 2. Training on the use of SWAP model hosted by ICARDA	1. Jun 2011 2. Aug 2011	Travel can occur	1. Ongoing mapping of soil salinity in Iraq 2. Ongoing analysis of irrigation management options in Iraq

9 (I)	Develop investment options for continued salinity management in Iraq/linking with donors.	1. Communication programme for donors and Iraq govt to engage with this project as a tool for developing investment options in irrigation and salinity control in Iraq 2. Investment options developed that align with donors strategic plans for the region	1. Nov 2011 2. Aug 2012	Interest of donors	1. Engagement with donors & Iraq govt 2. Investment options for donors and Iraq govt
10 (J)	Integration (To deliver on project objectives, outputs)	1. Report on the spatial distribution of soil salinity, its causes and socio-economic and environmental impacts in central and southern Iraq 2. Preliminary definition of strategic approaches to manage soil salinity that suit local environmental and socio-economic conditions 3. A matrix of key productivity limitations and investment requirements to improve irrigated agriculture	1. Feb 2011 2. May 2011 3. Aug 2012		1. Problem definition for Iraq govt and donors 2. Strategic approaches for Iraq govt and donors 3. Integrated information for use by all levels of Iraq government and donors
11 (K)	Communication strategy (building the teams; building the network in Iraq/with Iraq; ensuring 'sustainability' of the activities post project	1. A web portal for communication within the project team 2. A website for public communication of the project aims and progress	1. Sep 2011 2. Nov 2011		1. Use by team members 2. Raise profile of project

PC = partner country, A = Australia

5.3 Project personnel

5.3.1 List of participants involved in the project

Australian commissioned and collaborating organisations (or IARC)

Name	Sex (m/f)	Agency and position	Discipline and role in project
Dr Evan Christen	M	CSIRO	Irrigation & drainage hydrology scientist – leader Australian input, irrigation/drainage & integration activities
Dr Wendy Quayle	F	CSIRO	Irrigation water quality scientist – water salinity trends and salinity framework development & integration activities
Dr Richard Soppe	M	CSIRO	Remote sensing for irrigated ag specialist - Agricultural production and water use & integration activities
Dr Hayley Norman	F	CSIRO	Saltland forage specialist – selection of salt tolerant crop and fodder species, fodder analysis & integration activities
Dr Ray Evans		SKM Australia	Catchment scale hydrogeology and salinity management
Dr Ed Barrett-Lennard	M	University of Western Australia	Saline agronomy specialist – factors affecting production, selection of salt tolerant crop and fodder species
Mr David Smith	M	CSIRO	Irrigated agriculture technician – agricultural water use and production, salinity mapping
Dr Manzoor Qadir	M	ICARDA/IWMI	Saline soil and water management
Dr Shoaib Ismail	M	ICBA	Saline agronomy
Prof Faisal Taha	M	ICBA	Saline agronomy
Dr Theib Oweis	M	ICARDA	Irrigation engineer
Dr. Kamel Shideed	M	ICARDA	Assistant DG- International Cooperation and Communication, Chairman of the Project Steering Committee
Communication Specialist		ICARDA	Communication

Partner country institution(s) or collaborating IARC

Name	Sex (m/f)	Agency and position	Discipline and role in project
Dr Raad Omar Salih	M	State Board for Agricultural Research (SBAR), Ministry of Agriculture (MoA)	Farm-level irrigation management (crop water requirement; irrigation methods) and soil management
Dr Ahmed Al-Falahi	M	SBAR, MoA	Irrigation district and farm-level soil salinity management
Dr Iman S Salman	F	Directorate of Planning, MoA	Farm-level soil fertility management
Dr. Kasim Ahmed Saliem	M	SBAR, MoA	Soil survey and classification

Dr. Abd Alkarem Hassain	M	National Program on Water Resources in Tigris-Euphrates Basin, MoA	Basin-, irrigation district-, and farm-level water and salt balance
Dr. Tareq Salim Salem	M	SBAR, MoA	Farm-level soil fertility management
Dr. Abdulkhalik S. Naima	M	SBAR, MoA	Farm-level agronomic and cultivation techniques on salt-affected soils
Dr. Khalid Ibraheem	M	SBAR, MoA	Irrigation district-level water resources assessment
Mr. Raheem Hadi	M	SBAR, MoA	Farm-level soil salinity management
Mr. Shaaln Salih Ibraheem	M	SBAR, MoA	Farm-level irrigation management (crop water requirement; irrigation methods)
Dr. Ahmed Salih Mhaimeed	M	University of Baghdad, Ministry of Higher Education (MoHE)	Basin-, irrigation district-, and farm-level soil survey and salinity assessment; GIS/RS
Dr. Iman Abdul Mahdi	F	University of Baghdad, MoHE	Farm-level soil salinity management
Dr. Abdullkarem Hassin	M	University of Wasit, MoHE	Irrigation district and farm-level soil salinity management
Dr. Hussian Hamid Gatae	M	Ministry of Water Resources (MoWR)	Basin-, irrigation district-, and farm-level soil survey and salinity assessment; GIS/RS
Dr. Kamel Majed	M	MoWR	Farm-level irrigation management
Dr. Dakel R. Nedewi	M	University of Basra, MoHE	Farm-level soil salinity management
Dr. Ibrahim B. Razaq	M	Department of Soil and Water, Ministry of Science and Technology	Irrigation district-, and farm-level saline water management
Dr. Abd Aljabbar Khalaf	M	MoWR	Basin-, irrigation district-, and farm-level water and salt balance
Mr. Ahmed Hamode	M	Ministry of Environment	Environmental pollution

5.3.2 Description of the comparative advantage of the institutions involved

ICARDA

The International Center for Agricultural Research in the Dry Areas (ICARDA) was established in 1977 as an autonomous, non-profit, international research center. ICARDA is one of the 15 international research centers supported by the Consultative Group on International Agricultural Research (CGIAR), which is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the International Bank for Reconstruction and Development (IBRD) and the United Nations Development Programme (UNDP).

ICARDA's mission is to contribute to the improvement of livelihoods of the resource-poor in dry areas by enhancing food security and alleviating poverty through research and partnerships to achieve sustainable increases in agricultural productivity and income, while ensuring the efficient and more equitable use and conservation of natural resources..

ICARDA has a global mandate for improvement of barley, lentil and faba bean and serves the non-tropical dry areas in the improvement of on-farm water use efficiency, rangeland and small ruminant production. In the Central and West Asia and North Africa (CWANA) region, ICARDA contributes to the improvement of bread and durum wheat, kabuli chickpea, pasture and forage legumes and associated farming systems. It also works on improved land management, diversification of production systems and value-added crop and livestock products. Social, economic and policy research is an integral component of ICARDA's research to better target poverty and to enhance the uptake and maximize impact of the research outputs.

Collaboration between ICARDA and Iraq dates back to 1979 and has covered many agricultural research areas including natural resources management, crop improvement, and capacity building. Through a number of successful projects, ICARDA has established an efficient collaboration mechanism with the national agriculture research systems of Iraq.

CSIRO

CSIRO's particular differentiated contribution arises from:

- the organisation's legislated role as Australia's national science agency conveying an expectation that CSIRO provides science leadership on matters of national significance
- the organisation's legislated role to carry out scientific research that contributes to the international responsibilities of the Australian Government
- CSIRO's deep history and continuing strength in agricultural R&D which means it is perhaps the only Australian R&D institution that can engage internationally as an "advanced research institute" in forging new institutional relationships with the CGIAR and NARS systems.
- The increasing relevance of the scale and breadth of CSIRO to the multi-disciplinary and cross-sectoral nature of emerging food security issues, which means that CSIRO can make the links between agricultural R&D and related fields such as land, water, climate, energy and sustainable development R&D.
- CSIRO's whole-of-system approach, facilitated by our internationally multi-disciplinary staff and research skills from field to basin scale and appropriate tools and models across these scales
- the size and charter of CSIRO provides opportunities to develop enduring institutional relationships that build capacity in the international research for development domain

IWMI

The International Water Management Institute (IWMI), founded in 1984, is charged with the mission of "improving the management of water and land resources for food, livelihoods and nature" in developing countries and with a vision for a "water for food secure world". IWMI conducts a worldwide research and capacity-building program to improve water and land resources through better technologies, policies, institutions, and management. Since its inception, IWMI has developed a comprehensive understanding on the management of water in the agriculture sector through research in key areas such as water productivity from field to basin scales, water access, allocation and distribution, groundwater management and conjunctive use of groundwater and surface water, environmental flows and wetland management, and wastewater irrigation.

IWMI is organized around four themes that were derived from a comprehensive analysis of the key water, food and poverty alleviation issues. The themes are strongly interrelated and work together in combination with external partners to solve complex multidisciplinary issues. The themes cover Water Availability and Access; Productive Water Use; Water Quality, Health and Environment; and Water and Society. IWMI's headquarters are based in Colombo, Sri Lanka and the Centre maintains regional and sub-regional offices throughout Africa and Asia. With a multi-cultural, multi-disciplinary research staff of over 100 IWMI is well placed to make cross comparisons of results and learn from the knowledge and experience generated in different hydro-ecological and socio-cultural environments.

IWMI has considerable knowledge and experience in the area of soil salinity and it management within irrigation systems. This experiences ranges from the managing salinity in irrigated areas of Pakistan through to the rehabilitation of abandoned saline soils and the use of marginal saline drainage waters in Central Asia. Furthermore the project will benefit from IWMI's triple approach to the uptake of its research results. This includes building uptake strategies into projects, involving regional strategies to continue with uptake after the life of the projects, and aligning corporate information and communications to support uptake strategies.

ICBA

The International Center for Biosaline Agriculture (ICBA), based in Dubai, is an international center undertaking research and development to meet these challenges. Originally established in 1999 as a research and development institute focusing on the problems of salinity and using saline water for irrigated agriculture, the International Center for Biosaline Agriculture has evolved over the last ten years into world class modern research facilities and a team of international scientists to conduct research on improving the well-being of poor farmers cultivating under marginal conditions. Strategically the Center has broadened its initial focus on applied research and technology development in saline irrigated agriculture to the broader mandate to improve agricultural production with an *integrated water resource system approach*.

ICBA's strategy and programs are dynamic and respond to practical management problems for marginal areas. ICBA explores the studies carried out around the world and applies what is already known from these studies and innovations developed by the Center to solve problems facing farmers.

ICBA's research falls into four main areas:

- Integrated water resources systems;
- Marginal quality water resources;
- Capacity building and Knowledge sharing

Within each of these programs, work is organized through a series of projects, each with clearly defined problems (research), or needs (information, networking and training), that are addressed, and potential outcome(s)

The crops that ICBA is working on fall into four broad categories:

- Forage and field crops
- Ornamental and landscape plants
- Trees
- Vegetables and horticulture

ICBA is currently implementing its research program in 22 countries with grants from eighteen international donors.

UWA

UWA has a leading research capacity in the development of productive uses for salt affected and waterlogged land in Australia. UWA staff (Barrett-Lennard and Colmer) have played key roles in the CRC Dryland Salinity and the Future Farm Industries CRC. Research activities in these CRCs have focused on the breeding and development of salt tolerant cereals, the integration of fodder species into farming systems and the development of criteria for the diagnosis of saltland capability.

Iraq

The Ministry of Agriculture has several institutions and research station and is capable of conducting the work plan of the project. Research laboratories are located provinces in central and south of Iraq, which will support the project in analyses of soil and water samples. There are about 100 scientists working in various sections conducting trials.

The Ministry of Water Resources is responsible for managing surface and ground water. It supervises the administrations of irrigation drainage and land reclamation. It has prior experience in mapping soil salinity.

The Ministry of Science and Technology conducts research and consultations on managing natural resources (water and soil). They have advance instruments and devices which can contribute greatly to the project.

Ministry of Higher Education - There are several universities in central and southern Iraq such as Baghdad University, Waist University, and Basrah University. Each university has the capability of supporting the project in the field of personal, laboratories and research stations.

The Ministry of Environment has several tasks and duties one of important subject is the environment of agricultural soils studies are carried on the environment of soils especially desertification land deterioration and water pollution. The salinity is of great interest.

5.3.3 Summary details of the role of each participant involved

ICARDA

Dr. Feras Ziadat is a Soil Conservation and Land Management Specialist at the IWLM Program at ICARDA. He has an MS degree in soil conservation from the University of Jordan, and a PhD from Cranfield University, UK (dissertation: application of GIS and remote sensing for land use planning in arid areas). Following the completion of his PhD, he taught for eight years at the University of Jordan, where he was Associate Professor of Land Resource Management, GIS and Remote Sensing. His research interests cover GIS and remote sensing, land degradation, soil-landscape modeling, land use planning, land suitability, and integrated watershed management in dry rangelands. He has led several research projects including developing improved management tools for water-limited irrigation using remote sensing, low-cost methods to control erosion, soil and land-use mapping, predicting soil properties from DEM-derived terrain attributes, developing a web resource on soils, analysing the temporal and spatial pattern of land use and land management.

Dr. Mohamed A. Ahmed has over fifteen years of professional international agricultural research and development experience in eastern, southern and northern Africa and west and central Asia. He joined ICARDA in 2007 as an Agricultural Policy Economist. He authored or co-authored over 30 publications. His writings have covered various topics including economics of technological change, economics of soil fertility management, policies for the sustainable management of land and enhancing food security; and policies for improving the competitiveness of smallholder livestock producers in Africa. During his research career at ICRISAT, ILRI and ICARDA, he has participated in many policy dialogs including workshops and conferences with policy makers for dissemination of research results.

Dr. Weicheng Wu is a Remote Sensing Specialist at ICARDA and has expertise in the following aspects: (1) geospatial information processing and exploitation (RS+GIS), (2) land system dynamics and change research (land use/cover, land degradation, water resources, etc.), (3) multi-biome biomass characterization (biomass, crop yield, carbon balance) and (4) man-nature interactive analysis and modelling.

Dr. Yigezu Atnafe Yigezu has over 10 years of development work experience including two years of research in an ILRI/IFPRI joint project on sustainable land management in East Africa. Dr. Yigezu has strong quantitative skills and his research interests include subsistence production and productivity, technology adoption, dissemination and impact, market and policy analysis and sustainable resource and environmental management.

Dr. Osman Abdalla is a bread wheat breeder at ICARDA. He has over 25 years of experience in breeding bread wheat, durum wheat, and triticale and with good background experience in sorghum and sesame breeding as well as extensive hand-on experience in seed production and seed certification. He has substantial experience in providing scientific, technical, and managerial leadership to research programs.

CSIRO

Dr Evan Christen is an irrigation and drainage engineer with 19 years experience. He has particular skills in drainage design and management for waterlogging and salinity control, and importantly the appropriate reuse and disposal of saline drainage water. He also has undertaken research into irrigation management and the sustainable use of groundwater for irrigation. He has been project leader of large teams assessing social and biophysical aspects in irrigated landscapes and irrigation communities.

Dr Richard Soppe has 14 years experience in irrigation water management. He has researched drainage requirements and crop water use in saline shallow watertable environments. He has researched the sustainable reuse of saline drainage water. For the past 6 years he has researched the determination of crop water use, including groundwater use, and biomass production using remote sensing. This has included projects in China, Middle East, Africa and Americas researching improved irrigation water management and options for biosaline agriculture using highly saline wastewaters.

Mr David Smith has 21 years research experience in irrigated agriculture. He has specialist skills in modelling the impact of climate, soil and management variables on wheat, rice and maize yields in Australia and India. He has been involved with projects to provide growers and water managers tools to better match irrigation with vine water use spatially and temporally. He has a lifetime interest and skills in maintaining weather data and reference evapotranspiration calculation and use in agriculture.

Dr Wendy Quayle is a research scientist, specialising in the management and monitoring of irrigation and drainage water quality and the impacts of irrigation on soils. She is responsible for undertaking laboratory and field research focusing on sustainable irrigation farming systems towards improving the management and monitoring of water, pesticides, salinity and chemical components of irrigation drainage. Most recently she has been involved in the development of the Primary Industries Standing Committee (PISC) Water Use in Agriculture Strategy

UWA

Professor Ed Barrett-Lennard is a Research Professor at the University of Western Australia and a Principal Research Officer in Agricultural Resource Management. He is a former Director of the Centre for the Management of Arid Environments (Kalgoorlie), and has the experience of many years of research in the productive use and rehabilitation of saline land. He has had particular expertise in research and development on productive use and rehabilitation of saltland and the development of saltland pastures; research and development into plant responses to salinity and waterlogging; research and development on water use and design requirements of revegetation systems; research and development on potential commercial woody plants in the lower rainfall areas, and Development of extension information and materials in many areas of revegetation with trees and shrubs.

ICARDA/IWMI

Dr. Manzoor Qadir is soil and water management scientist with interests on salinity management through soil, irrigation, and crop-based approaches. Since 2003, he is coordinating a joint program of ICARDA and IWMI that addresses productive use of marginal-quality water resources (treated urban wastewater and saline drainage and groundwater) and salt-affected soils. He has particular expertise in managing saline, sodic, and magnesium-affected soils in countries of Central West Asia and North Africa.

IWMI

Andrew Noble is a soil chemist with considerable experience in the rehabilitation degraded production systems in temperate legume based pasture systems of southern Australia and farming systems of wet and semi-arid tropics. He has undertaken research in Central Asia in the rehabilitation of abandoned saline/sodic irrigated lands using bioremediation approaches.
Asad Sarwar Qureshi has significant experience as a water resources manager in the area of irrigation / drainage/ groundwater management. He has undertaken action research associated with developing groundwater management and water conservation strategies for the water short areas and evaluating agronomic and engineering solutions to mitigate incipient environmental problems.

Alexander Platonov is a GIS/RS specialist who has considerable experience in assessing the impacts of agricultural production systems in large scale irrigation schemes in Central Asia with a focus on water resources and salinity management.
Andrew Noble is a soil chemist with considerable experience in the rehabilitation degraded production systems in temperate legume based pasture systems of southern Australia and farming systems of wet and semi-arid tropics. He has undertaken research in Central Asia in the rehabilitation of abandoned saline/sodic irrigated lands using bioremediation approaches.

ICBA

Dr. Shoaib Ismail, a Pakistani national, is a halophyte agronomist at ICBA. He is a research scientist and university educator with 30 years experience in saline agriculture research and development. His field of specialization is on management of production systems with halophytes and other salt tolerant plants, under saline conditions. His main area of focus is on forage and bioenergy productions systems. Prior to joining ICBA, Dr Ismail was Associate Professor in the Department of Botany, University of Karachi, Pakistan. His research was focused on forage production from saline and sodic soils and the use of saline irrigation water for sustainable productive agriculture in arid and semi-arid areas. He has worked on a number of national and international projects in Pakistan sponsored by local and international funding agencies. Dr Ismail holds a PhD in Plant Physiology from the University of Karachi and has many refereed publications to his credit.

Dr. Abdullah Dakheel is a field and forage crop scientist at ICBA. Originally from Syria, he has a strong background in agricultural ecology and physiology of crop and natural plants. He worked at Aleppo University and as a consultant in ecology and physiology of cereal crops. He moved to the UAE as Associate Professor of Arid Land Ecology at UAE University, where he assumed the position of Research Farm Director in addition to his other responsibilities. Dr Dakheel, holds a PhD in Ecology from the University of California, Davis. He has over 25 years of research and academic experience.

Dr. NK Rao, genetic resources scientist, joined ICBA in July 2006. An Indian citizen, he received his PhD from University of Reading, UK. He was previously employed as Germplasm Conservation Scientist with the International Plant Genetic Resources Institute (IPGRI) in Nairobi, Kenya, and contributed significantly to the training and capacity building activities in several countries. Before IPGRI, Dr Rao served as the Curator and Head of Genebank at ICRISAT in Hyderabad, India. Earlier, he was a postdoctoral scientist at the International Rice Research Institute (IRRI) in the Philippines. Dr Rao has over 30 years of experience in genetic resources conservation and management and published over 80 scholarly works, including journal articles, technical manuals and book chapters.

Dr. Shabbir A Shahim, salinity management scientist, joined ICBA in 2004. Dr. Shahim holds a PhD from the University College of North Wales, Bangor, UK. He has over 25 years of experience in teaching, research and development in Pakistan, the UK, Australia, Kuwait and the UAE. He served as Associate Research Scientist at the Kuwait Institute for Scientific Research and as Associate Professor-Soils at the University of Agriculture, Faisalabad, Pakistan. His research has focused on soil salinity and related issues in irrigated agriculture, reclamation and rehabilitation of soils in the arid and semi-arid regions. Prior to joining ICBA, he was employed as Manager, Soil Resources Department, at Environment Agency-Abu Dhabi. Dr Shahid is an author of over 100 publications in refereed journals, proceedings, books, technical reports and manuals.

Dr. Nurual A Akhand is an irrigation management scientist at ICBA. He holds a PhD in irrigation engineering from the University of Arizona. He has a strong professional background in research planning and management of irrigation and drainage systems, and water quality. Dr Akhand worked with Bangladesh Agricultural Research Council (BARC) as a senior research scientist. Before joining ICBA in February 2006, he worked in soil water flow, drainage, water quality and groundwater simulation modeling in Canada. Dr Akhand has published numerous papers in refereed journals, conference papers and technical reports.

Dr. Khalil Ammar is a hydrogeologist at ICBA. He holds a PhD in Civil and Environmental Engineering, from Utah State University, specialising in Water Resources Management /Groundwater Quality Management. His main areas of work include, Environmental Impact Assessment; Vulnerability assessments of groundwater resources to contamination, Groundwater modeling (Flow, Fate and transport); Health risk assessment; and Environmental Economics. Dr. Khalil worked in CH2M HILL, Southwest Office - California/USA and Utah State University.

Iraq

Dr. Ahmed Adnan Ahmed Al-Falahi is managing researcher at State Board for Agricultural Research. He received an M.Sc. in Soil chemistry from Baghdad Univ (1979) and a PhD in soil chemistry and soil salinity Baghdad Univ (2000), conducting research in the field of soil salinity and the soil-plant relationship. He has published more than 25 papers in soil salinity and soil-plant relationship. Dr. Al-falahi will work on Irrigation district and farm level soil salinity.

Mr. Shaalan Salih Ibrahim, MSc in soil and water management (Anbar University, 2006), is the Senior Agriculture Engineer (SBAR,MoA). Dr. Ibrahim performed work on soil and water management. He will work in the project on farm-level irrigation management. He was trained on land management and soil salinity in Perth, Australia and soil analysis at ICARDA- Syria.

Dr. Abdulkhalik S. Naima, has an MSc in soil physics (Baghdad University, 1983), and a Ph.D. in soil physics and irrigation (Baghdad University 2001). He is chief of research at (SBAR,MoA). Dr. Naima works on irrigation methods, assessing soil moisture and crop water requirements. In the project, he will work on farm –level agronomic and cultivation techniques on salt affected soils. Previously, he worked in soil and water management in Doha - Qatar (2005-2009).

Dr. Ahmed Salih Muhaimeed is professor of soil survey and land management and head of soil and water department, College of Agriculture – Baghdad University. He obtained an MSc from Nebraska, USA (1978) and a PhD from Colorado State University, USA (1981). He supervised 15 MSC and PhD. Students. Research fields of interest include soil survey, classification, remote sensing, and GIS. He will work on basin, irrigation, district and farm level soil survey and salinity assessment.

Dr. Dakel R. Nedewi is professor of field irrigation and saline soils management. He obtained an MSc and PhD from the University of Baghdad in 1983 and 1998 respectively. Previously, he was head of the soil and water sciences department at the University of Basra. He has supervised 14 MSc and 2 PhD students. In this project, Dr. Nedewi will work on Farm- Level soil salinity management.

Dr. Hassan Hamid Gatae has a PhD in soil survey from the University of Baghdad 2001. He is affiliated with the Ministry of Water Resources, basin irrigation district and farm-level soil survey and salinity assessment, GIS/RS.

Dr. Ibrahim B. Rasaq is the director of soil and water resources department since 2005 in the office of agricultural research and food technology. He obtained an MSc in soil chemistry from Canada in 1980 and a PhD in soil fertility from the USA in 1989. He was trained in the US on the use of EM38 Device to map salt affected soils.

Dr. Kasim Ahmed Saliem obtained an MSc In soil genesis and classification (Ghent University, Belgium, 1982), a PhD In soil management (Baghdad University, Iraq, 2000), and is a senior researcher and head of planning and follow–up at the State Board for Agricultural Research (SBAR- MOA). He is active in work on management of gypsiferous and salt- affected soils and cultivation of crops using sprinkler and drip irrigation methods with different qualities of water. He has been trained in Holland, Syria, Jordan, and Iraq on various aspect of soil and water, and has published more than twenty scientific papers.

Dr Raad Omar Salih obtained a PhD in soil physics (UK, 1978) and is head of the soil research department working on irrigation methods, organic fertilization and cultivation of grain crops in salt affected soils. He has attended workshops and training courses in Holland, USA, Egypt, Syria, and Jordan. In the project, Dr. Salih will work on farm-level irrigation and soil management.

Dr. Tareq Salim Salem obtained an MSc in soil physics (Belgium. 1982) and a PhD in soil fertility (Baghdad University 2000). He is a senior chief researcher (SBAR, MoA) and works on soil fertility and cultivation of field crops using saline water. He will work in the project on farm-level soil fertility management. He has been trained in Tunisia on fertilizer production and has published a number of scientific papers.

Dr. Khalid Ibrahem Mukhlif, PhD-Hydrology and hydrogeology (Baghdad University 1994), I work on surface and ground water management , water Harvesting , uses remote sensing and GIS in Hydrology .I will work on irrigation district –level water resources assessment

Dr. Iman S. Salman works in the department of water and soil/ office of planning at MOA. Dr. Salman has an MSc in soil science from Baghdad University in 1997 and a PhD in kinetic and thermodynamics- potassium status and behaviour in Iraqi soils in 2007 also from Baghdad University. Dr. Salman performed work on the effect of some organic wastes in mineralization of carbon and nitrogen and nutrients balance in potassium fertilization. Dr. Salman will work in project Farm- Level soil fertility management. Dr. Salman is also trained in Perth, Australia and Seoul, S.Korea.

Dr. Abd Aljabbar Khalaf is an expert in soil and water management and director of soil and water department at the ministry of water resources, currently working on water-salt balance and use of saline water in agriculture.

Dr. Abdul Kareem H. Audafa obtained a PhD in soil salinity from Baghdad University in 2007. Dr. Audafa is director of Al-Siwara research station (SBAR-MOA) and works on water-salt balance. Dr. Audafa is also a lecturer in the College of Agriculture, Waist University.

Dr. Iman Abdul Mahdi is assistant agricultural engineer, soil science department, College of Agriculture, University of Baghdad. She obtained an Msc in 1988 and PhD in 2000. Her field of interest is the use of saline water in leaching saline soils. She will work in the project on farm-level salinity management.

Mr Ahmed Hammode is senior chief chemist, Department of Chemistry, Baghdad Environment Directorate, Ministry of Environment. He obtained an MSc from University of Technology in 2000.

Dr.Abdul Jabbar Khalaf Almeini is head of the Department of Environmental Studies/ National Center for Water Resources Management /Ministry of Water Resources (MoWR). He obtained a Ph.D in Agricultural Sciences and has published many soil survey reports, conducted research in numerical classification, land evaluation, assessments of soil survey reliability, water quality assessments and proposing water quality indexes. He studied the use of saline water in agriculture, soil moisture regime, and other ecological studies.

Dr. Hassan Hameed Kata'a obtained a PhD in Agricultural Sciences. He is an expert and head of soil survey and classification at the division/Dept of Environmental studies, National Center for Water Resources (MoWR). He has published research studies, and reports in the fields of soil surveying, environmental studies, water harvesting, and application of remote sensing technologies in soil survey studies.

Dr. Kamil Majeed Mohammed obtained an MSc in soil physics from Ghent University in 1981, and a PhD in Agricultural Science- water and soil management from Baghdad University in 2007. He is affiliated with the Department of Environmental studies / National Center for Water Resources, Ministry of Water Resources (MoWR). He is a researcher in the Al Raad experimental station and has more than 30 years experience in the fields of water and soil managements, use of saline water, field irrigation, water, consumptive use for crops, and drip irrigation.

Jafer Kathom Alwan AL- Amiry is senior engineer in the Ministry of Water Resources/ General Directorate of Planning and Follow-up. He obtained an MSc in water resources management through UNESCO IHE / Netherlands. He has participated in many training coursed at ICARDA, JICA, and Egypt.

Mr. Jafier Kadam Alwan is a senior engineer in the department of operation and maintenance of irrigation projects- Office of Planning, Ministry of Water Resources.

Raheem Hadi Abdullah obtained an MSc in soil and water management (Baghdad University, 2005). He is senior Agriculture Engineer (SBAR,MoA) and worked on soil and cultivation of field crops. He will work in the project on farm –level soil salinity management . he is also trained on water harvesting, soil analysis at ICARD and desertification and soil conservation in Bare –Italy (1982).

5.4 Intellectual property and other regulatory compliance

5.5 Travel table

PART A Commissioned IARC

Trip no.	Person or position	Estimated date of travel	From / to	Purpose	Duration (days)
	Manzoor Qadir	May 2011	Aleppo/Baghdad	Follow up on first year field trials	5
	Osman Abdalla	May 2011	Aleppo/Baghdad	Follow up on first year field trials	5
	Weicheng Wu	May 2011	Aleppo/Baghdad	Follow up on first year field trials	5
	Mohamed A. Ahmed	May 2011	Aleppo/Baghdad	Follow up on first year field trials	5

PC = partner country, A = Australia

PART B Australian Collaborating Organisation/s

Trip no.	Person or position	Estimated date of travel	From / to	Purpose	Duration (days)
1	Evan Christen	November 2010	Griffith/Aleppo	Inception workshop; Data collation, analysis team work	14
2	Evan Christen	May 2011	Griffith/Aleppo	Finalise reports on surveys	14
3	Evan Christen	Dec 2011	Griffith/Aleppo	Review first cut of productivity assessments and investment options, assess best-bet trials and institution aspects, discuss first draft salinity management framework	14
4	Evan Christen	July 2012	Griffith/Aleppo	Finalisation of investment plans and reports, wrap up workshop	14
	Ray Evans	November 2010	Canberra /Aleppo	Inception workshop; Data collation, analysis team work	14
	Ray Evans	May 2011	Canberra / Aleppo	Finalise reports on historical water / salinity trends	14
	Ray Evans	December 2011	Canberra / Aleppo	Review productivity assessments and investment options, assess institution aspects and present first draft salinity management framework	14

	Ray Evans	July 2012	Canberra / Aleppo	Finalisation of investment plans and reports; wrap up workshop	14
1	Hayley Norman	November 2010	Perth/Aleppo	Establish field trials	14
2	Hayley Norman	December 2011	Perth/Aleppo	Review field trials, first cut of productivity assessments and assess best-bet trials	14
3	Hayley Norman	May 2012	Perth/Aleppo	Finalise field trials and reports	14
1	Richard Soppe	November 2010	Griffith/Aleppo	Inception workshop; data collation analysis and teamwork	14
2	Richard Soppe	May 2011	Griffith/Aleppo	Review progress on productivity and salinity assessments by remote sensing	14
3	Richard Soppe	December 2011	Griffith/Aleppo	Review productivity assessments, salinity survey and best bet trials to assess investment options	14
1	Ed Barrett-Leonard	November 2010	Griffith/Aleppo	Inception workshop and establish field trials	45
2	Ed Barrett-Leonard	May 2011	Perth/Aleppo	Maintain field trials and finalise reports on surveys and historical water/salinity trends	45
3	Ed Barrett-Leonard	Dec 2011	Perth/Aleppo	Review field trials and review first cut of productivity assessments and investment options, assess best-bet trials and institution aspects, discuss first draft salinity management framework	45
4	Ed Barrett-Leonard	July 2012	Perth/Aleppo	Finalisation of field trials and investment plans and reports, wrap up workshop	45

PC = partner country, A = Australia

PART C Overseas Partner Organisation/s

Trip no.	Person or position	Estimated date of travel	From / to	Purpose	Duration (days)
	Shoaib Ismail (ICBA)	October 2010/ March 2011	Dubai/Aleppo	Inception workshop/ establish field trials	5
	Abdullah Dakheel (ICBA)	October 2010/ March 2011	Dubai/Aleppo	Inception workshop/ establish field trials	5
	N.K. Rao (ICBA)	October 2010/ March 2011	Dubai/Aleppo	Inception workshop/ establish field trials	5

	Shabbir Shahid (ICBA)	October 2010/ March 2011	Dubai/Aleppo	Inception workshop/ establish field trials	5
	Asad Qureshi (IWMI)	October 2010/ March 2011	Lahore/Aleppo	Inception workshop/ visit project area	10
	Andrew Noble (IWMI)	October 2010/ March 2011	Vientiane/Aleppo	Inception workshop/ visit project area	5
	Alexander Platonov (IWMI)	October 2010/ March 2011	Tashkent/Aleppo	Inception workshop/ visit project area	5

PC = partner country, A = Australia

6 Appendix A: Intellectual property register

6.1 Administrative details

Project ID	LWR/2009/034
Project title	Soil salinity management in central and southern Iraq
Assessment provider	Dr Kamel Shideed
If not Australian project leader, provide title	Project Leader, Commissioned IARC
Date of assessment	5 October 2010

6.2 Categories of intellectual property and brief description

Plant or animal germplasm exchange

Does the project involve:	**Yes**	**No**
provision of germplasm by Australia to a partner country?		X
provision of germplasm from a partner country to Australia?		X
provision of germplasm from or to an IARC or another organisation and a project participant?		X
use of germplasm from a third party		X
material subject to plant breeders/variety rights in Australia or another country?		X

Proprietary materials, techniques and information

Does the project involve provision (from one party to another) of:	**Yes**	**No**
research materials or reagents (e.g. enzymes, molecular markers, promoters)?		X
proprietary techniques or procedures?		X
proprietary computer software?		XX

Other agreements

Is any aspect of the project work subject to, or dependent upon:	**Yes**	**No**
other materials-transfer agreements entered into by any project participant?		X
confidentiality agreements entered into by any project participant?		X

6.3 Foreground, background and third party Intellectual Property

This includes, but is not limited to patents held or applied for in Australia and/or in partner countries and/or in third countries. For example, Foreground IP includes any new germplasm, reagents (such as vectors, probes, antibodies, vaccines) or software that will be developed by the project.

Foreground IP (IP that is expected to be developed during the project)

Ownership of or rights to Foreground IP other than as detailed in the ACIAR Standard Conditions must be approved by ACIAR.

	Yes	No
Is it expected that there will be Foreground IP?		X

Background IP (IP that is necessary for the success of the project but that has already been created and is owned by parties to the project)

Any agreements in place regarding Background IP should be provided to ACIAR prior to project commencement.

	Yes	No
Is it there Background IP?		X
If "yes", are there any restrictions on the project's ability to use the Background IP?		X
would there be any restriction on ACIAR or the overseas collaborator claiming their rights to IP for the project based on the Background IP (refer ACIAR Standard Conditions)?		X

Third Party IP (IP that is owned by or licensed from other parties)

Agreements governing the use of third party IP can be related to research materials, research equipment or machinery, techniques or processes, software, information and databases.

	Yes	No
Is there any relevant Third Party IP that is essential to the project?		X
If "yes", would there be any restriction on ACIAR claiming its rights to IP for the project (refer ACIAR Standard Conditions)?		

Other contracts, licences or legal arrangements

	Yes	No
Are there any other contracts, licences or other legal arrangements that relate to the project?		X

7 Appendix B: Budget

8 Appendix C: Supporting documentation

Documents attached:

Letters of support

Letters of approval

Curricula vitae