Better crop germplasm and management for improved production of wheat, barley and pulse and forage legumes in Iraq

REVIEW REPORT
May 2008

Project number: CIM/2004/024

Project title: Better crop germplasm and management for improved production of wheat, barley and pulse and forage legumes in Iraq

Project leader: Dr Ahmed Sidahmed, ICARDA

Country: Syria

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Dates of review: 13th – 17th April 2008

Methodology

The reviewer was supplied with written reports prior to meeting the project team. These comprised the first two annual reports of the project and three research reports presenting background information on crop rotations in northern Iraq, summarizing a baseline socio-economic survey in Nineveh (2006), and reporting socio-economic studies undertaken during 2006-2007.

The review was undertaken at ICARDA, Aleppo, Syria, with the attendance of contributing staff from ICARDA (21), Iraq (10), and Australia (3). The list of attendees is presented as Appendix 2. Presentations of all activities were made and discussed with the reviewer and team members over two days. Visits were made to experimental sites on the ICARDA experimental area and over one full day to two demonstration sites and two manufacturers of agricultural equipment, all within a 50 km distance from Aleppo.

A draft report was submitted for comment to ACIAR Program Manager, Dr Paul Fox, before revision to this final version.

Background

The project described here derives from the wish of the Australian Government to participate in the reconstruction of the agricultural sector in Iraq. This has been given a high priority by the Iraqi Government to improve the livelihood of rural people and reduce dependence on imported food. Agriculture currently provides about 8% of Iraq's GDP, 20% of its employment, and supports a rural population of 7 million. Total population of Iraq is approximately 26 million. Arable land is estimated at 11.5 million ha (Mha) comprising approximately 25 % of total area. The Food and Agriculture Organization (FAO) estimates that only 8 Mha are used for agriculture and less than half is cultivated annually. Seventy-five percent of cultivated area is located in central and southern regions. However, production of wheat, the staple food crop, and barley, an important livestock fodder crop, are concentrated in the northern provinces of Ninevah and Erbil and account for one third of total cereal production. Agriculture in these provinces is largely rainfed, but with some supplemental irrigation, and is based on mixed crop and livestock (small ruminant) production.

Agricultural production has declined by about 1.1% per annum over the past 15-20 years. Five-year average production estimates are wheat 860,000 metric tons (Mt), barley 720,000 Mt, rice 210,000 Mt, and corn, less than 100,000 Mt. Current total production of major grains is estimated to be half that in 1990. Three years of drought from 1999-2001 significantly reduced production. Rain-fed areas suffered from low rainfall, the current year, 2007/8, is looming as another of very low rainfall and low productivity.

Significant area and yield declines have resulted from shortages of inputs (seeds, fertilizers, pesticides) and machinery, inappropriate (or non existent) crop rotations, reduced availability of irrigation water, and deteriorating irrigation infrastructures. An effort was made in the early 1990's to counter economic sanctions and increase domestic food production by increasing areas and yields. The gains were short-lived, however, and crop area has since stagnated. While some Iraqi problems, such as input subsidies, are largely political, solutions to the major agronomic problems can be substantially solved by application of existing technologies and be subsequently improved by research. Modern cropping systems can increase both crop and animal production, the latter through reduction in fallow, bigger stubbles, and introduction of legume forages.

The proposed government strategy is a shift to a market-driven agricultural system that is intended to induce producers to change their production systems to become more competitive. In the long term this will require the development and dissemination of integrated packages of practices, appropriate for specific agro-climatic conditions that farmers can adopt to maximize their returns while protecting the natural resource base. In the immediate future, however, the focus would be better placed on removing limiting factors to provide a stepwise pathway for development and adoption.

The project is focussed in the northern province of Ninevah, the main wheat- and barley-producing region in Iraq. Activities distinguish three main agro-climatic zones; viz. high rainfall areas (HRA) with annual rainfall >450 mm, moderate rainfall areas (MRA) 350-450 mm, and low rainfall areas (LRA) < 350 mm. Production technologies are based mainly on traditional deep cultivation in crop management systems that have changed little over recent decades. Introduction of reduced tillage, improved cultivars, and integrated crop and pest management should enable greater crop productivity, reduce costs of production, and significantly increase resource-use efficiency (land, water, nutrients). In particular, the crop cultivars currently used in commercial production have not benefited from recent genetic improvement. They were obtained in the early 1980s from a modest breeding program within the Ministry, based on material introduced as part of collaborative programs with ICARDA, Australia, and other countries. As well as developing and disseminating available technologies, the project will evaluate potential solutions to production constraints identified by farmers.

Meeting this challenge to improve crop and livestock production in northern Iraq is given a high chance of technical success. Soils in the region are fertile and productive by Australian standards. Growing season rainfall is low, around 100-300 mm, and variable, so greater water-use efficiency (WUE) and drought tolerance are focal targets for crop improvement programs. Current average yields of wheat and barley of 0.73 and 0.62 t/ha, respectively, are small by international standards and are less than half those expected under such conditions. The target to at least double yields is based on the current levels of production and productivity improvements that have been achieved elsewhere in regions of similar winter rainfall. In those regions of Australia, productivity gain has averaged about 2.5% per annum over the past 20 years.

Low productivity of Iraqi crops is related to widespread unavailability of modern, improved cultivars together with inappropriate crop management practices. The area shares major constraints facing rainfed cereal and pulse cropping with southern Australia, including drought, heat, salinity, B toxicity, grain quality issues (mainly extensibility for flatbread), cereal diseases (mainly stripe rust), and pests and diseases of pulse crops. These are priorities for wheat, barley and pulse production in Ninevah Province also. The overlap of production challenges and research interests between Australian institutions, ICARDA, and Ministry of Agriculture (MOA) Iraq augur well for success of the project.

The project is designed to contribute to MOA national development plans and will build on previous experiences in Iraq of ICARDA. Institutions in Australia, particularly the Universities of Adelaide and Western Australia and the Western Australian Department of Agriculture have a strong comparative advantage in providing relevant expertise to assist in both of these areas, particularly when coupled with ICARDA, that has special expertise with barley, wheat and legume germplasm and developing expertise in cropping systems management.

The project has four major objectives: 1) to identify, promote and widely disseminate amongst farmers in the rainfed cropping regions of northern Iraq “best-bet” improved cultivars and crop management systems for wheat, barley and pulse and forage legumes; 2) to introduce, evaluate and select improved germplasm of wheat, barley and pulse and forage legumes for adaptation to rainfed farming systems in northern Iraq; 3) to identify, evaluate and select improved cropping system management options suited to rainfed farming systems in northern Iraq; 4) to enhance the capacity of Iraqi research and extension program to identify and evaluate potentially valuable germplasm and better crop/soil management technologies and promote their adoption by farmers.

The expected outcomes include, but are not limited to:

- Available “best bet” technologies identified and prioritized
- Acceptable technology packages promoted and disseminated
- Efficient production systems of seed needed in research and demonstrations established
- New crop management options identified, tested and evaluated with farmers
- Enhanced capabilities of Iraqi research program through joint research and specialized training programs
- Enhanced capabilities in evaluating adoption and impact of improved technologies
- Effective international collaborative networks between Iraqi, ICARDA and Australian institutions and scientists.

The project should have significant economic, social, and environmental benefits in the targeted areas. It is planned to at least double the yields of barley and wheat and improve pulse and forage crops through the joint development of appropriate cultivars while seeking cost and energy savings through revised crop management. The farmers, who are at the threshold of transition between a subsidized-input and a free market system, will benefit from greater yields and reduced costs. As the adoption of better crop/soil management technologies expands, environmental benefits will result from reduction in soil erosion and salinity and improvement of water quality.

Executive Summary and Recommendations

In Iraq, the yields of cereals have been falling at 1.1%/year during the last 20 years during a time when the country has been plagued by conflict that has destroyed much of the infrastructure and human capital for crop production research. Now, when Iraqi farmers are moving from a heavily subsidized to a commercially oriented agriculture, this project seeks to reintroduce Iraqi scientists and farmers to international level research and production technologies by concentrating on cereal production in the northern low rainfall zone where 70% of cereals are produced. The climate, soils, and rainfall are comparable with areas of southern Australia where, in contrast, research and innovation by scientists and farmers has maintained an average yield increase of 2.5%/year over the past two decades. In particular, understanding of crop production in these low rainfall areas of southern Australia indicates that yields in Iraq are less than half of the water-limited productivity so there is much scope to close this yield gap by applying more appropriate management practices further assisted by better adapted cultivars.

The lead organization in the project is ICARDA, the International Agricultural Research Centre for Dryland Agriculture based in Aleppo, Syria. The Iraqi contributions are from Ministry of Agriculture (MOA, Bagdad), The Department of Agriculture (DOA, Ninevah Province) and the University of Mosul. The latter was added during the project. The Australian organizations are the Universities of Adelaide and Western Australia and The Western Australian Department of Agriculture. Due to extreme insecurity, no foreign nationals have been able to visit Iraq and so the project has been run by remote control from ICARDA. Outside Iraq the focus of activity has been the collection of information, crop materials and equipment for work within Iraq, design of demonstration and experimental work, provision of equipment, and training of Iraqi personnel.

The approach adopted was to draw on expertise in Iraq, ICARDA, Australia and elsewhere to design some 'best-bet' production systems combining crops, cultivars and tillage practices. The project design was to implement these with collaborating Iraqi farmers from the outset and at the same time commence research to improve and adapt component activities to local conditions. The decision was sound and the 'best-bet' practices were well chosen. Demonstrations of cropping systems have now been maintained for three years at four locations in three rainfall zones and have given the project the impetus it requires for early impact. The project was equally ambitious with regard to research activities in Iraq, but in that case, it was only possible to maintain cultivar evaluations and tillage research experiments at one of the three intended sites, fortuitously located in the medium rainfall zone. This was the direct result of destruction of research infrastructure and serious problems of insecurity. In the event, ICARDA was able to supplement the research agenda with cultivar evaluations and cropping system experiments at ICARDA and demonstrations with farmers in the local area that shares climatic and soil characteristics with parts of the target zone in Iraq.

The significant success of the project to date has been the introduction of zero tillage (ZT) as a soil and crop management option for Iraq, and initially for Syrian farmers in the vicinity of ICARDA also. This management system now practiced over 100 Mha worldwide is well suited to low rainfall areas where it offers at least equivalent yields but at smaller production cost than conventional tillage, while improving soil quality and protecting it from wind and water erosion. These responses are evident in the results obtained so far and the economic advantages have special attraction to Iraqi farmers now faced with greatly increased fuel costs now that they are outside a heavily subsidized agriculture. Much work remains in refining the adoption of ZT to the northern areas of Iraq. There remain issues of adaptation of machinery, selection of better crop cultivars, rotations, and management of stubbles. The latter is a major issue in a region where usually sparse stubbles are commonly completely grazed by sheep and goats that are an integral part of the production systems. Much benefit from zero tillage derives from soil protection and increasing soil organic matter by stubble retention. In developing acceptable cropping systems, therefore, compromise must resolve the competition for stubble between grazing animals and soil conservation and quality. Part of the solution will be found in provision of alternative fodder supplies for grazing animals.

It is too early to claim major impacts of this project but significant advances are evident in all outcomes proposed for the project at the outset. The Iraqi counterparts are now once again linked into international level work on cultivar evaluation and crop management practices. Given the extraordinarily difficult situation in which they are working they have built a cohesive team, demonstrated commitment to the project, and made remarkable progress. The initial four objectives were sound in concept but probably overambitious in scale. Key demonstration sites were established in three rainfall zones as planned but cultivar evaluation

was possible at only one and it was not possible to establish the planned research plots in Iraq. However enough of what was proposed has been achieved to claim success. In this it is important to acknowledge the major contribution of ICARDA in undertaking experimental and evaluation work to compensate for that not possible in Iraq, for its assistance generally in all aspects of the project, and the leadership it has provided to the project. The Australians have provided sound advice on 'best-bet' options that enabled rapid initial progress in the field, and in the provision of advice and training in research methodology and data analysis,

Recommendations

1. The project team be reminded to include the missing cereal cultivar evaluations in the technical report for the third year of the project.
   This recommendation is to correct a limitation of previous reporting (Section 1 Obj 2.1). The purpose is to ensure that adequate analysis of germplasm evaluations can be included in the Final Project Report and be available to guide planning of subsequent work.

2. ACIAR classify the project as highly successful and favourably consider a proposed extension.
   This recommendation is based on the substantial progress that the project has made in all areas of the project and the determination of the Project Team to continue. While impact has been greatest in capacity building (Section 1 Obj. 4), the results of the demonstrations are already reaching farmers and machinery manufacturers (Section 1 Obj. 1). Given the response in comparable areas worldwide, a significant impact of ZT can be anticipated provided the adaptive research is carried out, and its value clearly presented through demonstrations and socio economic analyses. The value of the long-term trials that have been established will be obtained by continuation into the future (Section 1 Obj. 3.1).

3. ACIAR ensure that a continuing project focuses on the gains that have been achieved in the first phase. Overall, this implies a concentration of all aspects of work on the adaptability of zero tillage to production systems that include rotational crops and also alternative forage sources for sheep.
   Nutrient management and IPM were identified as important areas in the project document but little progress was made (Section 1.2). With the new focus on zero tillage these activities become clearly linked to the goal of water limited productivity and the required experimental program more narrowly defined and better related to rotational cropping systems. The advantage of stubble retention to soil conservation and improvement of soil quality, possible in zero-till systems, impacts greatly on fodder supply for grazing animals. That issue, too, becomes more clearly a part of considerations of optional cropping systems.

   Section 4 discusses follow-up activities in more detail, providing a wider range of suggestions for consideration during planning to extend the project.

4. ACIAR ensures that a continuing project provides a dedicated leader based at ICARDA.
   The success of the project to date reflects the attention given to it by the initial project leader (Dr. Piggin) who was previously involved in planning the project. Given that the problems of insecurity and communication will continue at least into the immediate future, continuing success will depend upon comparable, skilled and dedicated leadership.

1. Project outputs

Objective 1: To identify, promote and widely disseminate amongst farmers in the rainfed cropping regions of northern Iraq "best-bet" improved cultivars and crop management systems for wheat, barley and pulse and forage legumes.

objective	outputs/ milestones	What has been achieved?	What has not been achieved?	Are there additional outputs that could have been achieved?
1. To identify, promote and widely disseminate among farmers in the rainfed cropping regions of northern Iraq "best-bet" improved varieties and crop management systems for wheat, barley and pulse and forage legumes.	1.1. Constraints/ limitations in rainfed crop production identified through diagnostic study of farmers' existing practices.	Comprehensive diagnostic Baseline Survey (261 farms) of Ninevah Province completed in 2005 for three rainfall zones (high >450 mm/y, medium (350-450 mm/y, and low (<350 mm/y), analysis available in 2007. Farm types, sizes, tenure, and production mixes identified (PC). Role of supplemental irrigation identified (PC). University of Mosul introduced as a new partner.		
	1.2. Available "best bet" technologies identified and prioritized based on existing knowledge.	Initial planing meeting (11/2004) identified and prioritised 'best bet' cultivars of all main crops and management technologies of tillage and rotations for the 3 rainfall zones. Machinery requirements identified and ordered (PC, IC , A). Seed supplies arranged through ICARDA and Australian sources for 3-5 cvs of each crop type . Total of 20 t seed from ICARDA (16 t in first year) (IC and A)	IPM and nutrient management acknowledged but not well integrated in best-bet technologies .	
	1.3. On-farm Demonstrations established.	Established as planned on four farms (one with supplementary irrigation) in each of three rainfall (low, moderate and high) zones. Machinery and seed supplied. Appropriate rotations (wheat or barley, with pulse and forage legume) implemented for each zone with local cvs and new options (PC). Tillage options compared farmers' method (till and drop seed on surface), chisel plough, and zero tillage (ZT). Demonstrations are unreplicated in 2006-8 but use 180 large 1 ha plots (PC). Farmer's Field Days held in 2006 and 2007 (PC).	ZT seeders not available for first year (2006) experiments. Current (year 3) experiments limited to supplementary irrigation sites due to extremely dry conditions (< 25% average rainfall).	

	1.4. Potential constraints to adoption identified.	Field demonstrations confirm Diagnostic Survey of dominance of rainfall amount and variability and of availability and cost of machinery, agrochemicals, and high quality seed (PC). Importance of tenure, land size and extension services also identified (PC). Response to chisel plough suggests prevalence of subsoil compaction and need to treat soil before starting ZT (PC). Demand of sheep for stubble will impact on performance of ZT unless alternative sources of fodder are found (PC).		
	1.5. Acceptable technology packages promoted and disseminated.	Improved cvs readily accepted because yields were greater than local cvs in most cases. ZT yielded equal or more than CT and raised much interest because of smaller production cost (PC). Farmers are now adapting local seeders for ZT in Iraq (tyne and disc versions). Field days held at all three sites in 2006 and 2007 (PC). Farmer interest enhanced by visit to ICARDA in May 2007 of Iraqi group (8 farmers, 5 DOA staff) to inspect and discuss ZT trials. In Syria, demonstration plots (barley, chickpea and lentil on wheat stubble) established at 6 villages close to Aleppo (IC). A successful field day that received good press coverage was held at Barkoum Village in 2007 (IC). Four small scale machinery manufacturers in Syria are working on modifications of local seeders for ZT.		More field days in Spring 2008 to reveal advantage of ZT in this dry year

	1.6. Assessment of potential adoption and impact	Experimental data from first two years of demonstration trials compiled (PC). Initial analysis highlights cost advantage of ZT together with frequently greater yields in these preliminary trials.	Adoption and impact survey required to enable economic assessment and to include year-3 data now planned for June 2008. Results available Sept. 2008. Acknowledged that a longer period (~6 years) required for realistic adoption and impact studies.	

PC = Partner Country, IC = ICARDA, A = Australia

Objective 2: To introduce, evaluate and select improved germplasm of wheat, barley and pulse and forage legumes for adaptation to rainfed farming systems in northern Iraq.

objective	outputs/ milestones	What has been achieved?	What has not been achieved?	Are there additional outputs that could have been achieved?
2. To introduce, evaluate and select improved germplasm of wheat, barley and pulse and forage legumes for adaptation to rainfed farming systems in northern Iraq.	2.1. Cultivars of these crops that produce higher yields and/or better satisfy local market requirements through better disease resistance, drought tolerance, bread quality characteristics, etc., identified and evaluated with farmers at research stations and in farmers' fields.	Many cvs chosen for desired characteristics and including Specific-Constraint and International Nurseries provided and evaluated at one site (Rasheedya Research Station and two closeby farms, Alqush and al-Sheekhan) in the medium rainfall zone. 27 trial sets established in 2006 and 14 in 2007 (PC). Cultivars that yielded more than local cultivars were identified for most crops.	Similar activities planned for Research Stations in two more rainfall zones impossible due to damage and highly insecure situation. The data, especially of cereals, was not fully presented. A consolidation is essential to ensure basis for continuing evaluation	A compilation and (GxE) analysis of the extensive data that has been collected. Evaluation against water-limited potential yield.

	2.2. Efficient production systems of the seed needed in research and demonstrations established.	Seed for demos and research provided largely from ICARDA in first year (2005) and increasingly within Iraq in Years 2 and 3 (2006 and 07). A range of alternative crops (oats, oilseeds field peas) from Australia evaluated and bulked up at ICARDA for transfer/testing in Iraq.. Investigation of seed cleaning equipment completed (IC). One machine has been provided and tested in Iraq.	Nine more machines are now ready for delivery to Iraq (IC).	Plan of proposed use of these machines e.g. village or alternative scheme.

PC = Partner Country, IC = ICARDA, A = Australia

Objective 3: To identify, evaluate and select improved cropping system management options suited to rainfed farming systems in northern Iraq.

objective	outputs/ milestones	What has been achieved?	What has not been achieved?	Are there additional outputs that could have been achieved?
3. To identify, evaluate and select improved cropping system management options suited to rainfed farming systems in northern Iraq.	3.1. Specific production constraints, identified under Output 1.1, for which there are no immediate available technologies are identified and prioritized.	Experimental comparisons of alternative tillage systems focussing on ZT were established at ICARDA (2 demos in 2005/6, 4 trials in 2006/7, leading to 2 LT rotation trials from 2007/8). A sowing time comparison (early and late) was introduced in LT trials in 2008. (IC). Yields were greater with ZT in 2005/6 and 2006/7 and the response of ZT seems especially promising in the current dry year (2008) (IC). Nine evaluations of cvs. Of alternative crops (peas, oats, brassicas) 3 per year (IC).	Comparable research could not attempted in Iraq due to extreme insecurity	
	3.2. New crop management options that solve these constraints identified, tested and evaluated with farmers.	Work proceeds with local manufacturers for appropriate modifications to local machines in Syria (IC). Comparable work underway with farmers for larger machines required for larger farms in Iraq (PC).		

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Objective 4: To enhance the capacity of Iraqi research and extension program to identify and evaluate potentially valuable germplasm and better crop/soil management technologies and promote their adoption by farmers.

objective	outputs/ milestones	What has been achieved?	What has not been achieved?	Are there additional outputs that could have been achieved?
4. To enhance the capacity of Iraqi research and extension programs to identify and evaluate potentially valuable germplasm and better crop/soil management technologies and promote their adoption by farmers.	4.1. Enhanced capabilities of Iraqi research program through joint research and specialized training programs.	Improved expertise in planning and execution of experimental programs through team meetings held at ICARDA (83 Iraqi participants) (IC and A). Training of 63 Iraqis in 7 courses covering many aspects of crop production, improvement, nutrition and protection (IC). Awareness of international work in comparable cropping systems through 11 seminars given by Australian members including zero tillage as an emergent technology suited to low rainfall environments (A).	Interaction between research, demonstration and farmers was possible at the local but not national level. Training visits for 4 Iraqi scientists (increased from 3 planned/budgeted) delayed but will be completed before end of project period (A)	
	4.2. Research and extension staff are better able to promote and disseminate new technologies in partnership with farmers.	Cooperation improved between research and extension staff of MOA, DOA, and Univ. Mosul (IC and A). Work made possible by provision of capital items, tillage machinery, seed cleaners.		
	4.3 Enhanced capabilities in evaluating adoption and impact of improved technologies.	Five Iraqi socio-economists (MOA 3, Uni. Mosul 2) trained during several visits to ICARDA on baseline surveying and adoption and impact analysis. Increased expertise evident in socio-economic evaluations and presentation.		
	4.4. Effective international collaborative networks between Iraqi, ICARDA and Australian institutions and scientists.	Close collaboration with ICARDA scientists established through visits and training courses (IC) and with Australians during planning and annual project review meetings (A). Collaboration with Australian and ICARDA scientists increasingly evident in the two annual reports and in the presentations for this review (IC and A).	Training programmes for Iraqi scientists in Australia as planned (1 /year). Revised plans have been finalized for visit of 4 project scientists before end of project (A).	

PC = Partner Country, IC = ICARDA, A = Australia

2. Project Impacts (actual and *potential*)

The nature of this project, based as it is in the introduction of new cropping technology, precludes other than preliminary or predicted impacts. Commencing and operating under great difficulties and with just two initial years of data it is not possible to claim major impacts. On the other hand, great impact seems assured in the short term given the rapid expansion of ZT technology over 100 Mha worldwide during the last two decades, and its particular application to low-rainfall areas.

(i) *Community impacts (social, economic, environmental etc)*

- Collaboration of farmers, scientists and extension workers in establishment and maintenance of demonstration trials in Iraq and Syria.
- Early involvement of local machinery sector in the demonstration and research activities.
- *The economic advantages of ZT that derive from low costs and greater yields are evident in the preliminary results.*
- *Environmental benefits to soils and water can be expected in future*.

(ii) *Capacity-building impacts*

- The capacity of team members has developed during the planning, annual review and seminar meetings and has facilitated effective interactions evident at this Final Review.
- The project has encouraged and facilitated interaction between Iraqi scientists from various institutions (MOA, DOA, University of Mosul)
- Significant contribution to training Iraqi scientists and farmers at ICARDA (63 scientists in 7 courses, and 8 farmers for 5 days).
- Training visits for 4 Iraqi scientists to Australia that have been delayed for various reasons are now finalized and are being undertaken before the end of the project period.

(iii) *Scientific impacts*

- Direct contact with ICARDA and Australian scientists and access to their technologies and genetic resources has reintroduced Iraqi crop science to world standard plant improvement, including modern developments, and crop management practices appropriate to their region.
- The project has introduced Iraq scientists, and many in ICARDA also, to the importance and potential of ZT as a means to increase yields, improve resource-use efficiencies, and conserve environmental resources. Adoption requires continuing site-specific research and development.

3. Project execution

The project was planned for rapid progress and managed remotely. Foreign nationals were unable to visit experiments in Iraq where general insecurity also restricted Iraqis to few field sites and even then presented significant danger. This insecurity, in which the first project leader was assassinated, cannot be underestimated.

In order to proceed rapidly, the plan called sensibly for the project team to devise, on the basis of available information, ‘best-bet’ agronomic packages of tillage, crops, cultivars and

related management practices so that demonstration trials could be established from the outset. This, therefore, preceded a Baseline Survey of the region to define present cropping practices and constraints to production, as well as research required to refine cropping systems and selection from a broader range of germplasm to identify the best crops and cultivars for the system in northern Iraq.

The decision was sound and enabled the project to establish a complete set of field demonstration activities (4 sites in each of 3 rainfall zones) and commence interaction with farmers. The initial 'best-bet' practices that were based on years of experience of the team members in comparable environments proved to be remarkably appropriate so that the demonstrations have proceeded effectively. Farmers are already responding favourably to the yield benefits and cost reductions offered by ZT such that Field Days held in Iraq and Syria have been well attended. Some farmers are already modifying sowing equipment to the new technique.

An important feature of the project has been the annual planning and analysis meetings that have also served as additional training sessions to which the Australian members have contributed significantly with special seminars. These meetings have also been the method to ensure reporting of progress and the production of annual technical reports. Two have been produced so far. In addition, brief monthly reports have been provided to ACIAR/AusAID. Three internal reports have been prepared (Appendix 1). A significant challenge remains in the production of the Final Report.

Time is needed for research to identify or produce superior cultivars or modifications to management practices and this has been hindered by insecurity in the region. While plans were established to evaluate new cultivars and management systems at three sites, it was possible to establish only a single research single site in Iraq, Rasheedya Research Station, near Mosul in the medium rainfall zone.

The flexibility offered to the leaders of the project enabled compensating activities to be established quickly at ICARDA and the surrounding area and also to adjust budget expenditure as the project developed. Initial evaluation of some alternative crops (oats, oilseeds and field peas) and bulking of seed were established in the first year, as were demonstrations of ZT compared with conventional cultivation. In the next two years, six research trials comparing ZT with conventional cultivation were conducted. In the longer term, two of these long-term trials will become a valuable resource that was impossible to establish in Iraq. ICARDA staff have also established some complementary field demonstrations of ZT technology in the local region and have engaged local machinery companies in manufacture and modification of ZT seeders. The provision of high quality seed was quickly identified as a major constraint to adoption of new practices so a budget shift was made that has resulted in the extensive testing and now purchase of 10 seed cleaning units for Iraq.

The outcomes of the project are the result of the efforts of many people from a range of Institutions. The good progress in implementing planned activities within Iraq is due in large measure to effective facilitation of the project within MOA Baghdad by the Project Coordinator and DG of the State Board of Agricultural Research, Dr Saleh Bader, and dedicated leadership of project teams and field activities in Ninevah by the Project Leader, Dr Abdul Sattar Al-Rajibo. Australian collaborator input and expertise have also been important, contributing knowledge and experience to planning, review of results and training. It is, however, appropriate to acknowledge the crucial role that ICARDA has played in this project

in three respects. First, the range of expertise and resources that it has made available to plan and maintain the project and add activities to compensate for difficulties encountered in Iraq. Second, the training it has been able to offer to many Iraqis in a range of subjects associated with the project. Third, the dedicated leadership it has provided has found solutions and ensured continuation.

ICARDA has also managed the finances of the project. There have been many approved changes to the budget (e.g. seed cleaning machinery), delays in expenditure (training visits to Australia) and problems with transfer of funds to Iraq. The latter need solution for future work but overall the budget will be acquitted by the end of the project period. By then, the current balance will have been expended on seed cleaners, now on the point of delivery, and the training programs in Australia that are about to commence.

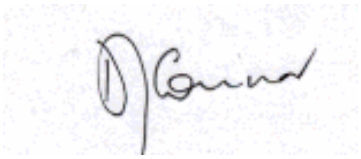
4. Follow-up

The project has made remarkable progress considering the impediments it has faced. Those impediments are likely to continue in the short term but even so, the project merits continuation for its importance, evident potential for success, and abilities that the team have developed to support it. It is important, however, to see an extension as an opportunity to capitalize on the major theme that has so far, viz. an evaluation of the potential of conservation cropping (ZT with components of stubble retention, diverse rotations, good crop management, etc) in the rainfed areas of northern Iraq and use the experience gained so far to focus the work clearly to that end. The following suggests features for consideration in developing the next phase.

- Restrict demonstration and research tillage comparisons to ZT v. conventional tillage (CT). Chisel ploughing never was a true annual alternative but the response to it in the first phase suggests serious compaction from past management.
- Any new sites for demonstrations, research, or farmer adoption must be checked for compaction before ZT is applied.
- The demonstrations must be kept simple. One strategy is to manage the two tillage systems in their optimum way. For example early sowing is an advantage of ZT that should be included. In research trials it can be dealt with differently with early- and late-planted treatments to distinguish between responses to ZT and sowing time.
- The yield gains from ZT in the first phase were achieved at yield levels below the water-limited potential. That must be the target benchmark for research and development in these water-limited areas.
- Monitoring of soil physical, chemical and biological properties will be needed in future work to develop nutrient and weed and disease control management. Simple measurements of soil water at sowing, flowering, and maturity can add a great deal to experiments and demonstrations.
- Long-term trials on ZT rotations should be established in Iraq as soon as possible.
- Emphasis should be given to direction and training on sound research methodology, paying particular attention to such things as replication, randomisation and statistical analysis. A manageable set of germplasm adaptation and crop management trials should be planned. Speculative technologies should be investigated first through small-plot trials rather than unreplicated demonstrations. Capacity should increase with increased involvement of the University of Mosul, especially through students.
- Given the importance of stubble to soil conservation and improvement of soil properties that improve workability, water-use efficiency, crop yield, and provide environmental benefits, a strong focus is also needed on stubble utilization and alternative fodder supply for ruminants. An important question will be the extent to which useful tillage/rotation experiments can be done without including grazing animals or stubble removal treatments.
- Germplasm evaluation must be focussed on the tillage/rotation/fodder supply comparisons. New cultivar options can be included in the demonstrations as they become available. Just how much to do, how and where are critical questions. What benefit, for example, can be gained from collaboration with Syrian research stations close to the Iraqi border?
- Short course training should be continued at ICARDA and by visits to Australia, while longer term research training projects, also with involvement of ICARDA as necessary, should be commenced soon and become the major contribution of the Australian Universities.

- Work with farmer groups and machinery manufacturers should be reviewed and be provided with adequate resources to ensure maximum adoption.
- Impact and adoption analyses should be formalized and methodology tested so that impact can be used to support the project outcomes as soon as possible during the next phase.
- The contribution of ICARDA is critical to the success of the project. To capture that expertise and to gain access the resources, the project needs a committed leader from ICARDA with adequate time to devote to the project.

Signature:



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Appendix 1.

Publications

1. Brief monthly reports to ACIAR/AusAID. May 2005-March 2008.

2. Reports of Project Planning-Reporting Meetings. Sept 05; Oct 06; Sept 07.

3. Annual Project Reports to ACIAR. 2005-06; 2006-07.

4. Technical Reports. First April 05-Oct 06; Second Nov 06-Sept 07.

5. Review of background information on crop rotation under the rainfall conditions in North of Iraq. June 2006.

6. Summary Report of the Baseline Socio-economic Survey Conducted in Ninevah Governorate July-August 2005.

7. Socioeconomic Studies Report 2006-07 March 2008.

8. Project web site (http://www.icarda.cgiar.org/ACIAR/) - established in 2007.

Appendix 2
List of Participants for ACIAR Iraq Review & Planning Meeting
13-17 April 2008

	Reviewer
1.	Prof. David Connor / University of Melbourne, Australia
	Australian Participants
2.	Prof. Kadambot Siddique / University of Western Australia
3.	Dr. Wal Anderson/ Department of Agriculture, Western Australia
4.	Prof. David Coventry/ University of Adelaide
	Iraqi Participants
5.	Dr Abdul Sattar A Jassim / University of Mosul / DOA Ninevah
6.	Dr Saad Abdul Jabbar Samir / University of Mosul
7.	Mr. Abd Almonem M .Mahmood / DOA Ninevah
8.	Mr.Hayder Nasser Bahjat Al-Sammak /DOA Ninevah
9.	Mr. Mahdi Salih Kheder /MOA- Agricultural Research Ninevah
10	Mr. Raad Ahmed Hameed / MOA Agricultural Research Ninevah
11	Mr. Saad Hatem Mohammed / MoA
12	Dr. Saleh Mohsin Bader Fatlawi / MoA
13	Dr Jaafar Sedeeq Saeed / DOA Ninevah
14	Dr Kasim Khalil Kasim/ MOA Agricultural Research Ninevah
	ICARDA Staff Involved in Meeting
14	Dr. Mahmoud Solh
15	Dr. Maarten van Ginkel
16	Dr. Elizabeth Bailey
17	Dr. Richard Brettell
18	Dr Ilona Kononenko
19	Dr. Kamel Shideed
20	Dr. Ahmed Sidahmed
21	Dr. Zaid Abdul Hadi
22	Dr. Jurgen Diekmann
23	Dr. Andrea Pape
24	Dr. Mohammed Imtiaz
25	Dr. Fouad Maalouf
26	Dr. Francis Ogbonnaya
27	Dr. Safaa Kumari
28	Dr. Mustafa Pala
29	Dr. Colin Piggin
30	Mr. Atef Haddad
31	Dr. Zewdie Bishaw
32	Mr. Abdul Aziz Niane
33	Dr. Saeed Kemal
34	Dr. Geletu Bejiga