2.0 PHYSICAL AND TECHNOLOGICAL IMPROVEMENTS

2.1 IMPROVING AGRONOMIC CROP PRODUCTION

ARDI implemented **24 projects** to improve Iraq's infrastructure for crop production in 2003 - 2006:

WHEAT AND BARLEY

2 **projects** to demonstrate improved wheat and barley production technology

3 **projects** to multiply certified wheat seed

2 **projects** to encourage expanded wheat production

2 **projects** to implement wide-scale wheat seed cleaning

3 **projects** to reduce damage from Sunn pest

RICE

2 **projects** to demonstrate improved rice production technology

SORGHUM

1 **project** to test performance of hybrid sorghum

1 **project** to demonstration sorghum production in the Marshlands

MAIZE

3 **projects** to establish inbred maize lines in Iraq

3 **projects** to demonstrate hybrid maize production technology

1 **project** to demonstrate maize production in the Marshlands

POTATO

1**project** to demonstrate improved potato production technology

Training for seed cleaning operations.

Seed cleaners have been distributed and technicians have received specialized training in operations and maintenance.

WHEAT AND BARLEY PRODUCTION

Wheat farmer in Dahuk.

Wheat grains were domesticated in the Fertile Crescent 10,000 years ago, with yields estimated to have been one metric ton per hectare (mt/ha)[1]. Today, wheat production is a significant economic activity in Iraq; wheat grows well in the higher rainfall areas of northern Iraq, and is also grown in other areas under irrigated conditions. The development of salt tolerant varieties makes wheat production possible, even on the saline soils of central and southern Iraq.

Despite favorable conditions for wheat production in Iraq, domestic production does not meet current food needs. Much of Iraq's population is sustained by bread wheat imports that enter the Public Distribution System (food ration) as milled flour, effectively reducing private sector returns to agriculture. While the command economy under the previous regime directed farmers to plant bread

1 Jared Diamond, in Collapse, and Guns, Germs and Steel, relates the story of the domestication of wheat in the Fertile Crescent approximately 8,500 BC.

wheat, starting in 2003 Iraq's farmers could elect to plant bread wheat, or durum wheat (for pasta and poultry feed), or barley (for livestock feed) based upon their calculation of expected return from the crop.

However, wheat yields in Iraq are low compared to neighbors with similar growing environments. Yields are constrained by a number of factors, the most significant of which are lack of financial incentive (low procurement price) and lack of farm-family cash or credit to purchase higher-yielding inputs. Wheat is often grown as a subsistence crop—with barley substituting for wheat in drier regions. A listing of the agronomic requirements for higher yields of both wheat and barley includes:

- Certified new high-yielding wheat seed introduced to a farm every 4-5 years;
- Seed cleaners and treatment for farmer-saved seed;
- Disease and pest control;
- Mechanized farm equipment (tractors, seed drills, combines);
- Availability of fertilizer, particularly DAP, and other agricultural chemicals; and
- Knowledge of how best to manage moisture retention in rainfed production through no-tillage conservation agriculture.

ARDI has provided significant assistance to wheat and barley producers in Iraq through the introduction of improved technologies to increase yield. Winter Crop Technology Demonstrations in the 2003 – 2004 and 2004 – 2005 winter cropping season demonstrated the importance of using improved certified seeds and other improved cultivation practices to increase yields. ARDI has also worked to improve the availability of high quality wheat seed through procurement and multiplication of certified seed, and through a widespread seed cleaning program. In addition, ARDI has provided assistance to address the problem of pest control, in order to reduce the effect of Sunn pest, which is significant for wheat and barley in Iraq's northern region.

Seed multiplication was implemented with local farmers to increase the amount of "Certified" or "Certified +1" available for planting.

WINTER CROP TECHNOLOGY DEMONSTRATIONS FOR WHEAT AND BARLEY

Farmer field day.

Very shortly after arriving in Iraq in October 2003, ARDI coordinated with the MOA/Baghdad to implement Winter Crop Technology Demonstrations for the 2003 – 2004 winter wheat and barley planting season. The demonstrations were intended to introduce improved technologies and practices to Iraqi cereal crop producers to increase yields of wheat and barley, in order to increase domestic production of these crops and to farmers' income. ARDI and the MOA designed the demonstrations based on the following premises:

- A large problem faced by small-scale farmers in Iraq is low farm productivity, which leads to low income and standards of living;
- Increased crop productivity will help to raise the standard of living of the farmers and their families and enhance national development;
- Adaptive crop research will yield improved technology, appropriate to

NOTE ON CONDUCTING DEMONSTRATION PROGRAMS IN FARMERS FIELDS:
A farm is a production unit with the primary objective of increasing productivity, profit and the well-being of the farm household. Consequently, researchers who experiment in farmers' fields must recognize and cope with the characteristics of an experimental area where production, not research, is the top priority.

Some of the distinctive features of the farmer's field as a test site, relative to research station, are:

- Lack of experimental facilities such as good water control, pest control, and equipment for such operations as land preparation and processing of harvest;
- Large variation between farms and even between fields in a farm;
- Poor accessibility, which creates problems of supervision by researchers;
- Lack of data describing the soil and climate of the experimental field;
- Availability of the farmer and his practices for use in experimentation.

the local conditions, situations, and needs of the farmers;

- The improved technology exhibited and tested in demonstration programs can be effectively delivered to the farmers by an extension system;
- The farmers will accept and adopt the improved technology after the utility and profitability of the technology has been effectively demonstrated; and
- The project can be maintained and institutionalized by the Ministry of Agriculture through an effective extension service.

Crop technology demonstrations are a key element of the overall "extension" or "technology transfer" process that usually begins in laboratories, progresses to field experiments, then to applied research, and finally to recommendations, demonstrations, and production campaigns. In 2003-2004, agriculture in Iraq was ripe for innovation, and new technologies indeed found their way from scientists to farmers' fields. The MOA/ARDI Winter Crop Demonstration 2003 – 2004 project was successful in introducing improved technologies for wheat and barley to Iraqi farmers; most remarkable was the breakthrough in salt tolerant wheat varieties. MOA/ARDI demonstrations showed skeptical farmers that wheat can indeed grow on saline soils. Farmers also observed improved cropping techniques, and saw that often less irrigation can be as good as maintaining high levels of moisture in their fields. Finally, farmers saw for the first time cereal crop yields topping four tons per hectare on their fields, using improved varieties and practices.

In 2004 – 2005, ARDI and the MOA expanded the Winter Crop Demonstration project to include sites in six additional governorates and to introduce new cropping techniques for potatoes, rice – wheat relay cropping, and barley and vetch for livestock forage. Perhaps the most important lesson learned in 2003 – 2004 was the remarkable response by Iraqi agriculture administrative and scientific leadership. Iraqi staff of the Ministry of Agriculture and associated universities commanded and executed agricultural extension in both the 2003 – 2004 and the 2004 – 2005 programs with excellence, determination, and confidence.

PROJECT DESIGN FOR WINTER CROP TECHNOLOGY DEMONSTRATIONS

The improved technology for crop production introduced in the Winter Crop Technology Demonstration projects was based on research by the State Board of Agricultural Research (MOA), the College of Agriculture at the University of Baghdad, and the Ministry of Science and Technology (MOST). The technology represents the most suitable combinations of practices for small-scale farmers in Iraq in the different agro-ecological zones (high rainfall, moderate rainfall, low rainfall, and irrigated conditions).

The MOA selected farmers and sites on which to establish demonstration plots according to the following criteria:

- The demonstration site was representative of most of the fields in the region;

Demonstration sites were marked with signs for Improved Practices and Technologies (left) and Traditional Practices (right)

- Location of the site was within the crops' agro-ecological zone (i.e. suitability);
- The site was easily accessible to both farmers and team members.

In this report, the "demonstration plot" refers to the area in which improved practices were implemented. Most of the demonstration plots for the Winter Crop Technology Demonstrations for wheat and barley were one hectare in area, except for irrigated plots which were two hectares in area. In most cases, a "local check" plot planted with traditional farmer cultivation practices was established adjacent or near to the demonstration plot, for purposes of comparison. In most cases, production data were collected from both the demonstration plot and the local check, and where available these figures are included in this report.

In all of the MOA/ARDI winter crop technology demonstrations, field days were an extremely important element. They were generally held, when possible, during the growing season and/or at harvest, at the demonstration sites. Area farmers were invited to attend these field days, which were led by technical staff from the Ministry of Agriculture, the College of Agriculture, and ARDI staff, who discussed with farmers the new technology used in the demonstration and answered questions about crop production. The local check plots enabled the farmers to observe firsthand the differences between using the new technology and the traditional practices, further encouraging them to adopt new technology on their own fields to increase yields and income. The field days enhanced the extension aspect of the demonstration program and fulfilled the objective of the crop technology demonstrations to introduce new crop technology to as many farmers as possible. In 2004 – 2005, 460 farmers attended field days for wheat production, In 2005 – 2006, 2,640 farmers attended field days for wheat production, and 100 farmers attended field days for barley production.

The results of the 2003 – 2004 and 2004 – 2005 Winter Crop Technology Demonstrations are discussed below (wheat, barley, and rice-wheat relay cropping). Results for the barley/vetch demonstration are discussed in 2.5: Improving Forage Crop Production and Rangelands.

Field days at trial plots were used to expose larger groups of farmers to the new technologies demonstrated during the trials. For many farmers it was the first on the ground intervention by an extension activity in their village in many years.

WHEAT CROP TECHNOLOGY DEMONSTRATIONS

A farmer crushes wheat in his palm to release the grain during a 2004 Winter Crop Demonstration field day.

As part of both the 2003 – 2004 and the 2004 – 2005 Winter Crop Technology demonstration projects, ARDI and the MOA implemented wheat demonstration plots to exhibit an improved package of technologies to increase yields over those from the farmers' traditional practices. The demonstrations were implemented in low rainfall areas, moderate rainfall areas, and high rainfall areas, as well as under supplemental irrigation and full irrigation conditions. MOA/ARDI also conducted demonstrations to introduce improved salt tolerant varieties of wheat during both the 2003 – 2004 and the 2004 – 2005 programs.

ACTIVITIES

The demonstration plots were planted according to the improved technical package with assistance and supervision of MOA Baghdad, MOAI/Sulaymaniyah, MOAI/Erbil, the College of Agriculture at the University of Baghdad, and MOST. The improved practices and technologies included:

Students from the College of Agriculture attend a field day to learn about wheat cropping technology

- Minimum tillage if possible of fallow land for weed control, two times;
- Chisel plowing for seed bed preparation or disking if needed in heavy clay soils;
- A harrow and/or drag used following the plowing to break up clods and flatten the seed bed;
- Modern drill use to place the seed at the correct depth in the soil, with a band of fertilizer laid in simultaneously underneath the seed;
- Use of improved varieties of certified seed treated with fungicide;
- A side dress of urea at tillering stage; and
- Herbicide application when necessary.

Production (yield) data were recorded from both the production plots and, when available, a local check plot planted with farmers' traditional practices for the purpose of comparison. Farmers attended field days to observe the improved yields and higher production from the fields planted with the improved technology package, and to learn more about this package so as to implement the practices in their own fields to improve their production. In the 2003 – 2004 demonstration project, a total of 460 farmers attended field days. The 2004 – 2005 project dramatically increased this number to 2,640 farmers who attended to learn about improved wheat cultivation practices.

Wheat demonstration sites 2003-2004.

HIGH RAINFALL AREAS

MOA/ARDI implemented technology demonstrations of bread and durum wheat during both the 2003 – 2004 cropping season and the 2004 – 2005 cropping season (see Tables 1 and 2).

TABLE 1 WHEAT DEMONSTRATION SITES 2003-2004

High Rainfall Areas		
Governorate	Type of Wheat	Number of Sites
Ninewa	Bread	4
	Durum	10
Moderate Rainfall Areas		
Ninewa	Bread	4
	Durum	12
Irrigated Fields		
Baghdad	Bread	3
Wassit	Bread	3
Qadissiya	Bread	2
Salt Tolerant demos		
Baghdad	Salt Tolerant	6
Qadissiya	Salt Tolerant	2
Wassit	Salt Tolerant	4
Total Sites		**38**

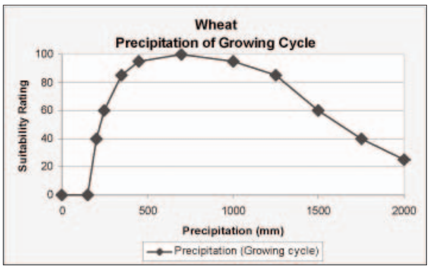
TABLE 2 WHEAT DEMONSTRATION SITES 2004-2005

High Rainfall Areas		
Governorate	**Type of Wheat**	**Number of Sites**
Ninewa	Bread	13
	Durum	14
Sulaymaniyah	Bread	2
	Durum	8
Dahuk	Durum	1
Erbil	Bread	4
	Durum	6
Moderate Rainfall Areas		
Ninewa	Bread	4
	Durum	5
Tameem	Bread	5
Sulaymaniya	Bread	4
	Durum	5
Erbil	Bread	9
	Durum	3
Dahuk	Bread	3
	Durum	9
Low Rainfall Areas		
Erbil	Bread	2
	Durum	6
Supplemental Irrigation		
Tameem	Bread	3
	Durum	2
Sulaymaniya	Bread	8
Dahuk	Durum	2
Irrigated Fields		
Qadissiya	Bread	7
	Durum	6
Salt Tolerant		
Baghdad	Salt Tolerant	2
Babylon	Salt Tolerant	2
Wassit	Salt Tolerant	4
Qadissiya	Salt Tolerant	2
Total Sites		**141**

In 2003 – 2004 the demonstrations were implemented in Ninewa governorate, which is the largest wheat growing area in Iraq and has some of the best conditions for wheat production. A total of four sites were planted for bread wheat and ten for durum wheat.

In the high rainfall areas, the demonstrations of bread wheat (Cham-4 cultivar) did not show improvements over farmers' varieties and practices; the average yield for the demonstration plots was 1.3 mt/ha, while the farmers practices yielded 2.1 mt/ha (see Table 3). It must be noted that the demonstration plots were planted late in the season due to late delivery of the seed, and thus received less rainfall. Bread wheat requires a lot of water relative to other wheat varieties for good production, and so the lack of rainfall on the demonstration plots had a significant impact on yield.

Wheat demonstration sites 2004-2005.



Climatic requirements for wheat with respect to precipitation for the entire growing season.

Cleaned and treated wheat seed stored in warehouse for planting in next season.

The improved durum wheat cultivars (Cham-1 and Cham-3) cultivated with improved techniques did perform better than those planted according to farmer practices; these cultivars were less affected by late planting and lack of rain. On average, the demonstration plots yielded 1.3 mt/ha, while the plots planted with farmer practices yielded 1.0 mt/ha.

TABLE 3 WHEAT YIELDS IN HIGH RAINFALL AREAS 2003-2004

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	4	1.3	2.1	-40%
	Durum	10	1.3	1	34%

A farmer in Dahuk examines extension materials distributed by the MOAI Erbil as part of the Wheat Crop Technology Demonstration project.

2004 - 2005

The demonstrations for durum and bread wheat in high rainfall areas were expanded as part of the 2004 – 2005 Winter Crop Technology Demonstration project. Additional demonstration plots were established in Ninewa, as well as in Sulaymaniyah, Dahuk and Erbil (see Table 4).

It must be noted again that the demonstration plots in Ninewa were planted late in the 2004 – 2005 season, and the crop therefore missed essential early rains, resulting in low yields. In addition, deteriorating security concerns in Ninewa during the 2004 -2005 season prevented ARDI or MOA staff from reaching the local check plots planted with farmer practices, and therefore no data were collected from these plots.

High rainfed wheat demonstration sites 2004 - 2005.

In Sulaymaniyah, Dahuk and Erbil, both bread and durum wheat cultivars planted with improved technology produced higher yields than the local check plots. The highest yield improvements were seen in Sulaymaniyah governorate, where the improved cultivar IPA-99 showed a 192% improvement over the local check

TABLE 4 WHEAT YIELDS IN HIGH RAINFALL AREAS 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	13	0.86	n/a	n/a
	Durum	14	0.97	n/a	n/a
Sulaymaniyah	Bread	2	2.6	0.9	192%
	Durum	8	2.5	1.7	51%
Dahuk	Durum	1	1.1	n/a	n/a
Erbil	Bread	4	1	n/a	n/a
	Durum	6	2	1.8	11%

(based on one local check plot). The durum wheat demonstration plots planted with the improved cultivar Acsad-65 showed an improvement of 51% over the local check plots.

MODERATE RAINFALL AREAS

2003 – 2005

In 2003 – 2004, demonstrations for bread and durum wheat were planted in Ninewa governorate; four sites were planted with improved Cham-6 bread wheat, and 12 were planted with improved Cham-1, Cham-3 and Cham-5 durum wheat cultivars. A number of local check plots were planted using farmer practices. The improved technology package planted with improved bread wheat cultivars resulted in an average yield of 1.6 mt/ha, representing an increase in yield of over 22% as compared to the local check (see Table 5). The improved technology package planted with durum wheat did not show an increase over the local check plot planted with farmer practices; both yielded 1.9 mt/ha.

In 2004 – 2005, the demonstrations for bread and durum wheat in moderate rainfall areas were expanded to include sites in Sulaymaniyah, Dahuk, and Erbil. Demonstrations were planted in Ninewa again, but as noted above the crop was planted late and missed essential early rains and therefore produced low yields. Also, the deteriorating security situation prevented ARDI or MOA staff from reaching the local check plots, and no data were collected from these plots.

Moderate rainfed wheat demonstration sites 2004 - 2005.

TABLE 5 WHEAT YIELDS IN MODERATE RAINFALL AREAS 2003-2004

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	4	1.6	1.3	22%
	Durum	12	1.9	1.9	0%

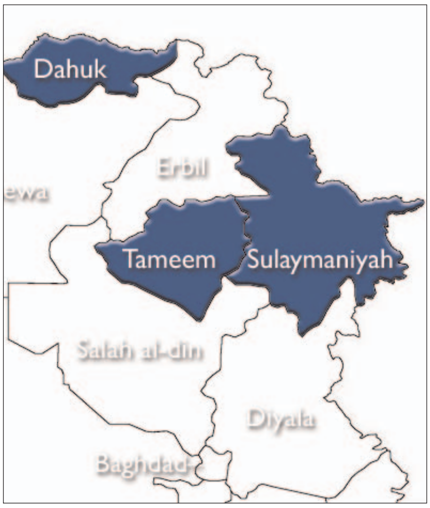
TABLE 6 WHEAT YIELDS IN MODERATE RAINFALL AREAS 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Ninewa	Bread	4	0.39	0.7	-44%
Tameem	Bread	5	1.9	2.3	-19%
Sulaymaniyah	Bread	4	2.17	0.96	126%
	Durum	5	2	0.78	151%
Dahuk	Bread	3	1.3	n/a	n/a
	Durum	9	1.2	0.9	35%
Erbil	Bread	9	1.4	1.1	30%
	Durum	3	2	1.4	37%

TABLE 7 WHEAT YIELDS, LOW RAINFALL AREAS 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Erbil	Bread	2	1.7	n/a	n/a
	Durum	6	1.9	1.7	10%

The best results from these demonstrations came from Sulaymaniyah, were the demonstration plots planted with the improved technology package achieved yields of 2.6 mt/ha for bread wheat and 2.5 mt/ha of durum wheat.



Low rainfed wheat demonstration sites 2004 - 2005.

LOW RAINFALL AREA

2004 – 2005

Demonstration plots were planted in 2004 – 2005 in low rainfall areas of Erbil, to demonstrate use of improved varieties and technologies to increase production in areas where wheat does not normally grow well due to lack of rain. The improved durum wheat cultivars (Acsad-65 and Cham-3) planted with improved practices yielded an average of 1.9 mt/ha, slightly better than the bread wheat cultivars planted with improved practices (1.7 mt/ha). The durum wheat planted with improved practices yielded an average of 10% higher than the local check plots planted with farmer practices (see Table 7). There were no local check plots planted for bread wheat.

SUPPLEMENTAL IRRIGATION

In northern Iraq, wheat production can benefit from supplemental irrigation. Demonstrations of supplemental irrigation for bread and durum wheat were held as part of the 2004 – 2005 Winter Crop Technology Demonstrations, on sites in Tameem, Dahuk and Sulaymaniyah governorate. In Tameem, plots were planted and irrigated at 50% moisture and at 100% moisture (see Table 8). The use of irrigation at 100% moisture produced higher yields than using irrigation at 50% moisture; for bread wheat, the improvement was 21%, and for durum wheat the improvement was 22%.

Supplemental pivot irrigation system in low rainfed area.

In Sulaymaniyah and Dahuk, the demonstration of irrigated wheat production consisted of plots planted with improved varieties and improved practices, including proper irrigation. Local check sites planted with farmer practices were planted in adjacent or nearby plots for comparison purposes. In Sulaymaniyah, the improved bread wheat cultivar (IPA-99) planted with improved practices including supplemental irrigation outperformed the local check in terms of yield by 148%. In Dahuk, the improved durum wheat cultivars (Acsad-65 and Cham-3) planted with improved practices including supplemental irrigation outperformed the local check by 13%.

TABLE 8 WHEAT YIELDS, SUPPLEMENTAL IRRIGATION (50% AND 100% MOISTURE) 2004-2005

Location	Type of Wheat	Number of Sites	Yield mt/ha	
			50% Moisture	100% Moisture
Tameem	Bread	3	3.3	4
	Durum	2	3.4	4.2

TABLE 9 WHEAT YIELDS, SUPPLEMENTAL IRRIGATION 2004-2005

Location	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Sulaymaniyah	Bread	8	2.7	1.1	148%
Dahuk	Durum	2	3.3	2.9	13%

FULL IRRIGATION

Wheat can grow well in the central region of Iraq under irrigated conditions. In 2003 -2004, ARDI and the MOA implemented demonstrations at nine sites in Baghdad, Qadissiya, and Wassit to exhibit an improved technological package that featured the use of the improved Iraqi-developed IPA-99 cultivar, as well as proper irrigation practices in terms of timing and quantity of water used. The plots planted with improved practices showed an increase of 60% over plots planted with farmer practices (see Table 10).

In 2004 – 2005, the demonstrations were expanded to 13 sites, seven in Qadissiya and six in Baghdad.

The average yield of all sites using improved practices increased from the 2003 – 2004 demonstration results (3.2 mt/ha) to 4.2 mt/ha. The yields obtained using farmer practices also improved, from 2.0 mt/ha to 3.0 mt/ha.

Full irrigation wheat demonstration sites 2004 - 2005.

TABLE 10 WHEAT YIELDS, FULL IRRIGATION 2003-2004

Governorate	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Qadissiya	Bread	4	3.9	2.2	77%
Wassit	Bread	2	1.9	1.2	58%
Baghdad	Bread	3	3.8	2.7	41%
Average			**3.2**	**2**	**60%**

TABLE 11 WHEAT YIELDS, FULL IRRIGATION 2004-2005

Governorate	Type of Wheat	Number of Sites	Average Yields (mt/ha)		% Improvement
			Demo Plot	Local Check	
Qadissiya	Bread	7	3.5	2.4	46%
Baghdad	Bread	6	5	3.8	32%
Average			**4.2**	**3**	**40%**

State Owned Enterprise wheat silo in Iraq.

SALT TOLERANT WHEAT

Wheat farmers in Thi-Qar observe improved production achieved using salt tolerant wheat cultivars

Saline soils negatively affect crop production in large areas of central and southern Iraq. In many, production is not possible under the current saline soil conditions. Newly developed salt-tolerant bread wheat varieties, Furat and Dijila, have been undergoing a selection process in Iraq for 12 generations, in order to develop and introduce these varieties to Iraqi farmers, so they can bring saline soils into production. These two varieties were introduced as part of the 2003 – 2004 and 2004 – 2005 Winter Crop Production demonstration projects, the first large-scale demonstrations of them in Iraq. In addition to the use of the improved varieties, the technology package included proper fertility and pest management practices, and multiple irrigations with water to promote root development.

The salt tolerant wheat cultivars produced yields that were much higher than the local checks; indeed, many farmers were not able to produce any wheat

Field trials using salt tolerant wheat.

using traditional practices. In 2003 – 2004, the demonstrations of Furat and Dijila cultivars produced similar yields (2.4 mt/ha and 2.5 mt/ha, respectively), and showed an improvement of 245% over the local check.

In 2004 – 2005, the demonstration program was expanded to include a site in Babylon, in addition to sites in Qadissiya, Baghdad, and Wassit again. Although the salt tolerant varieties again far outperformed the traditional practices, the overall yield of wheat in the area was poorer in the 2004 – 2005 season (an average of 1.8 mt/ha, compared to 2.5 for 2003 – 2004). This held true for the local checks as well.

TABLE 12 SALT-TOLERANT WHEAT YIELDS 2003-2004

Location	Number of Sites	Yield (mt/ha)		
		Furat	Dijila	Local Check
Qadissiya	2	1.4	1.6	0.6
Baghdad	6	2.5	2.7	0.9
Wassit	4	2.7	2.7	0.6
Average	**12**	**2.4**	**2.5**	**0.71**
% Improvement		**245%**		

TABLE 13 SALT-TOLERANT WHEAT YIELDS 2004-2005

Location	Number of Sites	Yield (mt/ha)		
		Furat	Dijila	Local Check
Qadissiya	1	0.8	0.9	0
Baghdad	1	1.75	3.08	0
Wassit	2	1.9	2.2	0.64
Babylon	1	1.1	1.5	0
Average		**1.5**	**2**	**0.37**
% Improvement		**373%**		

RICE - WHEAT RELAY CROPPING DEMONSTRATION

Researchers inspect a rice-wheat relay cropping field.

While wheat is considered a principal winter cereal crop in Iraq, rice is an important summer crop. The production of these two crops can be complementary; farmers can use lands on which rice is cultivated during the summer to produce wheat during the winter. Such a rice–wheat relay cropping system enables increased production per unit area of agricultural land, and enables the farmer to increase total productivity and income. In addition, planting wheat on land used to cultivate rice negates the need for many agricultural practices usually implemented for wheat cropping. This saves the farmer time and the cost of inputs, which can help improve yields and profits.

The rice–wheat relay cropping system involves sowing (broadcasting) wheat into a rice field after the last irrigation of the rice, and before harvesting the rice crop (in Iraq, this generally occurs in the second half of October). In such a system, the wheat seeds get the benefit of soil moisture from the irrigation, which helps them emerge more quickly. The rice plants also offer protection to the germinating wheat seeds from birds and unfavorable weather conditions. After the rice is harvested, the wheat seeds continue to benefit from residual fertilizers that were applied to the fields during rice cultivation, and from an already weed-free field, reducing or negating the need for herbicide, which saves the farmer the cost and time of herbicide application.

Rice in field trial with various technology packages.

Small studies conducted on limited rice–wheat relay cropping in Iraq show that the adoption of such a system leads to increases in farmers' income and decreases seasonal unemployment, since the farmers can cultivate during two seasons. In central Iraq, the system has been shown to reduce water needs of the wheat crop by 50%. However, the rice–wheat relay cropping system is used by only a very small number of farmers. In order to expand the use of this system and increase unit area productivity and yield quality, ARDI and the MOA designed and implemented a demonstration of a rice–wheat cropping system as part of the 2004 – 2005 Winter Crop Technology Demonstrations.

Rice-wheat demonstrations were conducted in these governorates.

ACTIVITIES

The demonstration project for the rice–wheat cropping system was conducted at eight sites in four governorate: Najaf, Qadissiya, Babylon and Wassit. Two sites already under cultivation with rice were chosen in each governorate. The area of each site was two hectares – one to demonstrate improved practices with cultivation of wheat after rice, and the other to be planted with wheat according to farmers' traditional practices.

The improved technology package used in the demonstration sites included:

- Use of improved wheat seeds, with preference for certified seeds;
- Sowing rates of 120 – 140 kg/ha, and sowing date of wheat right after last irrigation of the rice crop and before harvesting, in the second half of October;
- Appropriate use of fertilizers, if necessary because rice fields have not been adequately fertilized;

- Treatment of weeds with 1.2 kg/ha of herbicide (in the case of planting uncertified wheat seeds);
- Field irrigation, depending upon plant needs for water and the soil condition. Due to a lack of moisture at the correct times in the 2004 – 2005 planting season, the demonstration plots were irrigated 2-3 times each.

Before the demonstration project, a workshop was held with the demonstration technical team, which was composed of staff from the Ministry of Agriculture, the College of Agriculture at the University of Baghdad, and ARDI, in order to discuss the work plan. A second workshop was held by the technical team at the agricultural rice research station in Najaf; this workshop was also attended by the participating farmers and the heads of the agriculture directorates at the sites in Najaf, Qadissiya and Babylon. The matters discussed included the economic importance of rice-wheat cropping, and the data that should be collected to estimate plant growth and yields.

The technical team held extension field days to exhibit results to farmers and encourage widespread adoption of the new technology. At the end of the season, the technical team held field days at the Najaf, Babylon and Wassit sites. These field days, which were attended by many farmers and officials of the agriculture directorates of those governorate, included a tour of the demonstration and local check fields. Farmers observed the increases in yield gained by using the rice-wheat cropping system. The field days concluded with an open discussion to evaluate the results of the demonstration and the potential for expanding the use of the rice-wheat cropping system.

RESULTS

At harvest, ten random samples (replicates) of 1 m^2 were taken to determine yields. The estimated productivity of the plots was calculated using the average productivity of these replicates. The results are noted below.

TABLE 14 WHEAT YIELDS, RICE-WHEAT CROPPING 2004-2005

Governorate	Average Yields (mt/ha)		% Improvement
	Demo Plots	Local check	
Qadissiya	3.8	2.9	31%
Babylon	5	3.5	43%
Wassit	3.7	2.6	42%
Najaf	3.9	2.9	34%
Average	**4.1**	**3**	**37%**

The rice-wheat cropping system showed an average production of 4.1 mt/ha using improved technology, while the local check showed an average yield of 3.0 mt/ha using farmer practices. The productivity of wheat per unit area varied among locations for both the fields cultivated using improved technology, and those cultivated using farmer practices. This may be attributed to the type of cultivar used; some fields were planted with improved cultivars (Tammoz-2, Al-Iraq and IPA-99) while others were planted with non-improved cultivars (Mexipak and Abu-Garib). The highest yields were in Babylon governorate (an average yield of 5.0 mt/ha for improved technology and 3.5 mt/ha for farmer practices, using improved Tammoz-2 and Al-Iraq cultivars in both sets of fields), while the lowest average yields were in Wassit (3.7 mt/ha for improved technology and 2.6 mt/ha for farmer practices, using non-improved Abu-Garib cultivars in both types of fields).

The increase in productivity per unit area in the demonstration fields planted with improved technology was accomplished in part as a result of using appropriate fertilizers at the correct quantities and application times. It was found that farmers used very limited amounts of phosphate fertilizers on their rice fields. In the fields planted with farmer practices, use of fertilizer on the rice crop did not exceed 80 kg/ha, and some farmers did not use any due to high market prices. This would affect the production of the wheat crop, and necessitated the use of additional fertilizers on the wheat crop on the fields planted with improved technology. In addition, the use of potassium sulfate had an additional positive effect on the crop planted with improved technologies, as a result of the benefit of potassium in photosynthesis and plant growth. In comparison, the fields planted with farmer practices received about half quantities of urea and phosphate fertilizers, and received no potassium sulfate, which likely contributed to reduced yields.

Beneficial insect on wheat.

The proper use of irrigation was another contributing factor to higher yields from the demonstration plots. These fields were irrigated three times: first in late December, for the second time in early March, and for the final time in early April. The irrigation was determined based on the shortage of rainfall in the 2004 – 2005 agricultural season. On the local check plots, the farmers irrigated their fields from two to four times, and not necessarily at the right times.

The benefit of using improved seeds to increase yields has been noted above. The use of these seeds is also beneficial because they are certified seeds, and therefore very clean and without weed seeds. Farmer saved seed of unimproved varieties generally contains weed seeds, necessitating the use of herbicide during the growing season. The use of rice–wheat cropping can improve the condition of the wheat seed produced on these fields; the rice fields on which the wheat is planted contain very few weed seeds and seeds of other wheat cultivars, so the wheat seed production will be homogenous. The sale price of such clean wheat seeds is higher, or if farmers choose to save the seed for their own use in the next season, the seed is of higher quality and will produce better yields.

BARLEY TECHNOLOGY DEMONSTRATIONS

Barley Demonstration Plot

As part of both the 2003 – 2004 and the 2004 – 2005 Winter Crop Technology demonstration projects, ARDI and the MOA implemented barley demonstration plots to exhibit an improved package of technologies to increase yields over the use of farmers' traditional practices. The demonstrations were implemented in low, moderate, and high rainfall areas.

ACTIVITIES

The demonstration plots were planted according to the improved technical package with assistance and supervision of MOA Baghdad, MOAI Sulaymaniyah and MOAI Erbil, the College of Agriculture and MOST. The improved practices and technologies included:

- Minimum tillage, if possible, of fallow land for weed control, two times;
- Chisel plowing for seed bed preparation or disking if needed in heavy clay soils;
- A harrow and/or drag used following the plowing to break up clods and flatten the seed bed;
- Modern drill used to place the seed at the correct depth in the soil, with a band of fertilizer laid in simultaneously underneath the seed;

Seed drill with seed and fertilizer dispensers.

- Use of improved varieties of certified seed treated with fungicide;
- A side dress of urea at tillering stage; and
- Herbicide application when necessary.

Production (yield) data were taken from both the production plots and the nearby local check plots planted with farmers' traditional practices for the purpose of comparison. Farmers attended field days to observe the improved yields and higher production from the fields planted with the improved technology package, and to learn more about this package in order to implement the practices in their own fields.

RESULTS

LOW RAINFALL AREAS

Low rainfall zones include areas with average annual rainfall from 200 to 350 mm/year. It is possible to grow barley under these conditions, although it is not normally possible to cultivate wheat. Farmers in the low rainfall areas of Ninewa governorate comment that they can expect a good crop of barley one year in five. In other years either low yields (less than 1.0 mt/ha) are achieved, or the crop is a complete failure. Farmers in these low rainfall, nonirrigated areas are typically poorer than farmers in the better moisture regimes in Iraq.

Barley demonstrations in low rainfall areas.

In 2003 – 2004, the demonstrations of the improved barley varieties Tadmor and Zambaka were successful in producing slightly higher yields than the local check. It must be noted that these demonstrations were planted late, well beyond the proper planting time, as the seed delivery was delayed. Nevertheless, the plots planted with the improved practices and the Zambaka improved variety showed average yields with an increase of nearly 15% over the local check (see Table 15).

TABLE 15 BARLEY YIELDS, LOW RAINFALL AREA 2003-2004

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)		% Improvement
			Demo Plots	Local Check	
Ninewa	Tadmor	10	0.48	0.47	2%
	Zambaka	9	0.54		15%
Average			**0.51**	**0.47**	**9%**

In 2004 – 2005, the demonstrations of improved barley were repeated in Ninewa, and expanded to include demonstration sites in Sulaymaniyah and Erbil. The demonstrations in Ninewa were held on 14 sites, all planted with Tadmor cultivars and improved practices. In these demonstrations, the improved practices outperformed the farmer practices by 35%. In Erbil, a local black barley was planted to demonstrate improved practices, and in Sulaymaniyah a local white barley cultivar was used. These cultivars outperformed the Tadmor planted in Ninewa, but no local checks were planted to compare their performance against farmer practices in the same area (see Table 16).

ARDI held field days in Erbil and Sulaymaniyah, in coordination with the Ministries of Agriculture in those governorates, to demonstrate to farmers the higher production using improved practices. In Sulaymaniyah, 50 farmers attended the field day, which was led by ARDI staff and the Director-General of Research and Extension at the MOA. In Erbil, 50 farmers and 10 MOA staff attended the field day.

MODERATE RAINFALL AREAS

Demonstrations of an improved technological package, including the use of improved barley varieties Reehan-3, Tadmor and Zambaka, were conducted in moderate rainfall areas of Ninewa in 2003 – 2004. A local check was also planted. The improved technology package planted with Tadmor showed an increase in yields of 57% over the local check. The improved technology package planted with Zambaka showed an increase in production of 26% over the local check (see Table 17).

In 2004 – 2005, the demonstration project was expanded to include sites in Tameem, Sulaymaniyah and Erbil, as well as sites in Ninewa. The improved technology package produced excellent results in Tameem (Tadmor cultivar) and Sulaymaniyah (white barley cultivar) with yields of 2.43 mt/ha and 2.38 mt/ha respectively. The local checks, in comparison, did very poorly, and were outperformed by an average of 114% by the improved technology sites (see Table 18).

Barley demonstrations in moderate rainfall areas.

TABLE 16 BARLEY YIELDS, LOW RAINFALL AREA 2004-2005

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Ninewa	Tadmur	14	1.22	0.9
Sulaymaniyah	White barley	1	2.5	n/a
Erbil	Black barley	1	2	n/a

TABLE 17 BARLEY YIELDS, MODERATE RAINFALL AREA 2003-2004

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Ninewa	Tadmur	3	1.9	1.2
	Zambaka	3	1.5	
Average			1.7	
% Improvement			**42%**	

TABLE 18 BARLEY YIELDS, MODERATE RAINFALL AREA 2004-2005

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Tameem	Tadmur	3	2.43	1.9
Ninewa	Rihane-3	2	1.7	1
Sulaymaniyah	White barley	1	2.38	n/a
Erbil	Black barley	2	1.8	0
	Average		**2.08**	**0.97**
	% Improvement		**114%**	

HIGH RAINFALL AREAS

Summary for Wheat and Barley Demonstration Programs: The MOA/ARDI crop technology demonstrations were a successful step towards improving wheat and barley production in Iraq. A total of 3,200 farmers attended field days led by ARDI and MOA technical staff to observe the use of improved practices to increase wheat and barley yields.

The demonstrations of certified seed use underscored the importance of using good seed to increase yields. ARDI followed these demonstration projects with seed multiplication projects to increase the stock of certified seed available to Iraqi farmers, and a seed cleaning program to increase the productivity of farmers' saved seed.

TABLE 19 BARLEY YIELDS, HIGH RAINFALL AREA 2004-2005

Governorate	Type of Barley	Number of Sites	Yield (mt/ha)	
			Demo Plots	Local Check
Sulaymaniyah	White barley	1	2.3	n/a
Dahuk	Black barley	3	1.7	n/a
	Average		**2**	**n/a**

WHEAT SEED MULTIPLICATION

The MOA/ARDI Winter Crop Technology demonstrations in 2003 – 2004 and 2004 – 2005 demonstrated the importance of using improved technology, including improved wheat seed varieties, to increase wheat yields and farmers' income. With the Oil for Food program under the previous regime, certified wheat seed of such varieties as Cham and Acsad-65 was imported and distributed to farmers. Since the end of this distribution program in 2003, farmers have largely been using seed saved from their previous harvest to replant their fields. When seed is replanted like this, it deteriorates genetically in each succeeding season, and the practice reduces the quality and the quantity of the crop.

Wheat seed; healthy on left, Sunn pest damaged on the right.

In the summer of 2004, the MOA indicated that the lack of certified seed in Iraq was a major constraint to improving wheat production. Only a limited amount of certified seed was held in Iraq, by two seed companies (Mesopotamia and the

Iraqi Seed Company), and the Ministry of Science and Technology. To mitigate the effects of the near-total lack of high quality seed in the market, ARDI assisted an MOA-subsidized distribution program for 2004 – 2005. In addition, ARDI and the MOA cooperated to implement wheat seed multiplication programs to multiply certified wheat seed in 2004 – 2005 and 2005 – 2006.

ACTIVITIES

ARDI imported certified wheat seed for these programs and contracted with farmers who had the technical ability to cultivate wheat with proper practices that met standards for certified seed production. To ensure that the seed multiplication effort was producing high quality seed, trained ARDI inspectors visited the seed multiplication fields twice during the growing season to inspect for off-types, harmful weeds, and insect damage to the crop. Fields that failed these inspections were rejected from the program. The seed that was produced on fields deemed qualified was accepted as "Certified+1" seed, meaning seed that is one generation removed from the official certification level, but cultivated to maximize genetic and physical purity. The seed from nonqualified fields is usually of fairly good quality, and the farmers whose fields were rejected as not qualified likely planted much of the seed produced during the next planting season, or sold it to other farmers who realized higher yields than would have been achieved with several-generation old-saved seed.

In exchange for the original procurement of certified seed and the technical assistance during the multiplication process, the qualified farmers participating in the multiplication programs agreed to return to ARDI two tons of Certified+1 seed for each ton of certified seed they had received and planted. The farmers were free to either keep the remainder of the seed crop for their own use, or sell it to other farmers. In the 2005 – 2006 multiplication programs, ARDI also provided seed cleaning services to remove debris from the seed and ensure pure, grade 1 seed.

RESULTS

For the 2004 – 2005 winter wheat planting season, ARDI procured 20 tons of certified Cham 6 wheat seed (bread wheat) for multiplication. ARDI distributed the seed to five farmers in Dahuk, selected for their progressive farming practices. The farmers were instructed how to plant and treat the fields in order to produce a certifiable crop. Each farmer planted 30-60 ha of seed, for a total of 200 ha. After two field inspections, ARDI agronomists certified that 155 hectares had been cultivated up to standard. The average yield for qualified fields was 1.7mt/ha, resulting in an estimated 264 tons of Certified+1 seed for the following season. From that amount, the farmers returned to ARDI a total of 40 tons of Grade 1 seed. ARDI also purchased an additional 44 tons of grade 1 seed and 52 tons of grade 3 seed to use in production programs the following year. The grade 1 seed was used during the 2005 – 2006 Wheat Production program in Sulaymaniyah, and the grade 3 seed was used for the Small Village Wheat Production program in Dahuk. Farmers retained the remainder of their seed yield, either to sell or to use for the 2005 – 2006 planting year.

The MOA/ARDI Wheat Seed Multiplication projects in 2005 – 2006 aimed to multiply and increase the availability of improved durum wheat (Acsad-65 and Cham-5) and salt-tolerant wheat cultivars. For durum wheat multiplication, ARDI worked with 124 farmers in Dahuk and Erbil to plant a total of 340 mt of imported certified seed- 200 mt of Acsad-65 and 140 mt of Cham-5. During the two-phase inspection process, ARDI certified 1,600 ha of the planted area as acceptable for certified seed production. The total amount of Certified+1 seed produced on this accepted land was 2,096 mt; an additional 1,124 mt of seed were rejected as not up to Certified+1 standards, although much of it was still of good quality. ARDI provided seed cleaning services to all the farmers, including those with rejected fields. A total of 3,297 mt of seed were cleaned. ARDI collected 425 mt of the seed from farmers according to the contract. This seed was granted to a cooperative formed for agricultural input supplies; this

TABLE 20 CHAM 6 WHEAT SEED MULTIPLICATION 2004-2005

Site	Seed planted (mt)	Accepted area (ha)	Rejected Area (ha)	Yield on Accepted Area (mt/ha)
1	3	30	0	1.6
2	3.5	0	35	n/a
3	4	40	0	1.6
4	6	60	0	1.9
5	3.5	25	10	1.5
Total	**20**	**155**	**45**	

TABLE 21 WHEAT SEED MULTIPLICATION 2005-2006

Governorate	Number of Sites	Total Certified Seed Produced (mt)	Seed Collected by ARDI (mt)
Erbil	7	1,910	**425**
Dahuk	3	1,026	
Total	**10**	**2,936**	

Salt tolerant wheat seed demonstration areas.

cooperative will make the seed, in addition to extension services, available to farmers on a fee basis in the 2006 – 2007 wheat cropping season. The fee will enable the cooperative to recapitalize and continue procuring and multiplying certified wheat seed to increase its availability to Iraqi farmers.

(above) ARDI inspectors in a wheat seed multiplication field

The total amount of Certified+1seed produced by this program, if it is all used as seed, will plant approximately 23,000 ha in the 2006 – 2007 wheat cropping season.

Wheat cannot normally grow on highly saline soils (above). Salt-tolerant varieties enable farmers in high salinity areas to produce wheat (below).

For salt tolerant wheat multiplication, ARDI used 14 mt of the salt tolerant wheat seed produced as part of the 2004 – 2005 Winter Crop Technology demonstration. These improved cultivars (Furat and Dijila) were planted in saline-soil areas of southern Iraq in Muthanna, Qadissiya, Baghdad, and Babylon governorates (see Table 22).

Most of the seed was planted in coordination with the MOST at 11 sites in Baghdad governorate. Unfortunately, due to security concerns, ARDI staff were not able to reach the sites after harvest, and the entire crop of the wheat seed remained with the farmers. It is hoped that the harvest will be used as seed, either by the farmers or sold to other farmers to increase the area planted to salt-tolerant wheat in the 2006 – 2007 winter wheat season.

The total amount of seed produced (not including Baghdad sites) was approximately 97 mt. If this is all used as seed next season, it will plant nearly 750 hectares of salt tolerant wheat. ARDI collected 13.7 mt of the seed to store for planting in the 2006 -2007 winter wheat season.

TABLE 22 SALT TOLERANT WHEAT SEED MULTIPLICATION 2005-2006

Governorate	Number of Sites	Seed Produced (mt)	Seed Collected (mt)
Qadissiya	2	30	4.3
Baghdad	11	n/a*	n/a*
Muthanna	1	32	5
Thi-Qar	2	35	4.4
Total	**16**	**97**	**13.7**

WHEAT PRODUCTION PROJECTS

SMALL VILLAGE WHEAT PRODUCTION PROJECT 2005 – 2006

In the 2005 -2006 planting season, ARDI implemented a Small Village Wheat Production project to help internally displaced persons, who had recently returned to their lands in the rural mountainous areas of Dahuk, to gain a source of food and/or income from wheat production. This area is suitable for wheat production, but the farmers lacked the resources to buy inputs, including wheat seed.

ACTIVITIES

ARDI provided 270 poor farmers (IDPs) with a total of 52 mt of grade 3 Certified+1 wheat seed, which was produced as part of the 2004 – 2005 Wheat Seed Multiplication program. Grade 3 means that the seeds are smaller and less uniform than the best grade 1 seed, but can still produce good yields.

Small village wheat production project was conducted in Dahuk.

Sunn pest damage wheat by injecting an enzyme that not only makes the seed bitter but smaller and less likely to germinate the following year.

RESULTS

Unfortunately, much of the wheat crop produced as part of this project was badly damaged by Sunn pest. These fields were based at the foot of mountains where Sunn pest overwinter, and as a result were the first fields to be hit by the Sunn pest as they moved down into the wheat fields. Approximately half of the fields were damaged to the extent that they could not be harvested for grain; these farmers instead used the fields to graze livestock. The other fields were harvested; half of these farmers chose to sell the yield to traders, and the others kept it for household consumption.

Despite the problems with Sunn pest, the farmers were extremely grateful to ARDI for the wheat seed. Without the seed, they said, they would have had no means to produce any type of crop this season.

Wheat field of a poor farmer in Dahuk governorate

WHEAT PRODUCTION PROJECT 2005 -2006 SULAYMANIYAH

ARDI used the 84 mt of grade 1, Certified+1 wheat seed produced in the 2004 – 2005 Wheat Seed Multiplication project to implement a large-scale wheat production program in Sulaymaniyah. This project demonstrated to Iraqi farmers the benefit of using improved seed to increase yields.

ACTIVITIES

ARDI worked with ten large-scale farmers in Sulaymaniyah to plant a total of 593.5 ha with the seed. The farmers achieved an average yield of nearly 1.3 mt/ha, with some farmers achieving yields above 2 mt/ha.

At the end of the growing season, ARDI held farmer field days, hosted in coordination with technical staff from the MOA Agriculture Research Center and the local Farmers Union Association. Area farmers were invited to the field

TABLE 23 LARGE SCALE WHEAT PRODUCTION SULAYMANIYAH 2005-2006

Site	Seed Received (mt)	Area Planted (ha)	Yield (mt/ha)
1	11.25	80	1.8
2	4.55	32.5	0.76
3	15	100	0.92
4	13.65	98.5	1.1
5	5.25	37.5	2.1
6	7	50	2
7	5.25	37.5	1.2
8	14	100	1.2
9	2.8	20	1.1
10	5.25	37.5	0.6
Total	**84**	**593.5**	
Average			**1.13**

Large scale wheat seed multiplication project occurred in Sulaymaniyah.

days; a total of 57 attended, with many taking time off from their work to attend. They were impressed with the improved yields from using the Certified+1 seed, and many expressed interest in investing in this improved seed. Many did note the general lack of availability of this seed, an ongoing problem that needs additional attention.

Local television newscasters filming the wheat harvest at a large scale field trial in the North.

WHEAT SEED CLEANING

Seed cleaner and field operations, fall 2005

ARDI's efforts to improve wheat production in Iraq, through technology demonstrations, seed multiplication projects, and production projects were all based on the premise that good, clean seed is the single most significant factor in improving the quantity and quality of wheat yields. The rest of the input package – fertilizer, pesticides, and other good cultural practices – will not help farmers if the seed planted in the ground is of poor quality.

Since the end of the Oil-for-Food program, under which the Government of Iraq (GOI) imported and subsidized certified wheat seed, many Iraqi farmers have not had access to certified seed and have been replanting their saved seed. The consequence of this practice is that up to 25% of their planting material is composed of weed seeds, lentils, weak grain and other types of nonproductive debris. This reduces the quality and quantity of wheat production.

If farmers do not have access to certified or Certified+1 seed, they can improve their saved seed through seed cleaning. Seed cleaning is a mechanical process in which the seed cleaner sorts the grains by size, thus grading the wheat seed while also removing impurities. Grade 1 is the designation for the biggest and most uniform seeds, which are therefore the highest quality. Grade 3 is the lowest grade, but it is also pure, highly productive wheat seed.

(above) Farmer saved seed, filled with unproductive debris
(below) Pure grade 1 cleaned seed

ACTIVITIES

2005 - 2006 PLANTING SEASON

In 2005, ARDI implemented a program to procure and distribute seed cleaning machines. This program gave Iraqi wheat producers access to machinery to rid their planting material of nonproductive matter.

In the summer of 2005, ARDI procured 164 seed cleaning machines (500 kg/hr capacity). These machines were chosen because they are small, mobile, inexpensive, and easy to use. ARDI worked with the MOA to determine the optimal distribution and location of the seed cleaners throughout the country, and coordinated with private entrepreneurs to operate the seed cleaners for farmers. Through a competitive bidding process, ARDI selected six NGOs to operate 164 seed cleaners under contract, free of charge to farmers. In addition, four cooperatives in rural areas each received a seed cleaner as an in-kind grant; these cooperatives charged a small fee to cover operating costs. ARDI provided comprehensive training in the operation and maintenance of the machines, and trained a total of 208 operators from all of the organizations which received the seed cleaners.

RESULTS

The seed cleaners were distributed to all 18 governorates; those areas with higher wheat production received a greater proportion of the cleaners (see Table 24). ARDI paid the operating costs for the machines to enable farmers to have their seed cleaned free of charge, in order to expose as many farmers as possible to the benefits of seed cleaning. A total of 7,406 farmers brought 35,307 mt of seed for cleaning, resulting in 31,738 mt of cleaned grade 1 seed suitable for planting. Surveys indicate that approximately 99% of this seed was retained by farmers and most likely planted. At a seeding rate of 130 kg/ha, this was enough to plant nearly 243,000 ha of land in the 2005 – 2006 planting season.

TABLE 24 RESULTS OF 2005-2006 SEED CLEANING PROGRAM

Governorate	# of Seed Cleaners	Farmers cleaning seed	Seed Cleaned (mt)	Grade 1 Seed (mt)	Hectares planted (estimate)*
Anbar	3	47	660	599	4,580
Erbil	19	1,622	6,373	5,679	43,436
Babylon	4	98	411	352	2,695
Baghdad	6	169	877	813	6,215
Basrah	2	60	281	239	1,827
Diyala	6	362	1,869	1,709	13,073
Dahuk	12	304	1,482	1,368	10,466
Kerbala	2	47	196	166	1,268
Muthanna	3	60	224	194	1,480
Najaf	3	63	285	248	1,898
Ninewa	44	1,368	11,252	10,065	76,983
Qadissiya	6	341	1,090	979	7,489
Salah al-Din	9	116	2,332	2,122	16,229
Sulaymaniyah	18	1,732	1,789	1,547	11,831
Tameem	14	504	4,379	4,147	31,714
Thi-Qar	3	83	464	370	2,828
Wassit	11	307	790	701	5,362
Missan	4	123	553	441	3,371
Total	**164**	**7,406**	**35,307**	**31,738**	**242,746**

*Estimate assumes 99% of grade 1 wheat seed is used as seed, and 130/ha seeding rate.

** Need estimated output from cooperatives

The photo demonstrates the effect of proper agronomic practices on the viability of wheat. The field on the left was cultivated with traditional methods and is highly contaminated with weeds.

2006 – 2007 PLANTING SEASON

ARDI's NGO and cooperative implementation partners operated the seed cleaners procured in 2005 for the 2006 – 2007 planting season. In the second season of operation, ARDI did not provide for the operating costs, and the organizations charged a fee averaging $5 per metric ton of seed cleaned. This type of fee-based business model for seed cleaning is sustainable, and will enable the organizations to maintain the cleaners and reinvest in their business in future seasons.

The success of the project attracted the attention of the US Military, and ARDI worked with them to procure and distribute additional seed cleaners for Iraq for the 2006 – 2007 planting season. The US Military funded the procurement of 173 seed cleaning machines, and USAID/ARDI funded the training and distribution costs. The seed cleaners will be operated under contract with the same implementing partners used for the 2006 – 2007 season. The 173 seed cleaners were distributed as indicated in Table 25.

The results of the seed cleaning for the 2006 – 2007 planting season will not be known until after the publication of this report.

TABLE 25 SEED CLEANER DISTRIBUTION FOR 2005-2006 PLANTING SEASON

Governorate	# of Seed Cleaners
Anbar	7
Erbil	17
Babylon	6
Baghdad	3
Basrah	2
Diyala	8
Dahuk	8
Kerbala	2
Muthanna	3
Najaf	3
Ninewa	50
Qadissiya	5
Salah al-Din	9
Sulaymaniyah	19
Tameem	13
Thi-Qar	3
Wassit	11
Missan	4
Total	**173**

WHEAT PRODUCTION – SUNN PEST CONTROL

Sunn pest (*Eurygaster Integriceps*) is a major problem for wheat production in Iraq. Crop losses can reach almost 100% in severe infestations. Even smaller infestations have serious economic consequences for wheat producers because the Sunn pest injects an enzyme into the wheat grain that renders the flour unsuitable for breadmaking if more than 2-3% of grains are affected. The MOT will not buy wheat from farmers that has more than a few Sunn pest damaged grains. Even a small infestation of Sunn pest can damage a farmer's entire crop.

Sunn pest insects are most prevalent in the mountainous wheat-producing areas in northern Iraq but are now found in all wheat growing areas. Sunn pest spend the summer, autumn and winter in the mountains, and in the spring migrate to the fields as the wheat crop is maturing. The females lay eggs on the upper surface of cereal leaves. When this new generation of Sunn pest hatches, the nymphs and then young adult insects begin feeding intensively on the wheat grain and leaves to store up adequate food reserves before migrating to the mountains for eight to nine months.

RESULTS

A total of over 6 mt of Sunn pest were collected. If these insects had migrated to the wheat fields in the area, they could have reproduced a large new generation of Sunn pest. The reduction of the Sunn pest population benefited more than 2,400 farmers who produce wheat on 12,000 ha near to the area of the Sunn pest collection.

SUNN PEST SUSCEPTIBILITY TRIALS

Though hand collection of Sunn pest is feasible, it is difficult to implement in mountainous areas. The main method of control in these areas is pesticide application to the wheat crop. In the 2006 wheat season, ARDI investigated alternative, nonpesticide control methods for Sunn pest control, including resistant wheat varieties, sticky traps and food traps, to determine effectiveness in reducing Sunn pest populations, and the feasibility of applying the methods on a large scale. ARDI also made general wheat field observations to collect information on Sunn Pest levels and migration patterns.

ARDI implemented five trials and observation series in northern Iraq:

PROJECT	LOCATION (GOVERNORATE)
Imported wheat varieties	Dahuk, Erbil, Sulaymaniyah
Local wheat varieties	Sulaymaniyah
Sticky and food traps	Dahuk, Erbil, Sulaymaniyah
General wheat field observations	Dahuk, Erbil, Sulaymaniyah

IMPORTED WHEAT VARIETIES TRIALS

ARDI tested five varieties of imported wheat to evaluate their level of resistance/tolerance to damage by Sunn pest, and the level of natural enemies. The trials were planted in Erbil, Dahuk, and Sulaymaniyah; one Iraqi wheat and one Iraqi barley variety were also planted in the trials for comparison purposes. The trials were designed to be unsprayed for Sunn pest. In Sulaymaniyah, cages were placed over the center of the variety plots to exclude Sunn pest, and to assess yield and other characteristics in the absence of the pest.

Data on levels of Sunn pest and beneficial insects were taken every 10-14 days, and various yield and grain parameters were taken at harvest. Unfortunately, Sunn pest levels at all three sites were too low to be analyzed. In addition, the trial in Dahuk was abandoned as it was mistakenly sprayed twice against Sunn pest by the research station. It was noted that Sunn pest began appearing in the fields on 18 March, 6 April, and 23 March in Dahuk, Erbil, and Sulaymaniyah, respectively.

LOCAL WHEAT VARIETIES

Evaluation of local wheat varieties was undertaken in Sulaymaniyah only. The trial objective was to evaluate seven local varieties of wheat and one of barley to determine the level of resistance/tolerance to damage by Sunn pest, and the level of natural enemies. The trial was unsprayed. As in the imported wheat variety trial, cages were placed over the center of the variety plots to exclude Sunn pest, and to assess yield and other characteristics in the absence of the pest. Data on levels of Sunn pest and beneficial insects were taken every 10-14 days, and various yield and grain parameters were taken at harvest. Unfortunately, Sunn pest levels were too low to be analyzed. It was noted that Sunn pest began appearing in the fields 23 March, and egg masses appeared on 29 April.

(above) Removing Sunn Pest from sticky trap. (below) Searching for Sunn pest in their overwintering location under the snow in the high altitudes.

STICKY AND FOOD TRAPS

Evaluation of the effectiveness of two types of trap for monitoring Sunn pest levels and migration patterns was undertaken at two sites each in Dahuk and Erbil, and one site in Sulaymaniyah. One trap design was of wood, 30 cm x 40 cm mounted on 75 cm high stakes, colored red, yellow, green or brown, and covered with sticky material. The other trap design was a plastic bowl, sunk into the ground, colored white, yellow or blue, and containing a date paste food material.

At all sites, the traps were located in wheat fields. Trap catches were relatively low, but the yellow sticky traps tended to catch more Sunn pest than the other colors of the sticky traps. The brown sticky traps caught the least insects at all sites. No distinct peaks of catches were observed. Food trap catches were lower than those of the sticky traps, and the date paste did not act as an attractant. Counts were too low to distinguish any potential differences between the colors. It appears that Sunn pest were caught in these traps by accident, rather than any form of attractiveness.

The yellow sticky traps warrant further investigation, but not the food traps, at least with the date paste food attractant.

SUNN PEST OBSERVATIONS AT OVER-WINTERING SITES

ARDI observed Sunn pest during the latter part of 2005 and the spring and summer of 2006 in Dahuk and Sulaymaniyah, in order to record Sunn pest levels and migration patterns in the mountain overwintering areas. These data can help inform Sunn pest control efforts.

In Sulaymaniyah, Sunn pest numbers were highest in June and then decreased to much lower levels later in the year. However, at all observations the highest numbers were recorded at the highest altitudes. The decrease in numbers may have been due to migration to altitudes lower than 1,000m, but also there appeared to be high levels of parasitism and fungal infection. In June, when the highest numbers of Sunn pest were recorded, the levels of combined parasitism and fungal infection were highest at the lower levels and decreased with altitude, from 25.4 percent to 14.0 percent. These levels of natural control would have had a marked effect in reducing the numbers of overwintering adults. Later in the year, the percentage of natural control was much higher as greater proportions of the lower numbers of insects recorded were affected.

In Dahuk, observations were made on the first mountain from March to July 2006, and on the second mountain in May and July 2006. On the first mountain different sites were used for each observation, but since the sites were all on the same shoulder of the mountain along a 6km arc, the data were grouped according to altitude. Records from altitudes below 900m were from valley bottoms close to the mountain. Insects were counted in 5 x 1m2 areas at each observation. Insects recorded in March were the remnants of the overwintering population. Large numbers of new adults were already at high altitudes in June, moving slightly higher in July. On the second mountain, only two counts, on 18 May and 11 July, were made at elevations of 1,216m and 1,239m. No Sunn pest were recorded on either occasion at either altitude.

GENERAL WHEAT FIELD OBSERVATIONS

Wheat fields were monitored for levels of Sunn pest at seven sites in Dahuk and one site in Sulaymaniyah. The objective was to assess the incidence and timing of appearance of migrating old adults, eggs, nymphs, and new adults. Insects were counted in 10 x 1 m2 sampling units selected at random on each occasion at each site.

In Dahuk governorate as a whole, levels of Sunn pest were variable. In certain areas the Sunn pest population reached high levels; for example, in one location levels up to 42 Sunn pest per square meter were recorded. The FAO spray threshold for Sunn pest in Iraq is 6-12 nymphs or 2-3 adults per square metre. In these areas the wheat crop was both sprayed by farmers themselves and aerially treated by the military from 16 to 28 May at the request of the MOA.

However, this same location also reported on 12 June that Sunn pest damage was much less in the 2005 – 2006 season than in 2004 – 2005, at 5-10% compared to 90%. Reasons for this were given as better pest monitoring and treatment at the appropriate time; the use of a more effective pesticide (alpha-cypermethrin instead of dimethoate); and hand collection of overwintering adults in the mountains at the end of the 2004 – 2005 season.

Information on which monitoring sites were actually sprayed is not clear, but it appears that all sites, with the exception of one village, were treated. The sites where ARDI conducted hand collection in late 2005 is approximately 35 – 55 km. to the east-northeast and northeast, and in a second location approximately 45 – 60 km away, also to the east-northeast and northeast, the distances and direction depending on the monitoring site.

In Sulaymaniyah, little background information on general Sunn pest levels and pesticide treatments is available, and only one site was monitored. This site was located approximately 37 km south-southeast of where Sunn pest was hand collected in late 2005, although there are mountains up to 2,000 m high between the site and the collection site. The site was also approximately 17km north-northwest of the mountain at which Sunn pest was also hand collected in late 2005.

Sunn pest levels at this site were lower than the average in Dahuk. Since only one site was monitored, it is difficult to say whether or not the hand collection of Sunn pest at the overwintering sites in late 2005 had an effect on Sunn pest levels in 2006.

RICE TECHNOLOGY DEMONSTRATIONS

Rice grown in Anbar governorate.

Rice is a popular crop for cultivation in Iraq. It is a staple of the Iraqi diet, and farmers produce it in nearly every region of the country. The area annually planted with rice in Iraq amounts to approximately 200,000 hectares, and is increasing each year. This area is distributed as 10,000 hectares in the northern part of Iraq, 100,000 hectares in the central region (Euphrates basin), 50,000 hectares in the south-central region (Tigris basin), and 40,000 hectares in the southern region.

Rice productivity in Iraq is still low as compared to the world average. Production ranges between 2.4 – 3.2 mt/ha for the local aromatic variety (Anbar). This low productivity does not meet increasing consumer demand.

The low productivity of Iraqi rice cultivation can be directly tied to the inefficient soil and crop management practices used by farmers. In order to improve rice production, in 2004 and 2005 ARDI and the Ministry of Agriculture implemented a Summer Crop Production Program for rice. The objectives of the program were to:

1. Increase rice production by implementing a package of improved agricultural practices on multiple production plots, including improved varieties and cultivation practices;
2. Increase the economic returns for rice farmers; and
3. Provide a training program to the farmers and extension agents on modern rice production practices through workshops and field days.

The program introduced two varieties, Yasmin and Anbar-33. Yasmin is an aromatic and high-yielding rice variety with great potential and Anbar-33 is an improved variety that builds on traditional Anbar varieties that are in high demand by Iraqi consumers.

The improved technology package introduced as part of the demonstration project was developed by the MOA, and includes:

- Land preparation: mechanical plowing and leveling;
- Use of improved seeds, at a sowing rate of 120 kg/ha, planting mid-June;
- Irrigation through flooding and drying method at appropriate times in the growing cycle;
- Appropriate use of chemical fertilizers before and after planting;
- Weed control though the use of herbicide Stam F34;
- Mechanical harvesting.

FARMER FIELD DAYS

Farmer field days are an important part of the MOA/ARDI crop technology demonstration programs. These field days extend the reach of the program to many farmers, introducing them to new technology to use on their own fields to increase yields and income.

In the 2004 Rice Crop Technology Demonstration, 344 farmers attended field days. In the 2005 Rice Technology Demonstration, this number increased to 1,450.

RICE PRODUCTION – TECHNOLOGY DEMONSTRATION SUMMER 2004

ACTIVITIES

In the summer of 2004, ARDI and the MOA cooperated to implement rice demonstrations with the above-mentioned improved technology package in four governorates in central and southern Iraq: Najaf, Qadissiya, Diyala, and Wassit. In each governorate except Wassit, the demonstrations were established on one-hectare area plots. Half the plot was cultivated according to improved practices (demonstration), and the other according to traditional farmer practices (control) for the purpose of comparison. In Wassit, a 1.5 ha site was established with improved practices at the agriculture research station there.

RESULTS

The demonstration plots planted with improved practices showed an average increase in yield of 37% over plots planted with traditional farmer practices. The largest increase was achieved in Diyala, where use of Meshkab-2 variety and the improved package of technology showed an improvement in yield of 78% over traditional farmer practices.

In the test plot planted at the agriculture research station in Wassit, the yield of the Anbar variety of rice was only 3.3 mt/ha. This low production was due in part to a fuel shortage, which prevented proper irrigation of the rice crop.

TABLE 27 RICE YIELDS - DEMONSTRATION AND LOCAL CHECK PLOTS 2004

Governorate	Variety	Number of Sites	Yield (mt/ha)		
			Demo Plot	Local Check	% Improvement
Najaf	Anbar	4	4.7	3.2	47%
	Yasmin	3	5.3	4.4	22%
Qadissiya	Anbar	3	4.2	3.9	7%
	Yasmin	4	5.8	4.1	43%
Diyala	Meshkab 2	1	5.8	3.2	78%
Average			**5.2**	**3.8**	**37%**

The main purpose of the demonstration project was to introduce the new technology package to farmers, and farmer field days were an important element of the project. These field days were held at the time of flowering of the crop. Area farmers were invited to observe the fields, and to discuss with agriculture managers and staff from agriculture directorates in each governorate the technology package and how to implement it on their own fields. A total of 344 farmers attended the field days (one each in Qadissiya and Babylon, two in Najaf).

In addition, many workshops were held before and during cultivation and harvest with staff from the MOA and College of Agriculture – Baghdad University, to discuss implementation of the demonstrations and the technology used. The most important workshop was held in the middle of the season, at which staff from the research centers delivered lectures on proper irrigation and fertilization techniques to maximize rice yields in Iraq, and the role of extension in transferring these techniques to farmers. Many staff from the research centers and MOST attended the workshop, in addition to professors and the Dean of the College of Agriculture – Baghdad University.

TABLE 28 RICE YIELDS, RESEARCH SITE PLOTS 2004

Governorate	Variety	Number of Sites	Yield (mt/ha)	
Wassit	Anbar	1	3.3	n/a

RICE PRODUCTION – TECHNOLOGY DEMONSTRATION SUMMER 2005

ACTIVITIES

In the 2005 rice cultivation season, MOA and ARDI expanded the rice technology demonstrations to locations in eight governorates: Najaf, Qadissiya, Wassit, Diyala, Muthanna, Babylon, Sulaymaniyah, and Erbil. In each governorate, two or three farmers were selected to establish demonstration plots. A total of 17 sites were established. At each site the farmers planted one hectare for improved practices (demonstration) and one hectare for traditional farmer practices (control).

RESULTS

The technical teams collected data on growth and productivity at each site, from both the demonstration sites and the local checks. This enabled a comparison between the traditional practices and improved practices, to demonstrate the

TABLE 29 YIELDS ON DEMONSTRATION SITES (MT/HA), RICE TECHNOLOGY DEMONSTRATIONS 2005

Governorate	Variety	Number of Sites	Yield (mt/ha)		% Improvement
			Improved Practices	Farmer Practices	
Najaf	Anbar 33	3	3.6	2.7	36%
	Yasmin	3	6.4		139%
	Anbar Baghdad	3	3.4		27%
Qadissiya	Anbar 33	3	3.8	3.2	22%
	Yasmin	3	5.6		77%
	Anbar Baghdad	3	3.9		24%
Muthanna	Anbar 33	2	4	3.5	14%
	Anbar Baghdad	2	3.9		11%
Wassit	Anbar 33	3	3.9	3	29%
	Yasmin	3	5.8		91%
	Anbar Baghdad	3	4.4		45%
Diyala	Anbar 33	3	3.5	3.2	9%
	Yasmin	3	3.4		5%
	Anbar Baghdad	3	4.4		36%
Babylon	Anbar 33	3	5.1	4	27%
	Yasmin	3	6.7		67%
	Anbar Baghdad	3	5.2		30%
Erbil	Kurdi	2	2.7	2.6	2%
	Sadri	2	2.8		6%

higher productivity that can be achieved by adopting the improved practices (see Table 29). The biggest gains in yields were achieved with the use of Yasmin variety of rice, which when planted with the improved technology package showed yield improvements of an average of 75% over the local checks.

Field days were held at all seven sites. Area farmers were invited to attend these field days, which were led by the technical teams comprised of staff from the MOA, the College of Agriculture, and ARDI. A total of 1,450 area farmers attended the field days to observe the results of the improved cultivation methods used on the plots. Since each site contained a plot planted with improved practices and one planted with traditional practices, it was easy for farmers to see the difference in the fields, and observe the increased production in the improved practices plot. The technical teams presented information about the improved practices, and the area farmers learned more about how to implement these methods on their own fields. These field days extended the reach of the 2005 rice production program by encouraging these area farmers to adopt the improved cultivation practices to increase production.

SORGHUM PRODUCTION

Sorghum is not extensively grown in Iraq, but it is a potential low cost feed source for both poultry and livestock. Poultry farmers currently rely on domestic wheat sources and expensive maize imports for feed. Sorghum is also an excellent green forage option for livestock, the production of which is also an important economic activity in Iraq.

Sorghum production trials were conducted in Baghdad, Missan, Babylon, Wassit, Qadissiya, Thi-Qar, Muthanna, Tameem, Sulaymaniyah, and Basrah

ACTIVITIES

In order to test the performance of sorghum hybrids in Iraq, ARDI performed trials on 13 imported sorghum hybrids in different agro-ecological zones in Iraq in 2005. ARDI procured and imported 13 hybrids of highly productive sorghum that are known to perform well in ecological regions similar to those in Iraq. These hybrids were thought to be adaptable to the Iraqi environment, especially in moderately saline and water stressed areas.

Mature sorghum showing well formed inflorescence.

ARDI performed varietal trials in ten governorates in order to identify the best performers in different regions of Iraq. These trials were conducted on plots in Baghdad, Missan, Babylon, Wassit, Qadissiya, Thi-Qar, Muthanna, Tameem, Sulaymaniyah, and Basrah. Two plots were planted in each governorate except Sulaymaniyah, where one plot was planted. Each plot was planted with all 13 hybrids, and two domestic synthetic varieties (Inkath and Rabeh) as a control.

Plots consisted of three rows, each 6 meters long, with spacing of 75 cm between the rows and 10 cm between plants. Seeds were sown at a depth of approximately 2 cm. The seeding rate was about 100% more than the desired number of plants harvested per plot. Plots were later thinned to desired test plant populations of 133,000 plants/ha. Seedbed preparation was good at all locations. Seeds were treated before sowing with Thiram (fungicide), and Cruiser (systematic insecticide against stem borer at a rate of 10 ml/ 1kg of seeds). Sowing dates ranged from July 18 – 30, 2005. Hybrids were planted following a Randomized Complete Block Design with three replications (see Table 30). Phosphorus, Potassium and Nitrogen fertilizers were applied in all locations. Weeds were controlled by cultivation, hand weeding and herbicide. Only herbicide currently registered for use on sorghum were used in these trials. All of the experimental plots were irrigated at sowing days.

Five workshops were arranged during the growing season, concerning breeding methods for sorghum plants, physiology, fertilization, weed control, and statistical analysis and methods for experimental procedures on farmer's fields. Eight study tours were arranged for the experimental station's staff of the Ministry Of Agriculture, and undergraduate and post-graduate students of College of Agriculture and Technical Institutes.

Teams of ARDI and MOA staff monitored the plots and recorded the following data for each of the hybrids, plus the local varieties: field emergence, number of days from planting to flowering, plant height, head length, grain weight, grain yield, and grain yield at 15% moisture. These characteristics are useful in evaluating the overall performance of the hybrid. Yield is one of the most important measurements, as high yield is the objective of sorghum production, and also acts as a "sink" for other performance characteristics.

RESULTS

There were significant differences between yields in hybrids and in all locations. In the table to the right, the yields are extrapolated from the yield of the plants.

The most successful trial was achieved in Sulaymaniyah, where the hybrid sorghum plants produced an average of 8.4 mt/ha. There were five hybrids (5, 6, 8, 11, 13) that performed better than the local checks, which also performed well (yields of 9.3 mt/ha and 8.1 mt/ha). This suggests excellent conditions for sorghum production in Sulaymaniyah.

The most successful hybrid overall was Hybrid 13, which produced an average of 5.8 mt/ha over all locations. This hybrid outperformed the local checks in all locations except Babylon and Basrah. Overall, the hybrid genotypes outperformed the local checks by 18%. The improvements gained using the hybrid seed was most striking in Muthanna (73% improvement) and in Tameem (86% improvement).

TABLE 30 PERCENT IMPROVEMENT OVER TRADITIONAL PRACTICES, BY RICE VARIETY

Variety	% Increase Over Traditional Practices
Anbar 33	23%
Yasmin	76%
Anbar Baghdad	29%
Kurdi/Sadri	28%

It must be noted that the results of this report are based on only one season of testing. Another (and ideally two) trial years are necessary to confirm these results.

TABLE 31 AVERAGE YIELDS OF SORGHUM HYBRIDS AND LOCAL CHECKS, BY GOVERNORATE (MT/HA)

Location	Hybrid 1	Hybrid 2	Hybrid 3	Hybrid 4	Hybrid 5	Hybrid 6	Hybrid 7	Hybrid 8	Hybrid 9	Hybrid 10
Baghdad	7.3	4.4	5.6	4.9	4	3.9	4.2	4.1	5.1	5.1
Babylon	4	3.2	4.4	3.7	3.7	3.7	3.9	3.9	3.2	4.5
Wassit	4.7	4.9	5	5.5	6	5.5	5.6	5.7	6.5	5.2
Qadissiya	3.3	3	2.9	1.9	2.7	3	1.6	2.8	3	3.5
Muthanna	3.9	4.1	3.5	3.9	4.2	4.9	5.1	4	3.1	4.1
Thi-Qar	5.6	5.5	4.8	4.4	4.9	3.9	6.7	5.6	4.7	3.7
Basrah	5	8.1	7.7	5.4	4.9	4	4.6	5.1	4.7	4.8
Tameem	8	7.6	7	6.1	7	6.5	7.3	6.4	5.3	5.8
Sulaymaniyah	7.5	8.1	7.6	8.7	9.4	10.1	6.7	9.6	6.1	7
Average – Genotype	**5.5**	**5.4**	**5.4**	**4.9**	**5.2**	**5**	**5.1**	**5.2**	**4.6**	**4.9**

Location	Hybrid 9	Hybrid 10	Hybrid 11	Hybrid 12	Hybrid 13	Average Hybrids	Local Check	Local Check	Average Local check
Baghdad	5.1	5.1	3.6	6.7	5.5	5	5	4.8	4.9
Babylon	3.2	4.5	4.1	3.4	3.9	3.8	5.7	4.3	5
Wassit	6.5	5.2	5.3	5.1	6.3	5.5	6.1	6.2	6.1
Qadissiya	3	3.5	2.8	3.1	3.6	2.9	2.5	2	2.3
Muthanna	3.1	4.1	3	2.8	3.1	3.8	2.3	2.1	2.2
Thi-Qar	4.7	3.7	6.5	5.7	6.1	5.2	3.9	5.7	4.8
Basrah	4.7	4.8	3.7	6.3	5	5.3	5.3	5.1	5.2
Tameem	5.3	5.8	6.7	6.8	8.6	6.9	3.9	3.4	3.7
Sulaymaniyah	6.1	7	9.7	8.4	9.8	8.4	9.3	8.1	8.7
Average – Genotype	**4.6**	**4.9**	**5**	**5.4**	**5.8**	**0**	**4.9**	**4.6**	**0**

IMPROVING MAIZE PRODUCTION

Maize seed hybrids.

There is a potentially large domestic market for maize in Iraq, driven by poultry producers who currently rely on wheat for feed. Maize is a more nutritious feed for poultry, but due to low productivity of maize in Iraq, poultry producers have to buy expensive maize imports to include it in their feed rations. An increase in maize production would provide poultry producers with a source of less expensive domestic maize, which would in turn provide a larger market and higher income for Iraqi maize producers.

The current productivity of maize in Iraq is extremely low by international standards, averaging about 1 – 1.5 mt/ha, and therefore is not always a profitable activity for producers. This is largely due to the use of local open-pollinated varieties, as opposed to hybrids. Hybrids offer farmers increased yields, wider adaptability and reliability of both performance and quality, by exploitation of heterosis (hybrid vigor).

Hybrid maize seed production requires relatively high investments compared to other crops, such as wheat, and this is reflected in the higher price of the seed. The production of hybrid maize seed requires the production of inbred maize seed over several seasons, and then crossing to produce suitable, productive hybrid seed. In addition to the capital investment to create inbred lines, this requires a good deal of skill and knowledge of plant breeding.

ARDI took a dual-track approach to increasing maize production in Iraq through the introduction of hybrid maize seed. ARDI procured hybrid maize seed from international sources to test performance and establish suitability in different regions of Iraq through varietal testing. Once suitability was established, ARDI conducted production programs to show farmers the benefits of using hybrid maize seed, and to stimulate private sector interest in importing and selling hybrid maize to increase farmers' access to hybrid seed in Iraq.

At the same time, ARDI worked with the MOA and the private sector to lay the foundation for a hybrid maize seed industry in Iraq through production of stocks of inbred maize seed for hybrid maize seed production. ARDI imported inbred maize seed from public sources in the US, established nurseries to build the stock of this seed, and began the process of crossing to create suitable, productive hybrids.

(Opposite page) Maize is a tall, annual cereal grain that bears fruit on ears (female) that are fertilized by pollen from the male tassels at the apex of the bamboo-like stem.

The following sections will first discuss ARDI's work with imported hybrid maize seed, and secondly ARDI's efforts to build a hybrid maize seed industry in Iraq.

HYBRID MAIZE VARIETAL TRIALS

During the summer 2004 and spring 2005 maize cropping seasons, ARDI and the MOA tested 19 imported hybrids, in addition to three local varieties, to determine performance levels and establish suitability for use in various regions of Iraq. The imported hybrids were selected for testing based primarily on maturity group of FAO 500-600 and their performance in a similar environment in Texas. The Ministry of Agriculture and College of Agriculture/University of Baghdad administrated the project, supported by financial and technical assistance from ARDI.

The objectives of the MOA/ARDI 2005 varietal trials were to:

- Provide data so that in subsequent years the best suitable genetics can be created to produce hybrid maize. This is important because in 2003, local seed hybrids and synthetic varieties from Iraqi seed companies and experimental stations were lost to looting.
- Increase farm crop production in subsequent years by introducing highly productive maize hybrids from the United States, which have proven previously to be adaptable to the Iraqi environment;
- Provide a training program for new graduates and post-graduate students by improving their skills in conducting research field work in farmers' fields;
- Develop and improve the capacity of the experimental station staffs of the Ministry of Agriculture and the College of Agriculture for technology development and extension.

Maize trial in a Complete Randomized Block Design.

Using a reliable water source for the field trial.

ACTIVITIES

In 2004, testing sites were established in five governorates (Baghdad, Tameem, Babylon, Wassit, and Qadissiya), with two testing sites in each governorate. These locations were chosen because they represent a range of agro-ecological zones, enabling researchers to analyze the performance of the hybrids and establish suitability for a variety of zones throughout Iraq. In 2005, ARDI and the MOA established a second round of trials for 16 of the hybrids and two different local varieties in the same locations, with an additional location in Sulaymaniyah. This second round of testing was important because in any varietal testing project it is essential to replicate the trials in order to confirm results.

The trials were conducted following a Complete Randomized Block Design with six replications. Plots consisted of six 75 cm rows, five meters long, and spacing of the plants at 15 cm within a row. Phosphorus, potassium and nitrogen fertilizers were applied in all locations.

Seeds were treated before sowing with Thiram (fungicide), and Cruiser (systematic insecticide against stem borer) at a rate of 10 ml/kg of seeds. Phosphorus, potassium and nitrogen fertilizers were applied in all locations. Weeds were controlled by cultivation, hand weeding, and herbicide. All experimental plots were irrigated at 7-10 days intervals.

Hybrid maize harvest.

In the first round of testing the plots were harvested in November and December 2004, and in the second round of testing harvest occurred in June 2005. In 2004 the crop was harvested by taking ten plants from the two center rows, then drying them to 15.5% moisture. At a later date, after drying, the ears were shelled and grain weight was determined, and converted to a mt/ha value.

In 2005 the entire two center rows were harvested and weighed. Moisture measurements were taken in the field to determine maturity and yields were calculated in mt/ha using the following formula:

Yield = wet weight*factor(118.343) or
(94.6745)*(100 - % actual moisture)
width in meters / length in meters/number of rows harvested.

Note: factor (118.343) used when using only grain, factor (94.6745) used when using grain with cobs.

RESULTS

Based on the results of these two seasons of testing, it is clear that the hybrids performed well in all locations in which they were tested. The best imported hybrids produced over 30% more than the local synthetic varieties (see Table 32).

An important element of these varietal trials was to provide training for new university graduates from agricultural colleges and technical institutes and for

MOA research and extension staff. To this end, five workshops were arranged during each growing season, concerning breeding methods of maize plants, physiology, fertilization, weed control of maize, and methods of statistical analysis and experimental procedures on farmer's fields. In addition, fifteen study tours were held over the course of the two growing seasons to observe the experimental plots. Over 1,000 maize farmers, students of the College of Agriculture and Technical Institutes, and MOA staff attended these field days.

TABLE 32 AVERAGE TOTAL YIELD (MT/HA) OF CORN GENOTYPES IN SUMMER SEASON 2004

Genotype	Baghdad 1	Baghdad 2	Babylon 1	Babylon 2	Wassit 1	Wassit 2
Hybrid 1	6.89	10.54	7.96	7.24	6.96	6.96
Hybrid 2	8.17	9.86	7.46	7.64	8.39	8.39
Hybrid 3	10.38	9.63	7.1	8.57	10.58	10.58
Hybrid 4	7.32	9.25	7.67	7.24	9.83	9.83
Hybrid 5	9.66	9.36	6.62	6.65	8.38	8.38
Hybrid 6	7.33	8.68	6.11	7.32	7.93	7.93
Hybrid 7	9.68	12.39	7.8	7.72	10.6	10.6
Hybrid 8	8.33	10.38	7.62	8.31	10.86	10.86
Hybrid 9	8.29	10.4	7.51	7.61	9.53	9.53
Hybrid 10	9.56	10.29	7.2	8.71	8.73	8.73
Hybrid 11	7.51	8.19	8.02	9.56	9.84	9.84
Hybrid 12	8.48	8.08	6.86	6.91	7.83	7.83
Hybrid 13	7.52	9.94	6.43	6.98	7.88	7.88
Hybrid 14	7.51	8.46	5.86	8.62	8.53	8.53
Hybrid 15	5.9	9.34	8.37	8.98	6.81	6.81
Hybrid 16	7.28	9.89	7.02	8.36	7.94	7.94
Hybrid 17	6.76	6.32	--	8.67	7.84	--
Hybrid 18	6.58	7.87	--	8.82	8.48	--
Hybrid 19	5.73	9.23	--	8.55	7.99	--
Hybrid 20	5.74	7.26	--	9.34	8.46	--
Hybrid 21	7.38	7.97	--	8.49	8.93	--
Local 1	5.85	7.34	6.38	7.15	7.15	7.15
Local 2	6.88	7.65	6.81	7.81	9.11	7.81
Average by Location - Hybrid	**7.71**	**9.21**	**7.23**	**8.11**	**8.68**	**8.79**
Average by Location- Local	**6.37**	**7.5**	**6.6**	**7.48**	**8.13**	**7.48**

Note: All yield data is expressed in tons of grain per hectare at 15.5% moisture, and weight measurement is in mt/ha.

Skilled workers planting hybrid based seed according to a set research design.

Tameem 1	Tameem 2	Qadissiya 1	Qadissiya 2	Average by Genotype
13.34	12.78	8.89	9.08	**9.06**
12.33	11.96	9.28	10.38	**9.39**
11.46	10.98	11.75	10.97	**10.2**
12.01	12.39	10.42	12.04	**9.8**
11.73	12.56	9.26	12	**9.46**
11.51	10.39	8.31	11.08	**8.66**
11.78	12.19	10.13	11.55	**10.44**
11.01	11.01	12.92	9.86	**10.12**
10.86	10.44	10.46	9.78	**9.44**
11.98	9.88	10.37	10.56	**9.6**
11.06	10.62	11.04	10.68	**9.64**
10.95	11.21	8.94	7.99	**8.51**
10.89	12.11	8.61	9.42	**8.77**
10.44	10.98	10.27	9.26	**8.85**
10.52	12	8.93	10.58	**8.82**
10.19	11.01	7.9	10.04	**8.76**
10.09	13.39	7.18	--	**8.61**
11.21	12.04	6.96	--	**8.85**
9.84	10.04	5.41	--	**8.11**
11.53	14.24	7.96	--	**9.22**
10.04	12.32	6.84	--	**8.85**
9.48	7.75	9.26	8.86	**7.64**
11.29	11.94	9.11	9.24	**8.77**
11.18	**11.64**	**9.13**	**10.33**	
10.39	**9.85**	**9.19**	**9.05**	

Incomplete pollination.

TABLE 33 AVERAGE TOTAL YIELD (MT/HA) OF CORN GENOTYPES IN SUMMER SEASON 2005

Genotype	Baghdad 1	Baghdad 2	Babylon 1	Babylon 2	Wassit 1	Wassit 2
Hybrid 1	4.6	8.83	6.5	6.5	9.4	10.82
Hybrid 2	6.6	8.41	5.1	5.1	11.62	11.83
Hybrid 3	6.8	8.5	5.81	5.8	7.9	11.17
Hybrid 4	11.37	10.4	6.7	6.8	9.51	12.77
Hybrid 5	8.8	9.9	4.9	4.9	9.9	13.5
Hybrid 6	7	8.89	5.6	5.6	8.11	9.82
Hybrid 7	7.5	8.63	4.1	4.1	13.34	12.7
Hybrid 8	8.7	11.01	7.2	7.2	10.89	14.22
Hybrid 9	7.5	9.2	5.6	5.6	10.8	13.92
Hybrid 10	5.3	6.3	4.6	4.7	9.11	13.81
Hybrid 11	5.99	6.6	4.5	4.5	9.7	13.47
Hybrid 12	5.7	10.2	5.8	5.7	9.4	9.5
Hybrid 13	6.99	10.4	5.1	5.4	8.3	10.61
Hybrid 14	3.5	7.15	3.8	3.8	9.7	10.65
Hybrid 22	5.6	10	7.3	7.3	12	11.11
Hybrid 23	5.3	10	4.7	4.7	12	13.03
Local 1	5.6	6.1	5.3	5.3	10.31	11.62
Local 2	5.3	5.2	5.9	5.9	6	10.06
Average by Location – Hybrids	**6.7**	**9.03**	**5.46**	**5.48**	**10.11**	**12.06**
Average by Location- Local	**5.45**	**5.65**	**5.6**	**5.6**	**8.16**	**10.84**

Note: All yield data is expressed in tons of grain per hectare at 15.5% moisture, and weight measurement is in mt/ha.

Tameem 1	Tameem 2	Qadissiya 1	Qadissiya 2	Sulaymaniyah 1	Sulaymaniyah 2	Average by Genotype
8.14	5.53	11.3	8.2	5.21	5.81	**7.57**
8.07	5.3	8.7	6.4	6.83	5.56	**7.46**
8.1	4.01	9.8	7.1	5.73	4.85	**7.13**
7.29	4.04	11.4	8.2	5.6	5.22	**8.28**
8.45	4.7	8.3	6.92	5.63	5.78	**7.64**
8.52	4.5	8.6	7.5	5.69	6.62	**7.2**
9.14	4.32	9.5	8.2	5.64	5.52	**7.72**
9.15	4.99	12.9	8	6.6	5.22	**8.84**
7.56	5.86	10.2	8.2	5.69	5.69	**7.99**
8.29	4.49	8.33	6.3	5.44	3.89	**6.71**
7.34	5.11	8.39	5.6	4.43	4.59	**6.68**
7.38	5.11	8.33	6.9	6.53	6.34	**7.24**
7.95	4.92	8.4	7.2	5.46	6.12	**7.24**
7.39	6.16	6.1	5	4.91	4.71	**6.07**
8.91	6.07	12.1	7.22	5.58	5.67	**8.24**
6.85	5.35	10.8	5.7	5.46	6.07	**7.5**
7.19	4.65	10.9	4.3	4.32	3.23	**6.57**
5.48	3.71	9.3	4.45	3.57	2.85	**5.64**
8.03	**5.03**	**9.57**	**7.04**	**5.65**	**5.48**	
6.34	**4.18**	**10.1**	**4.38**	**3.95**	**3.04**	

ON-FARM HYBRID MAIZE PRODUCTION

After two seasons of testing to establish suitability of the imported hybrids, ARDI and the MOA expanded the hybrid maize production program to promote production on a larger scale, on private farms. The objectives of these farm-level production projects were to demonstrate to farmers the economic feasibility of large-scale maize production in Iraq and stimulate interest in local agribusiness to produce or import hybrid maize to replace low-yielding Iraqi varieties. These production demonstrations also provided the MOA and ARDI researchers with additional information to establish suitability of hybrids in different regions, and provided ARDI with an opportunity to stimulate interest in private sector agribusiness for hybrid maize importation and retail.

TABLE 34 ON-FARM HYBRID MAIZE PRODUCTION PROJECT 2005

Governorate	Number of Farmers	Seed Distributed (mt)	Area planted (ha)	Yield Hybrid Seed (mt/ha)
Diyala	250	5	250	n/a*
Babylon	400	8	350	n/a
Wassit	400	8	350	n/a
Qadissiya	250	5	250	n/a
Missan	150	3	150	4.7
Kerbala	120	3	120	n/a
Tameem	274	8	273	9
Total	**1,844**	**40**	**1,743**	**--**

*Plots in Babylon, Wassit, Qadissiya and Kebala were supervised by the MOA, and production data was not delivered to ARDI

HOW INBRED MAIZE LINES ARE CREATED:

STAGE 1

1. Selection of a desired characteristic: A population of maize plants is planted. A plant with a particular positive characteristic is targeted- it may exhibit insect or drought resistance, high yield, or good root quality.
2. Prevention of outside pollination: Before the plant flowers, its reproductive organs are protected from outside pollination. Bags are placed over the "silks," the part of the female reproductive system that receives pollen, and the "flower," the part of the male reproductive system that produces pollen.
3. Self-pollination: When the maize plant flowers, pollen is collected in the pollen bag and is used to pollinate the silk on the same plant.
4. Collection of seed: The mature ear of the maize plant contains seeds that were produced through the self-pollination described in step 3. These seeds are collected for Stage 2.

2005 SUMMER MAIZE SEASON

ACTIVITIES

In 2005, ARDI worked with the MOA to establish maize production sites in Diyala, Tameem, Babylon, Wassit, Qadissiya and Kebala governorates, on the lands of nearly 1,844 maize producers. Based on the results of the varietal tests in 2004 and 2005, ARDI procured 40 mt of hybrid maize seed of the same family of hybrids as those that were tested and performed well. ARDI implemented the demonstration sites in Missan and Tameem, while the MOA supervised the distribution and planting of seed in Diyala, Babylon, Wassit, Qadissiya and Kebala governorates (see Table 34 on prior page).

ARDI also cooperated with Syngenta, a private sector agricultural input supply company to implement the 2005 production program. ARDI procured the seed from Syngenta, which then provided farmers with private sector extension. Syngenta representatives worked with the farmers to supervise application of herbicide and seed treatment with insecticide and fungicide.

RESULTS

ARDI collected production data from the sites in Missan and Tameem; the other sites were supervised by the MOA, and they collected and kept production data from those sites. The yields from the hybrid maize sites were much higher than production from local maize varieties, which is estimated to be approximately 1 – 1.5 mt/ha. In Missan, farmers achieved an average yield of 4.7 mt/ha using hybrid maize, and in Tameem farmers were able to produce 9 mt/ha, over six times the productive capacity of local maize.

2006 SUMMER MAIZE SEASON

In 2006, ARDI implemented a second hybrid maize production project in coordination with Iraqi private sector entities including an NGO and a cooperative. It was important to begin building private sector interest and capacity for hybrid maize seed procurement and sale, because until a hybrid maize seed industry can be built up in Iraq, it will be necessary to import hybrid maize seed from international seed companies. This requires the establishment of Iraqi agribusinesses to import and sell the seed; these agribusinesses can also be a source of private extension services for farmers to help them increase their maize yields.

ACTIVITIES

For the summer 2006 maize cropping season, ARDI partnered with an Iraqi NGO to work with 100 maize farmers in Anbar, Baghdad, and Tameem governorates. ARDI procured 25 tons of high quality maize seed, which the NGO distributed to the farmers. Each farmer planted 10 – 15 ha of land to maize, for a total of 1,250 ha. The NGO provided technical assistance to the farmers throughout the cropping season to introduce modern cultivation techniques for maize, including the proper use of fertilizers and pest control. The maize crop will not be harvested until after the publication of this report, but the producers can expect yields of 7 – 10 mt/ha, for a total production of 10,000 mt of maize. In exchange for the hybrid seed and technical assistance, the farmers will return to the NGO a portion of their harvested grain at the end of the season. This will

capitalize the NGO for the next cropping season, so that it can again make hybrid seed and other inputs available for farmers to purchase. By accepting in-kind payment of grain at the end of the season, the NGO will enable farmers who could not otherwise afford the up-front cost of seed and inputs to use high quality inputs and increase their production and income.

ARDI procured an additional 25 mt of hybrid maize seed to capitalize a cooperative formed for hybrid maize seed procurement and sale. The cooperative will establish a similar program to work with farmers in Tameem, Erbil, Dahuk, and Ninewa in the cropping season after this report is published.

ARDI found that there was additional interest in the private sector in establishing agricultural input supply companies for the sale of hybrid maize seed and other inputs, and providing private extension services to farmers. In June, ARDI held a workshop for six NGOs interested in establishing businesses for seed cleaning and agricultural input supply. These NGOs worked with the ARDI Agronomic Crop Production specialist to learn the steps necessary to establish a successful business. ARDI worked with these NGOs to create business plans, which the NGOs are now following to establish their businesses. The development of agricultural input supply from the private sector will increase farmers' access to high quality, productive inputs that will enable them to increase their production and income.

HYBRID MAIZE SEED PRODUCTION – INBRED MAIZE

At present, the only source of hybrid maize seed for Iraqi farmers is through international seed companies. There is no domestic hybrid maize seed industry in Iraq to provide farmers with a source of productive, suitable hybrid maize seed. From 2003 to 2006, ARDI worked with the MOA and the private sector to establish such a hybrid maize seed industry. This involved the donation of

HOW INBRED MAIZE LINES ARE CREATED: (CONTINUED)

STAGE 2

1. Selection of the desired characteristic: The seeds produced at the end of Stage 1 are planted. When the maize grows, the plants with the desired characteristic are selected.
2. Self-pollination: These plants are self-pollinated in the same process described in Stage 1.
3. Collection of seeds: The seeds are collected from the mature ears, and the cycle continues through multiple seasons.

At the end of multiple cycles, the seeds that are produced contain the characteristic that was isolated through the inbreeding process. These seeds represent an inbred maize line. This inbred seed can continue to be replicated without the process of manual self pollination; large plots can be planted with inbred seed and allowed to self-pollinate within the plot, provided that the inbred maize seed is planted with a buffer of at least 1km from other maize plants, to ensure no cross-pollination occurs.

Crossing these inbred creates strong, vigorous maize seeds with desirable characteristics. However, these hybrids will not reproduce true to type, so it is necessary to maintain stocks of inbred maize seed to continue the process of crossing for hybrid production.

inbred maize seed from public sources in the US and the establishment of nurseries to increase the stock of the seed over several seasons. ARDI worked with the private sector to hand off this hybrid maize seed production program to a local cooperative, which will now be responsible for maintaining stocks of inbred maize seed and creating suitable hybrids through crossing.

INBRED MAIZE TRIALS 2004, 2005, 2006

In 2004, ARDI procured ten inbred lines of maize seed from the public sector in the United States. ARDI gave the seeds to the MOA, and continued to work with researchers at the MOA to propagate the lines. The seeds, which numbered approximately 100, were planted in a nursery at a MOA research station in Baghdad, in order to multiply the lines and increase the supply of the inbred seeds. In addition, some of the inbred plants were crossed to produce hybrids. This testing is important to determine the productivity of different maize hybrids in Iraq, and select the most productive to increase yields. The process was conducted as described in the side bars (on prior page).

ARDI provided technical assistance to MOA researchers in the form of a Maize Production Workshop, which aimed to increase knowledge about seed breeding, and in particular, the production of maize seed. Staff from the State Board for Agriculture Research attended the workshop.

At the end of the season, ARDI harvested the inbred maize seed, which was kept and planted the next season to continue the process of increasing the stock of available inbred maize seed, and to begin the process of creating and testing suitable hybrid maize crosses.

In the 2005 spring cropping season, ARDI again established a nursery using the inbred maize seed produced in 2004. In this season, ARDI made a decision that a private sector entity was most appropriate to continue work to establish a hybrid maize seed industry, through inbred maize seed production and hybrid crossing after the end of the ARDI program. At harvest, the nursery produced 5.5 kg of inbred maize seed. ARDI staff also began crossing inbred seed to create hybrids, to test the suitability of the various hybrid crosses.

In the 2006 season, ARDI began work with a cooperative formed for inbred maize seed production and hybrid crossing. The cooperative was granted the stock of inbred maize seed built up over the 2004 and 2005 cropping seasons. In addition, ARDI provided technical assistance to plant the nurseries for the 2006 summer cropping season, and to begin crossing hybrids again to continue testing suitability. This cooperative will continue to build and maintain stocks of inbred maize seed, and will eventually begin producing hybrid maize seed on a commercial level for sale to farmers. This will provide farmers with a domestic source of hybrid maize seed, in addition to sources from international seed supply companies.

POTATO PRODUCTION

Potato field with new center pivot irrigation system.

Despite increasing domestic consumption of potatoes in Iraq, and technological developments to improve potato productivity over the last 30 years, potato production has remained lower than in other countries. Iraq currently imports potatoes from neighboring countries, including Iran, Turkey, and Syria.

There is therefore an opportunity for Iraqi farmers to adopt improved technologies to increase production, meeting domestic demand and decreasing potato imports. As part of the 2004 – 2005 Winter Crop Technology project, ARDI and the MOA cooperated to implement a demonstration of improved cultivation methods for potatoes, including the use of hybrids, appropriate cost-effective use of chemical fertilizers and pesticides, mechanical planting, and furrow planting. The data from the harvested demonstration plots indicate that the improved methods, particularly the use of the El Paso hybrid, resulted in higher yields and larger tubers.

Désirée potato

ACTIVITIES

Demonstrations were established in eight locations in regions where potatoes have traditionally been cultivated: Baghdad (four locations), Ninewa (two locations), and Tameem (two locations). Each demonstration site had a total area of two hectares; one hectare was planted with improved practices (demonstration) and one hectare was planted with farmers' traditional practices (control).

The demonstration plots were planted with two varieties imported from the

Flowers of the eggplant (below) are similar to the potato (above) and tomato.

The potato, tomato, and eggplant are all part of the *Solanaceous* species in taxonomy.

Netherlands: Désirée class E and El Paso class A. The local check plots were controls.

In addition to the use of these improved varieties, the following practices were also applied:

- Soil preparation with plowing, disking + rotivating + furrowing;
- Seeding rate of 3mt/ha, with furrows;
- Tubers treated with mixture of fungicide + bactericide immediately before planting;
- Fertilizer applied according to proper methods, including a foliar treatment;
- Weed control with Sincor or patoran preplanting, 500 gm/ha;
- Pest and disease control with locally purchased pesticides to control insects and bacterial and fungal diseases;
- Harvest: The farmers began cutting the foliage when the lower leaves of the plant started to turn yellow and fall to the ground, which is considered the first sign of maturity. The cutting was done either by hand or by mower, for large areas. After this point, the farmers harvested the

potatoes either by tractor or by mechanical harvester.

The potato demonstrations were supervised by a team from the MOA, the College of Agriculture at the University of Baghdad, and ARDI. This team held a workshop early in the demonstration process to discuss project objectives. Research staff also lectured on the nature of different potato hybrids, and weeds and fertilizers.

Potato field data collection to evaluate the impact of proper fertilizer and pesticide use.

During the growing season, field days were held to give area farmers the opportunity to observe the higher levels of production achieved using improved technology on the demonstration plots. Field days were held at the Baghdad and Tameem demonstration plots in May, with a total of over 100 participants. Staff from the College of Agriculture and the Agriculture Directorate discussed the new methods with the farmers, who were very interested in adapting the new technologies to increase their own production. MOA and ARDI technical staff noted that farmers can adopt some of the improved techniques to increase their profits at no cost. For example, some farmers in the demonstration overused chemical fertilizers and pesticides in their plots; in some cases, the farmers used more than double the recommended quantity of fertilizer. The extra amounts cost money but do not contribute to increased production. If farmers simply decrease the amounts of pesticides and fertilizers to recommended quantities, they will decrease their input cost and increase their profits.

RESULTS

The average yield of the El Paso variety planted with improved practices (two plots) was 15.9 mt/ha, compared to the average yield of 9.7 mt/ha for the Désirée hybrid planted with improved practices (six plots), and 7.3 mt/ha for the Désirée hybrid planted with farmers' practices (eight plots). The El Paso hybrid

Désirée potato plant

Potato tuber

Potato sprouting

showed good results against diseases. No infection was recorded in either location. El Paso is the most favored hybrid in the Iraqi market and has been tested for six successive seasons by private and public sector importers.

The potato yields were graded according to three sizes: 25-33mm, 35-55mm, and greater than 55mm. The El Paso variety tubers were consistently large; 60% of the tubers were larger than 55mm, and 26% were in the 35mm – 55mm range. In comparison, the Désirée hybrids planted with improved practices yielded 27% in the 55mm+ range, and 37% in the 35mm – 55 mm range. The Désirée hybrids planted with farmers' traditional practices yielded 28% in the 55mm+ range, and 35% in the 35mm – 55 mm range.

The plots planted with improved practices showed no signs of disease or pests, while every plot planted with farmers' traditional practices was affected by disease and/or pests. Four plots were affected by Potato Leaf Roll Virus (PLRV), five by Potato Virus M (PVM), and one by early blight (two plots had both PLRV and PVM).