SEED UNIT

Five-Year Report 1997-2001

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ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland, and small-ruminant production; and the Central and West Asia and North Africa region for the improvement of bread and durum wheats, chickpea, and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural-resource management practices. ICARDA meets this challenge through research, training, and dissemination of information in partnership with the national agricultural research and development systems.

The results of research are transferred through ICARDA's cooperation with national and regional research institutions, with universities and ministries of agriculture, and through the technical assistance and training that the Center provides. A range of training programs is offered, from residential courses for groups to advanced research opportunities for individuals. These efforts are supported by seminars, publications, and specialized information services.

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The mission of the CGIAR is to promote sustainable agriculture to alleviate poverty and hunger and achieve food security in developing countries. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem-solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to the strengthening of agricultural research in developing countries.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the International Fund for Agricultural Development (IFAD) are cosponsors of the CGIAR. The World Bank provides the CGIAR System with a Secretariat in Washington, DC. A Science Council, with its Secretariat at FAO in Rome, assists the System in the development of its research program.

SEED UNIT

Five Year Report 1997 - 2001

The International Center for Agricultural Research
in the Dry Areas (ICARDA)
P.O. Box 5466, Aleppo, Syria

This report was written and compiled by program scientists and represents a working document at ICARDA. Its primary objective is to communicate research results quickly to fellow scientists, particularly those within West Asia and North Africa, with whom ICARDA has close collaboration. Editing of the report was kept to a minimum.

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1. INTRODUCTION

The objective of the Seed Unit of ICARDA is to strengthen national seed systems in Central and West Asia and North Africa (CWANA) and build sustainable seed supply systems. The Unit has received financial support from the Government of the Netherlands and the Government of Germany. These generous financial contributions provided an extra opportunity for key activities in the field of human resource development and economics of seed production.

As the Unit has not published an annual report since 1997, this five-year report reviews the activities, which have been carried out in the period 1997-2001. This report discusses work carried out by the Unit in nine sections: WANA Regional Seed Network (Section 2), Economics of Seed Production (Section 3), Seed Security (Section 4), Research (Section 5), Human Resources Development for the Seed Sector (Section 6), Seed Production and Distribution (Section 7), and International Activities (Section 8). Section 9 summarizes the Status of Cooperation with Regional Programs and Countries, and Section 10 and 11 present the Seed Unit Staff, External Consultants and a list of Publications.

2. WANA REGIONAL SEED NETWORK

The WANA Seed Network operates under the guidance of the WANA Seed Council (WSC), which is composed of senior seed program mangers of member countries who serve as Country Representatives (CRs). The Seed Unit provides a proactive Secretariat. From the outset, the WANA Seed Network has been a catalyst in promoting cooperation, enhancing exchange of information and providing a mechanism for sharing experiences to build an integrated seed industry across the region.

Through its member countries, the Network undertakes various initiatives to develop a common platform for the integration of national seed systems, with a view to promote regional seed trade. These activities are focused on the following key areas:

- Collection and dissemination of information through technical publications, review of national seed programs and a regular newsletter.

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- Collection and dissemination of information through technical publications, review of national seed programs and a regular newsletter.

- Harmonization of policy, regulatory and technical procedures relevant to varieties and seeds.
- Linkage with regional and international organizations working on seeds and development.

The Secretariat manages the Network and monitors the progress of activities carried out by lead countries as part of technical backstopping. Financial support from the GTZ Seed Project in Egypt for conducting Steering Committee and WSC meetings is highly acknowledged.

2.1. Network Meetings

2.1.1. Steering Committee Meetings

The fifth, sixth, seventh and eighth Steering Committee (SC) meetings of the WANA Seed Network were held, respectively in Cyprus (1997), Egypt (1998), Lebanon (2000) and Egypt (2001). All the committee members from Cyprus, Egypt, Lebanon, Morocco, Syria, Turkey and the Secretariat staff attended the meetings. In each Steering Committee meeting, a comprehensive status report on Network activities was prepared and presented by the Secretariat. The Steering Committee provided the leadership required in implementing the activities of the Network.

In 2001, members of the SC attended the First Congress of the African Seed Trade Association held in Cairo, Egypt. The main purpose was to create opportunities for the SC members to meet and exchange experiences with colleagues in the seed sector from different national, regional and international organizations and familiarize themselves with trends in global seed industry development.

2.1.2. WANA Seed Council (WSC) Meeting

The Third WANA Seed Council was held on 5-6 May 1999 in Cairo, Egypt. All CRs and observers were invited including some private seed companies and national seed associations from member countries. The Council meeting was attended by 15 CRs, observers from UPOV and ISF, and four national seed associations from Egypt, Morocco, Pakistan and Turkey. The WSC

reviewed the progress made with each activity since its Second Council meeting in 1995 in Turkey. It streamlined the Network activities and outlined its future direction. Each activity was reviewed by CRs outlining the achievements and constraints faced in implemention.

The review revealed variation in the progress made with Network activities. It was recognized that the resources available to CRs for carrying out their lead functions may vary, as well as the ease of collecting certain types of information in response to inquiries from other countries. The Council noted the following key points during its deliberations.

- All Network activities are useful, but some were difficult for certain lead countries to manage. In such cases, it was suggested that another country be assigned to assist the lead country in implementing the activity.
- Frequent changes in CRs affected the implementation of assigned activities in some member countries.
- In larger countries with diverse seed sectors, it was suggested to form a small committee to support the CRs. Alternatively, it was suggested that the National Seed Council or Seed Association becomes involved in gathering information.

After the Council meeting, the CRs participated in a workshop on "Plant Variety Protection: Current Status and Implications for the Development of the Seed Industry in WANA" organized by the Seed Unit and UPOV. The workshop aimed at creating awareness about the implications of PVP and reviewing the status in the WANA region. Resource persons from Australia, The Netherlands and UPOV made technical presentations, while the CRs presented technical country reports. In addition, the CRs attended the Third Egyptian Seed Conference organized by the GTZ seed project, Central Administration for Seed Certification and Testing (CASC) and Central Administration for Seed Production (CASP). This introduced CRs to the ongoing policy and regulatory reforms and restructuring of the seed sector in Egypt.

2.1.3. Changes in Country Representatives and Election of New Steering Committee

New CRs were appointed for Algeria, Ethiopia, Iraq, Jordan, Libya, Pakistan, Sudan, Turkey and Yemen following retirement or change of duties

of CRs within the national seed program of the respective countries.

The term of existing SC usually ends with the convening of the WSC meeting. The Council meeting increased the membership of the SC from five to six countries electing Egypt as ex-officio. Following the nominations Cyprus, Egypt, Lebanon, Morocco, Syria and Turkey were elected as new SC members until the next Council meeting.

2.1.4. New Membership and Widening Participation

The Council decided that countries with significant agricultural economies are asked to join the Network, as they will benefit from the regional activities in the seed sector. The Secretariat therefore approached some countries in the region to become members, and Djibouti joined the WANA Seed Network in 2000 as its 19th member and nominated a CR.

The linkage with national seed associations and the formation of a regional seed association was discussed as a way of developing the Network and involving the private sector. Within this context, the Secretariat had prepared a draft constitution to stimulate discussion. For this reason, four existing national seed associations from Egypt (Egyptian Seed Association), Morocco (Association Marocaine des Semences et Plants), Pakistan (Chamber of Private Seed Industry) and Turkey (Turkish Seed Industry Association) were invited to attend. Accordingly, presentations were made on the experiences of APSA and ISF and followed by reports from national seed associations. In the ensuing discussions it was agreed for the time being to concentrate efforts on establishing a few more national seed associations in the region. This was agreed as a new Network activity and the Pakistan Chamber of Seed Industry was asked to take the lead and develop a strategy in collaboration with the national seed trade associations, the Secretariat and ISF. The existing seed associations were also accepted as regular contact point for the private seed sector and being informed on all Network activities.

2.1.5. Network Funding

During the last six years, considerable progress has been made with very limited resources, due to strong and firm commitments from most member

countries. The limited budget presents an operational problem for the Network. To put the Network on sound and sustainable financial base the Secretariat has prepared a new project focusing on new developments for submission to potential donors. As an alternative it was suggested that member countries subscribe to the WANA Seed Network and pay a nominal fee to support some of its activities. However, this appears to be a problem for some countries, which are entirely dependent on government budgets. No firm decision was made, although it was agreed to explore the possibilities.

2.2. Highlights of Network Activities

Most of the Network activities are aimed at collecting, assembling and summarizing existing information in member countries with a view of developing a model policy and/or regulatory framework across the WANA region. Progress is presented below and summarized Table 2.2.

2.2.1. Discontinued Activities

Following intense discussion, the Council discontinued the following activities due to technical and legal problems and unrealistic expectations: (a) preparing a database of morphological variety description (Pakistan) and (b) regional variety evaluation (Libya). Instead the Council suggested implementing a sub-regional variety description and listing for North Africa.

2.2.2. Completed Activities

During the Council meeting information collected on: (a) seed industry costs (Algeria), (b) seed technology education (Iraq), (c) regulations for establishing seed companies (Yemen), and (d) catalogue of crop and weed species (Cyprus) was presented and summaries circulated.

Seed Industry Costs - Algeria: Information collected on seed production and marketing costs were summarized and distributed during the Council meeting. All responses were from 'official' seed organizations and related to major crops. It was suggested to collect in the future seed and grain prices rather than detailed seed production costs.

Seed Technology Education - Iraq: Data collected from 17 universities in 12 countries was summarized. Seed courses are offered mostly as elective in undergraduate degree programs in agriculture. Six universities offer seed courses at an MSc level, but only one offers specialization in Seed Science and Technology.

Regulations for Establishing Seed Companies - Yemen: Information was received from nine countries, but mostly not sufficiently complete to prepare a summary. It is suggested that a summary be prepared with some assistance from the Secretariat.

Crop Species Catalogue - Cyprus: The catalogue of crop species was published in 1999 as WANA Seed Network publication No. 20/99. The document summarized information on annual and perennial crops cultivated in 15 member countries in the WANA region.

Weed Species Catalogue - Cyprus: The catalogue was envisaged to strengthen exchange of weed seed collections among seed testing laboratories in the region. The information summarized noxious and common weeds associated with cereals, legumes, oilseeds, forages and vegetables from 16 countries and was published in 2001 as WANA Seed Network Publication No. 23/01.

2.2.3. On-going Activities

Seed Certification Scheme - Turkey: The status of national seed quality control and certification schemes from 15 member countries was collected and reviewed by Turkey. A draft regional seed certification framework was prepared in collaboration with the Secretariat for discussion during the 1999 Council meeting . The Council approved the framework of the scheme as a basis for harmonizing certification procedures across the WANA region and asked for translation into Arabic. The document is available both in Arabic and English and some countries expressed willingness to participate if a regional scheme could be launched.

Referee Seed Testing - Morocco: A reliable estimate of seed quality can be achieved if samples are taken, and analyses carried out, using the most appropriate methods and procedures based on internationally accepted standards. The Network initiated regional referee testing to encourage exchange

of experience and promote uniform application of seed analyses methods among different laboratories of member countries. The Service de Contrôle des Semences et Plants in Morocco coordinates, analyzes and reports the results of the referee tests.

In 1997, 1998 and 2001 referee tests were carried out on alfalfa, clover (*Trifolium alexandrinum* L.) and maize, respectively. The results received for alfalfa (15 laboratories from 10 countries), clover (18 laboratories from 11 countries) and maize (17 laboratories from 13 countries), respectively were published in Network Publication No. 16/1997, Number 21/1999 and Number 22/2001. The results were distributed to the participating seed testing laboratories with suggestions for improvement from the coordinator in Morocco.

Database for Seed Trade - Tunisia: In 1999, information gathered on seed import and export has been summarized and distributed. It was agreed that the database should include source of seed and its monetary value to get a clear picture of the seed trade and updated regularly. The CRs asked to contact general trade statistics, import-export permit or quarantine offices to find most recent statistics available.

Model Seed Policy - Sudan: Several countries responded at an early stage and a summary was prepared in 1995. A new questionnaire was circulated during the Council meeting in 1999 and CRs were requested to respond. Given the importance and interest in seed policy it was agreed that the Secretariat develops a model policy in consultation with the lead country.

Variety Release Mechanisms - Ethiopia: It was agreed that information gathered so far reviewed and a model procedure prepared and circulated to member countries for comments. This could contribute to the process of harmonization and the easier movement of tested varieties between countries of the region.The Secretariat has developed a comprehnsive questionnaire to collect information from member countries.

Regulations for Seed Trade - Jordan: It was agreed to summarize whatever information available and develop a model seed trade regulations for circulation and comments.

WANA Seed Directory - Egypt: In 1998, the WANA Seed Directory was revised and published (WANA Seed Network Publication No.17/98) listing

the public and private organizations involved in the seed sector of the member countries to encourage contacts within and outside the WANA region. The new directory contained additional information on list of senior personnel in the seed sector from 15 member countries. The directory would be updated regularly every two to three years.

Crop Varieties Catalogue - Morocco: A significant number of crop varieties have been released within the region. Some varieties were released in more than one country, but often under different names. The Catalogue summarizes information on cereal, legume, oilseed and forage crop varieties (and their synonyms) currently grown in WANA region as well as the list of breeders/maintainers. The list was updated and published WANA Seed Network Publication 18/98). The list could become a useful regional variety list within the framework of the regional seed certification scheme.

WANA Standards Catalogue - Syria: The Catalogue includes field and seed standards used for certification of most important agricultural and horticultural crops. In 1999, the catalogue was revised and included additional standards for oilseed, industrial (cotton, sugar beet) and some important horticultural crops (mostly seed standards). Moreover, the AOSCA scheme used for varietal certification and suggested standards for FAO's 'Quality Declared Seed' were included for selected crops. This document (WANA Seed Network Publication No. 19/99) is a useful aid to prepare the regional certification scheme.

2.2.4. Seed Network Official Newsletter and the Focus on Seed Programs Series

SEED INFO is the biannual newsletter of the Network and aimed at stimulating information exchange among seed staff in the region and beyond. The newsletter provides news and views from across the wide cross section of contributors to generate discussions that are of interest at the national, regional and global levels. Since January 1998, the newsletter is also published in Arabic, an additional significant step in getting closer to the target readers. At present about 800 Arabic and 1200 English copies are distributed within and outside the CWANA region. Nineteen English and 8 Arabic issues of the newsletter were published and distributed by the Secretariat from1997 to 2001.

SEED INFO on the Web: From July 2001 the English version of SEED INFO is also made available on the internet at the ICARDA website.

Focus on Seed Programs: The 'Focus on Seed Programs' series provides a detailed profile of the national seed industries in member countries highlighting major policy, regulatory, institutional and technical components in much concise format. From 1997 to 2001 eight issues of 'focus' were published, featuring the national seed programs of Cyprus (1997), Lebanon (1997), Tunisia (1997), Ethiopia (1998), Oman (1998), Pakistan (2000), Jordan (2001), Iraq (2001) and Algeria (2001).

Table 2.1. WANA Seed Network (WSN) publications

Equiment Lists

Diekmann, M. 1993. Equipment and Supplies List: Seed Health Testing. WSN No. 1/1993

Bishaw, Z. and B. Gregg. 1993. Equipment and Supplies List: Seed Testing. WSN No. 4/1993

Technical Publications

Diekmann, M. and A.J.G. van Gastel. 1993. Disease Descriptions for Field Inspection in Seed Production for (a) Loose smut of wheat and barley, (b) Common bunt of wheat, (c) Ascochyta blight of chickpea, and (d) Covered smut of barley. WSN No. 2/1993

Diekmann, M. 1993. Seed-borne Diseases in Seed Production. WSN No. 3/1993

Gregg, B., S.A. Wanis, Z. Bishaw and A.J.G. van Gastel. 1994. Safe Seed Storage. WSN No. 5/1994

Gregg, B., S.A. Wanis, A.J.G. van Gastel and Z. Bishaw. 1994. Marketing Seed. WSN No. 6/1994

Bishaw, Z., A.J.G. van Gastel, B. Gregg and S.A. Wanis. 1994. Inspecting Seed Fields of Self-pollinating Crops. WSN No. 7/1994

Legal Document

Gregg, B., S.A. Wanis, Z. Bishaw and A.J.G. van Gastel. 1996. Plant Variety Protection: Decree under national seed law of a country of West Asia and North Africa. WSN No. 12/1996

Directory

Secretariat. 1998. WANA Seed Directory. WSN No. 17/1998

Catalogues

Secretariat. 1998. WANA Catalogue of Varieties. WSN No. 18/1998

Secretariat. 1999. WANA Catalogue of Field and Seed Standards. WSN No. 19/1999

Secretariat. 1999. WANA Catalogue of Crop Species. WSN No. 20/1999

Secretariat. 2001. WANA Catalogue of Weed Species. WSN No. 23/2001

Referee Tests

Tourkmani, M. 1995. WANA Referee Test - Bread wheat. WSN No. 10/1995

Tourkmani, M. 1995. WANA Referee Test - Lentils. WSN No. 11/1995

Tourkmani, M. 1997. WANA Referee Test - Alfalfa. WSN No. 16/1997

Tourkmani, M. 1999. WANA Referee Test - Clover. WSN No. 21/1999

Tourkmani, M. 2001. WANA Referee Test - Maize. WSN No. 22/2001

Table 2.2. Summary and progress of the WANA seed network

Activities	Lead country	Progress made and future action
Seed industry costs	Algeria	Information received from member countries presented
WANA catalogue of crop species	Cyprus	Final document published in 1999
WANA catalogue of weed species	Cyprus	Final document published in 2001
WANA seed directory	Egypt	2nd edition published in 1998; Revision made every 3 years
Variety release mechanisms	Ethiopia	Data collected reviewed; Model format to be developed
Seed technology education	Iraq	Data from 12 countries (17 universities) summarized
Regulations for seed trade	Jordan	Collection of data made; Model form to be developed
Database on seed publications	Lebanon	Database regularly updated when available
Regional variety evaluation system	Libya	Activity discontinued; Sub-regional variety list suggested
WANA catalogue of crop varieties	Morocco	2nd edition published in 1998; Updated every two years
WANA referee seed testing	Morocco	Continue with one referee test organized every year
Database for variety description	Pakistan	Activity abandoned; Sub-regional pilot suggested
Model seed policy	Sudan	Response to new questionnaire requested; Secretariat assist in developing model policy
WANA catalogue of standards	Syria	2nd edition published in 1999; Standards for key forage crops suggested
Database on seed import and export	Tunisia	Data should be updated annually; Collaboration with FIS suggested
Seed certification systems	Turkey	Draft scheme accepted in principle; Follow-up suggested for feedback/consen sus with Ministries/Certification Agencies
Regulations for establishing seed companies	Yemen	Data collected summarized and synthesized into a document
National/Regional Seed Association	Pakistan	Develop strategy to encourage formation of more national seed associations
Secretariat	Seed Unit	Publish newsletter 'Seed Info' and 'Focus'; Publish Network and special technical publications; Assist to develop model policy with lead country; Assist develop model variety registration with lead country

3. ECONOMICS OF SEED PRODUCTION

The German-funded project on "Economics of Seed Production", which came to an end on 30 June 1998, was followed by a new project on "Efficiency and Effectiveness of Seed Production and Marketing Systems in WANA Region". The two projects provided an opportunity for key activities in the field of economics of seed production, which included collaborative research, training and consultancy contacts with national programs throughout the region. Several types of publications were produced based on these relationships and joint activities.

3.1. Collaborative Research

Four key research projects were undertaken in seed economics during the period under review.

3.1.1. Potential of a Small-holder Contract Scheme to Diffuse Tef Varieties (Ethiopia)

In many developing countries, small farmers are not considered efficient contract seed growers, and some important crops grown by them are of limited commercial interest to seed companies. The neglect of such crops limits the diffusion and use of improved varieties and quality seed by small farmers, thus contributing to low productivity.

This study assessed the potential of a contract scheme for small farmers in Ethiopia to produce seed of Eragrostis tef (commonly known as tef), which is the major staple cereal crop grown by smallholders. Ethiopian Seed Enterprise (ESE), the major producer of certified seed in the country, collaborated with ICARDA's Seed Unit to investigate the economics of tef seed distribution. Questionnaires were prepared and a survey took place between January and March 1997.

The study examined whether contracting small-scale growers could improve the local seed system so as to enable the diffusion of new varieties and the maintenance of varietal purity. Using data from a survey of 94 grow-

ers, 100 users and 102 non-users of certified tef seed, an attempt was also made to identify factors, which influence the economic efficiency of small-scale tef farmers.

Results: The study highlighted problems associated with contracting smallholders and suggested ways in which this approach could be improved to facilitate the uptake of good seed and better varieties. It also raised interesting issues about the diffusion of improved varieties of traditional crops and the way in which particular characteristics of a crop may affect the organization of seed supply.

To measure economic efficiency, gross margins (output value minus variable costs) were used to assess profitability in tef production. Results are presented in Table 3.1.

Table 3.1. Mean gross margin in tef production

Item	Certified Seed		
	Growers	Users	Non-Users
Output Value			
Mean yield (t ha-1)	0.662	0.913	0.716
Mean price (ETB t-1)	1701.20	1421.90	1746.60
Total revenue (ETB)	1126.19	1298.19	1250.57
	……..…....…...……ETB ha^{-1} ....….....…...……		
Variable Cost			
Seed	113.40	114.00	69.39
Land preparation	330.12	348.42	298.89
Seeding	20.02	21.11	18.36
Fertilizer	390.00	395.00	400.25
Herbicide	47.00	47.00	0.00
Hand weeding	20.24	41.64	80.14
Harvesting	100.16	115.20	121.23
Collection and stacking	20.32	18.10	20.65
Transport from field	20.16	19.65	17.82
Threshing and bagging	40.20	42.26	38.86
Transport to storage	10.54	8.78	5.25
Total cost	1112.16	1151.16	1070.84
Gross margin	14.03	147.03	179.73
Gross margin as % of total cost	1.26	12.77	16.78

To explain the variation in gross margins between farmers, Ordinary Least Squares (OLS) estimations were made using Gross Margin (GM) as the dependent variable and a range of socio-economic and demographic factors of growers, users and non-users as the explanatory variables as follows:

LINKS	Technical linkage expressed in number of institutions farmer had links with
AGE	Age of farmer in years
EDUC	Education of farmer expressed in number of school years
FARMSZ	Total farm size in hectares
OFFAC	Dummy variable for off-farm activity (OFFAC = 1 if either farmer or spouse received income from off-farm activities, and OFFAC = 0 otherwise)

The following equation describing the relationships between gross margin and the explanatory variables was therefore postulated, where α, β_1, β_2, β_3, β_4 and β_5 were regression coefficients and μ an error term:

$$GM = \alpha + \beta_1 \text{ LINKS} + \beta_2 \text{ AGE} + \beta_3 \text{ EDUC} + \beta_4 \text{ FARMSZ} + \beta_5 \text{ OFFAC} + \mu$$

The results of the regression analysis (Table 3.2) showed that, as expected, institutional linkages had a positive effect on the efficiency of growers. Of particular significance were links, which the growers had with crop research, farmers' cooperatives, fellow growers, other farmers, farmers' associations, extension services, NGOs and ESE. In this respect, the farmers held links with the extension services and farmers' associations in high regard.

Table 3.2. Estimates of factors influencing gross margins in tef production

Variable	Coefficient			t-Value			Standard Error		
	Growers	Users	Non-users	Growers	Users	Non-users	Growers	Users	Non-users
Constant	-411.48	-370.43	-105.75	-4.47***	-1.83ns	-0.53ns	92.10	201.88	201.14
LINKS	154.02			6.31***			24.40		
AGE	-0.90	-6.25	-8.85	-0.63ns	-1.61ns	-2.70**	1.43	3.89	3.28
EDUC	25.04	87.32	54.03	3.50***	5.75***	4.41***	7.16	15.19	12.25
FARMSZ	57.90	248.29	301.97	4.61***	6.34***	7.30***	12.56	39.19	41.16
OFFAC	-47.84	-217.94	-175.14	-1.07ns	-2.09*	-1.94ns	44.67	104.48	90.39
Adjusted R^2	0.62	0.56	0.63						
F-statistic	31.52***	32.16***	45.62***						

***Significant at $p \leq 0.001$; ** ≤ 0.01; * ≤ 0.05; ns not significant

Another factor that had a significant positive influence on efficiency was the level of education attained by farmers. It was found that 37% growers, 58% users of certified seed and 45% non-users of certified seed were literate, with corresponding mean school years of 2.2, 3.4 and 3.4, respectively.

Farm size also had a strong positive influence on gross margins for all categories of farmers. The farm size variable represented total area the farmer cultivated with all crops. The mean farm size for the growers, users and non-users were 2.2, 2.4 and 2.9 ha, respectively.

No obvious conclusion could be drawn regarding the effect of farmer's age. Involvement in off-farm activities, particularly for the users and non-users, could reduce the time farmers devoted to supervision of their own farm, particularly during crucial operations, which may have caused the negative coefficients (i.e., an inverse relationship between gross margin and off-farm activities). However, the influence of this factor was not clearly significant and it is likely that some different factors contributed.

The results showed that gross margins reflect the farmer's production response to price (ESE procurement price for seed and price of inputs), technology (farm size, education, technical linkages) and management factors (ownership, off-farm activities, education). Since it is not likely that all farmers will end up as successful growers, a careful study of these factors can help in identifying key growers who could be encouraged and supported to emerge as individual small-scale entrepreneurs dealing in seed production and distribution. These farmers should be encouraged to distribute quality material within the communities, using varying exchange mechanisms. Compared to outside organizations of the formal seed sector, these entrepreneurs have obvious advantages - including proximity and close relationships with fellow smallholders in the community. Monitoring the long-term progress of these key farmers provides a means of assessing the impact of this approach.

A major strength in having small-scale seed enterprises at village level is the effective link these could form between variety selection, seed multiplication, distribution and use, with all stages involving the participation of the smallholders themselves. This process is consistent with concepts of participatory plant breeding, and would facilitate the introduction of ideas and materials from the formal seed sector and adapting these to local conditions.

A successful scheme for tef can be a transferable model for other crops grown by small farmers.

Developing small-scale enterprises in rural communities undoubtedly takes time and requires difficult learning phases. Quick results should therefore not be overemphasized. Experience in similar activities show that farmer-based seed systems may take at least 10 years of external support to reach some level of sustainability.

Expected impact: A positive indication of impact was extension of the similar contract arrangements to barley during the 1997/98 season. Barley is another important small farmer crop in Ethiopia and raising productivity in both this crop and tef will enhance the welfare of farming communities adopting the scheme. The success of these efforts would be translated into higher on-farm productivity, food security and higher income for rural households who are involved in this scheme, as well as other farmers in the community who receive seed from them.

The preliminary findings have been compiled into a report. This report served as a working document for guidance in ESE's production planning for the following season (1997/98).

3.1.2. Economics of Forage Seed Production in Northeast Syria

Vetch (*Vicia sativa*) and barley (*Hordeum vulgare*) are important forage crops grown by farmers in Syria. Lentil (*Lens culinaris*) is not a typical forage crop but its straw is an important source of animal feed and many farmers may cultivate it partly for this purpose. Lentils are occasionally grown as a fodder with the whole plant being grazed green or cut and fed to livestock. In this study, costs and revenue data for vetch, barley and lentil from farmers' fields in northeast Syria and from seed multiplication plots at Tel Hadya are used to discuss opportunities for commercializing forage seed production.

Data: A total of 177 formal interviews (n = 177) were conducted in July 2001 with farmers in three districts within northeast Syria namely Malkiyeh in Zone 1 for vetch (n = 61), Hassekeh in Zones 3 and 4 for barley (n = 55) and Qamishli in Zone 2 for lentil (n = 61). Apart from a small proportion that

were seed growers for the General Organization for Seed Multiplication (GOSM), most of the farmers cultivated their crops for use as grain, although they usually set aside a certain proportion as seed.

As much as possible, data were collected from each farmer for the past two seasons (1999/2000 and 2000/2001). There was significant crop loss from drought during 1999/2000, while the following season of 2000/2001 season was a good one. The results of this study therefore provided an interesting comparison between two contrasting seasons.

Table 3.3. compares the mean seasonal rainfall recorded between October and May in Malkiyeh, Hassakeh and Qamishli districts during 1999/2000 and 2000/2001 with corresponding long-term (22 years) means.

Table 3.3. Mean seasonal rainfall in northeast

District	Average rainfall in mm		
	1999/2000	2000/2001	Mean (1978/79-2000/01)
Malkiyeh (Zone 1)	397.7	453.1	576.8
Qamisli (Zone 2)	224.2	493.1	421.4
Hassakeh (Zone 3)	93.5	327.4	282.7
Hassakeh (Zone 4)	137.3	381.3	242.5

Source: Directorate of Agriculture, Hassakeh, Syria

Malkiyeh is located in Zone 1, which receives the highest average rainfall. Farmers in this area grow wheat as the main crop and vetch as the next most important crop, followed by chickpea. Informal production and distribution of vetch seed has continued in the Malkiyeh area following an initial injection of seed by GOSM in the late 1980s as part of its contract grower scheme. Although GOSM stopped distributing certified vetch seed a few years later, cultivation of this crop has continued to expand and now covers a large area, many villages and an increasing number of farmers. Hassakeh district comprises both Zones 3 and 4. Most of the farmers interviewed in this district grow barley as the most important crop, followed by irrigated wheat as the next crop in terms of importance. The farmers interviewed in the Qamishli district grow a local red lentil cultivar although wheat is the most important crop. For comparison, data on costs, yields and prices were

also obtained from the ICARDA Seed Unit for seed multiplication of vetch, barley and lentil during 1999/2000 and 2000/2001.

Results: The results show that high potential yield, appropriate harvesting methods and commercial use of straw were important factors that determined profitability in cultivating vetch and lentil. Despite the low value of its straw, the cultivation of barley crop can be profitable in the rainfed areas because of low variable costs of production, since no fertilizer is used and there is hardly any weed growth. Under research conditions on the ICARDA farm, high yield potential combined with efficient mechanical harvesting of grain and straw render barley cultivation cost-effective (Table 3.4). Harvesting is normally a serious bottleneck in producing seed of most forage crops and can raise production costs. The case of barley demonstrated the importance of appropriate and efficient harvesting methods in contributing to overall cost-effectiveness.

Conclusions: The study has revealed that farmers in northeast Syria can get good margins when their operations are compared with formal seed production such as the one carried out at ICARDA. This indicates a potential for farmer producers at village level to produce seed cost-effectively and distribute this within the community. The case of vetch in Malkiyeh proved this point, since farmers there had continued to grow the crop and produced seed for a long period after the withdrawal of the public seed organization that first introduced vetch in the area. However, the admixture of vetch varieties in Malkiyeh meant that these communities needed support with new varieties and simple cleaning equipment to improve the quality of their seed.

Table 3.4. Margin/ha for vetch, lentil and barley grown in ICARDA seed production plots

Item	Vetch		Barley		Lentil		Barley[1]
	99/00	00/01	99/00	00/01	99/00	00/01	
Income							
Seed yield (kg/ha)	399	700	3294	2500	455	1076	987
Seed price (SYP/kg)	21	21	12	11	25	25	12
Income from seed sales	8379	14700	39528	27500	11375	26900	11844
Straw yield (kg/ha)	0	0	4510	3425	0	0	1352
Straw price (SYP/kg)	0	0	2	2	0	0	2
Straw value	0	0	9020	6850	0	0	2704
Total income	8379	14700	48548	34350	11375	26900	14548
Establishment costs							
Seed sown (kg)	100	100	100	100	100	100	100
Price of seed (SYP/kg)[2]	21	21	12	12	25	25	12
Seed cost	2100	2100	1200	1200	2500	2500	1200
Seedbed preparation and sowing[3]	4400	4400	3400	3400	4400	4400	3400
Sub-total establishment cost	6500	6500	4600	4600	6900	6900	4600
Variable costs							
Fertilizer[4]	270	270	1070	1070	270	270	1070
Fertilizer application using spreader	300	300	600	600	300	300	600
Weed control[5]	1500	1500	1500	1500	1500	1500	1500
Herbicide[6]	1273	1273	525	525	1273	1273	525
Mechanized herbicide application[7]	400	400	200	200	400	400	200
Harvesting	1750	1750	1750	1750	1750	1750	1750
Seed cleaning[8]	80	140	659	500	319	753	197
Sub-total variable cost	5573	5633	6304	6145	5812	6246	5842
Total cost[9]	12073	12133	10904	10745	12712	13146	10442
Net revenue (Gross Margin)	-3694	2567	37644	23605	-1337	13754	4106
Net revenue as percent of total cost	-30.6%	21.2%	345.2%	219.7%	-10.5%	104.6%	39.3%
Straw value as percent of total income	0	0	18.6%	19.9%	0%	0	18.6%

1 Assuming seed yield of 987 kg (farmers' yield at Hassakeh during 2000/01) and corresponding straw yield at ICARDA

2 Estimate is based on official price charged by the Syrian General Organization for Seed Multiplication (GOSM)

3 Costs of mechanical ploughing (primary tillage), harrowing and seed drilling

4 30kg Super phosphate @ SYP9/kg (vetch, lentil and barley) and 100 kg nitrogen @ SYP 8/kg (barley)

5 Mechanical inter-row cultivation supplemented by hand pulling. These do not include costs of chemical control in lentil

6 Vetch and Lentil (1kg/ha Bladex @ SYP518/l for pre-emergence + 1l/ha Focus Ultra @ SYP755/l) for post-emergence; Barley (1.5 l/ha Duplozan @ SYP525/l)

7 Cost of tractor-mounted sprayer per passage = SYP200 per ha

8 Air-screen and indented cylinder cleaning for all @ SYP 0.2/kg and gravity separation @ SYP 0.5/kg for lentil

9 Total cost does not include land and other activities carried out as research routine

3.1.3. Adoption and Use of Wheat and Faba Bean Seed by Farmers in El Sharkia, Egypt

This study analyzed the data of a survey conducted in 1995 by staff of the marketing department of the GTZ project on "Improvement and Decentralization of Governmental Seed Production and Marketing" (IDGSPM) in Egypt in collaboration with the Seed Unit. The survey had two main objectives:

- Identifying key factors that affect the adoption and use of certified seed of wheat and faba bean in the El Sharkia Governorate of Egypt.
- Analyzing and assembling useful information that could enable IDGSPM to formulate a marketing strategy for seeds of wheat, faba bean and other self-pollinating crops.

Data: A total of 156 households growing wheat and faba bean in the El Sharkia Governorate were interviewed in 1995 using a formal questionnaire. The farmers were classified into two categories on the basis of area cultivated: Category I (small farmers) with up to 1.26 hectares and Category II (large farmers) with over 1.26 hectares, according to logical separation between farm sizes in Egypt.

Analysis and Results: A preliminary review of the survey showed that the responses to many of the questions were not associated with seed sourcing behavior of the farmers. Cross tabulations were therefore made for key questions, which were considered relevant to seed marketing and to the study objectives. The results were straightforward for many of the key issues under investigation and therefore did not require further statistical treatment, particularly considering the relative small size of samples.

Table 3.5. Sample size by area category

Size category	Number of farmers	
	Wheat	**Faba bean**
I (Up to 1.26 hectares)	67	32
II (Above 1.26 hectares)	28	29

The results classified farmer behavior and most activities as scale neutral, since there were few notable differences in responses between small and large farmers. The following are some key results obtained:

Varieties grown by farmers: Sakha 69 was by far the most popular wheat variety, grown by over 80 percent of the farmers (Table 3.6), while for faba bean, the most popular varieties were G 1 and G 3, which were grown by the same proportion of farmers (Table 3.7). Very few farmers grew local varieties. The farmers claimed that the improved varieties grown were suitable for their various agro-ecologies.

Table 3.6 Wheat varieties grown by farmers

	Percentage of wheat farmers who grow this variety					
	Sakha 69	**Gamiza**	**G 163**	**G 155**	**Local**	**Not known**
All Wheat	82	4	11	1	1	1
I	82	5	12	2	0	0
III	82	4	7	0	4	4

Farmers' perception of improved varieties: For both wheat and faba bean, a high proportion of farmers have heard about improved varieties, tried them and continued to use the new varieties. As shown in Table 3.8, high yield was perceived as the main advantage for growing improved varieties. Next was better seed quality. Suitability for food preparation was also important for farmers especially for faba bean, implying a more domestic use of this crop as expected.

Table 3.7. Faba bean varieties grown by farmers

	Percentage of faba bean farmers who grow this variety				
	G1	**G3**	**G714**	**Local**	**Not known**
All Faba bean	39	41	5	8	7
I	31	44	9	7	9
II	48	38	0	10	3

Table 3.8. Advantages of using improved varieties

Attributes	Percentage of farmers who considered this attribute an advantage	
	Wheat (n = 91)	Faba bean (n = 55)
Grain yield	93	89
Grain quality	51	80
Straw quality	30	-
Food quality	42	71
Commercial features	21	49
Storage	21	31
Disease resistance	40	13
Pest resistance	1	2
Lodging tolerant	48	9
Shattering resistance	26	-

Sources of information for farmers: The results in Table 3.9 indicate that the extension service was by far the most popular means of disseminating technical information to farmers in this area of Egypt. Besides extension, TV was the next popular medium used by the farmers. Other means such as the radio, the neighbor, or other farmers played a less important part. Research, in particular, did not seem important for communicating information directly to the farmers.

Table 3.9. Means of transmitting information to farmers

Size	Percentage of farmers who claim they get information through this means							
Category	TV	Radio	Research	Extension	Neighbor	Relative	Farmers	Trader
All Wheat	51	14	6	91	29	15	22	1
All F/bean	56	28	2	93	41	23	46	2
I Wheat	49	12	-	93	30	19	22	-
II Wheat	54	18	-	89	25	4	21	-
I Faba bean	44	25	-	91	41	16	44	-
II Faba bean	69	31	-	97	42	31	48	-

Farmers' sources of seed: The cooperatives were the main source of wheat seed, while most farmers saved their own seed of faba bean (Table 3.10). The private sector was not involved in seed delivery for both crops, although the practice of seed purchase was well established, particularly for wheat. However, the price ratio of seed to grain of 2.69:1 was considered high. For farmers who saved their own seed, the most common practice was to set aside a part of the grain harvest and store it separately until the sowing season. Many farmers bought some seed each year, which they saved on their farms for an average of 2 -3 years before re-purchase of new seed.

Table 3.10. Sources of seed planted by farmers

Size	Percentage of farmers who obtained seed from this source			
Category	Company/Cooperative	Neighbor	Trader	Own-saved seed
All Wheat	63	0	0	36
All Faba bean	10	16	13	62
I Wheat	63	-	-	37
II Wheat	64	-	-	32
I Faba bean	10	-	-	63
II Faba bean	10	-	-	62

Conclusions: The results of this study show that agriculture is well developed in the Sharkia Governorate, despite its small farm sizes. There seems to be an effective extension service and farmers are aware of new varieties and modern technologies. The necessary inputs are generally available; the main constraint on the use of inputs such as fertilizer and pesticide is not lack of knowledge, but lack of cash to buy them. Mechanization is generally used and farmers are able to hire equipment if they do not own it.

The dominance of one variety of wheat is both interesting and worrying. Sharka 69 must be a very good variety with many desirable attributes to be so widely accepted. It would be interesting to probe the basis of its 'farmer appeal' in more detail. It also would be interesting to know its performance in trials before its release, for example were its merits obvious in trials from the outset, or did it's supremacy emerge in the hands of farmers? Also, have breeders made a serious effort to improve on it and with what success? The concern about such variety dominance arises from possible disease attack,

which could spread rapidly through a uniform population, although we must assume that its resistance genes are quite 'durable'. It is certainly clear that variety replacement may not be a significant reason for seed purchase.

The cooperatives were the main source of seed and the private sector is not involved, showing how the marketing arm of a government seed supply system could work well where it is supported by an effective extension service. Although such a situation could make private sector participation difficult, it nonetheless shows the importance of promotional activities in motivating farmers to adopt quality seed regardless of price considerations.

The issue of periodic replacement of farm-saved seed with seed from external sources was not clear from this study. More reliable information on this aspect could be obtained through a detailed tracing of stock on the farm during subsequent years. This is a difficult exercise to conduct and may require several years of careful monitoring. Similarly the results did not present a very clear picture on the use of credit.

To discover the role of credit, it is necessary to follow the trading activities of farmers over a period of time so as to clearly distinguish between what they express as their interest in credit, and their actual use of it.

Some inevitable shortcomings emerged when the survey results were analyzed. It would have been useful to know rather more about the grain market, particularly for wheat, since there is always a relationship between the price for grain and seed in this crop, which affects seed demand. Likewise, it would have been interesting to have some more large farmers in the sample. Since farmers were selected randomly, the composition of the sample reflected the size profile of farms, with a predominance of small farms.

A technical report based on the analysis and results of this study was prepared by the Seed Unit and submitted to IDGSPM, Cairo in September 1999.

3.1.3. Efficiency and Effectiveness of Seed Production and Marketing in WANA

This project was formulated against the background that countries in the West Asia and North Africa (WANA) region represent many different stages of seed sector development. Some still maintain strong public sector involve-

ment while others are undergoing restructuring and promoting the participation of private enterprises. There is a need in many of these countries to find alternative ways to deliver quality seed in a cost-effective way, particularly for small farmers who have limited access to formal sources of seed. Documented information is limited on these developments and countries need to share and learn from these diverse experiences. The aim of the project was to facilitate this process by obtaining information from a range of situations that are representative of changes taking place, and of the future direction of seed industry development in the region, as reflected in the range of countries that were selected.

The project was a collaborative effort between ICARDA and the national programs of Syria, Ethiopia, Yemen, Turkey, Egypt, Pakistan, Morocco and Jordan. To assist comparative analysis, the study methods used in the eight countries were similar. Qualified and experienced consultants were selected in each country and were given standard terms of reference to investigate issues relating to production and delivery. The studies involved a detailed review and assessment of present seed delivery systems, with particular emphasis on the flow of seed and varieties from the formal sector to small farmers.

Information collected formed a basis of detailed reports on the technical, economic and policy status of the seed industry in each country. Where restructuring was already in progress, an investigation was made on how the seed system could be modified to serve the needs of small farmers. The reports suggested options for making seed systems more cost effective and recommended policy changes aimed at improving the performance of the seed sector, particularly those components which have a bearing on the small farmers. A workshop for consultants and policy makers from different countries in the region is planned for 2002, during which the reports will be formally presented and discussed. The outcome of this workshop will form the basis of a synthesis publication comprising the eight country reports and an overview section. This will serve as a valuable reference and working document for technical and managerial staff in national seed programs, and policy makers in the region.

Results: By the end of 2001, the findings from the eight countries existed in draft reports, which contain up-to-date statistics and other useful data on

seed sector development. These reports will be finalized in 2002 and published as explained above. Key preliminary findings of these studies could be summarized as follows:

- The major constraints to agricultural development in all 8 countries are rural poverty and food insecurity, worsened by rapid population growth, particularly in the rural areas.
- Reorganization, liberalization and privatization are new policy initiatives that are being adopted widely, although the progress of these differs significantly between countries.
- New private seed enterprises are emerging particularly in Egypt, Morocco, Pakistan and Turkey, but these generally focus on high-value crops, particularly those with hybrids.
- Smallholders are the key source of food supply and they grow mainly less profitable low-margin crops, which are broadly neglected in national seed sector policies. There is a dilemma over which institutional arrangements should handle these crops, since both the private and public sectors tend to give a greater attention to more commercial crops.
- Compared with the food legumes and other self-pollinating cereals, the seed supply situation for wheat is much improved and supported by subsidies, probably because of the strategic importance of wheat as the leading staple food crop in all the 8 countries. Developing alternative enterprises for these are important technical and policy challenges.
- The studies recommend new institutional arrangements for smallholder seed supply in the changing policy environments of respective countries.

Conclusions: This project has made a significant contribution to efforts in developing appropriate seed systems in the WANA region. By placing emphasis on smallholder farmers, the project has addressed the important issue of poverty in the rural areas, where a majority of farmers depend on agriculture for their livelihoods and survival.

The results, analyses and findings contained in the country reports, when published, will serve as invaluable material for guiding technicians, managers and policy makers in organizing the seed sector of countries in the region. Furthermore, the same issues face many other countries outside the region such that these results would have much wider implications and impact.

3.2. Training

Training was a major part of the Unit's work in Economics of Seed Production. Details of the training programs are presented in Section 4 of this report. These included six follow-up courses in Economics of Seed Production held in Egypt and Ethiopia (1997), Morocco (1998), Sudan and Yemen (1999) and Algeria (2000), for a combined total number of 105 participants. An international workshop on Finance and Management of Small-Scale Seed Enterprises was held in Ethiopia for 49 participants in 1998.

Economics inputs were made to several other training courses at ICARDA Headquarters and in the region including annual seed production and processing courses; Pasture and Forage Seed Production Workshop in Ethiopia (1997); Women in Development course organized by the Natural Resource Management program for female participants from Egypt (1998); Seed Management Training for public and private sectors in Pakistan (2000), Seed Production and Marketing course in Turkey (2001), and Variety Management Course at ICARDA Headquarters (2001).

3.3. Consultancy

Informal consultancy guidance has been an important feature of training courses and other visits made to national programs throughout the region. Two consultancies (Egypt - Privatization and Turkey - Support mechanisms and institutional arrangements to make contract grower scheme commercially viable and attractive to small-scale farmers) were formal assignments, aiming at contributing technical expertise and providing guidance and direction to seed industry development. These are reported in Section 8.1. of this report.

Several visits were made to the southeastern Anatolia region during 2000 and 2001 to provide technical backstopping in data collection on costs of production and prices as baseline information for developing more appropriate alternative seed supply systems for small farmers cultivating self-pollinating cereals and grain legumes. This was carried out under the aegis of the ICARDA-GAP collaborative program.

4. SEED SECURITY

Both natural and man-made disasters can have devastating effects on agricultural systems and the environment. There is an increasing trend in such disasters (e.g., war or civil strife) worldwide and emergency assistance to regions affected by such stresses. Among natural disasters, drought is a threat in many dry areas of the world including some countries of the WANA region. During such disasters, farmers may be forced to deplete their meager seed stocks, resulting in the loss of well-adapted farmers' varieties, which could lead to erosion of valuable genetic diversity that is the building block for rehabilitation and restoration of agricultural systems.

'Seed security' is an important component of food security but relatively little information is available either on local practices or national strategies for emergency seed supply. A concerted effort is required to rehabilitate agriculture to a sustainable level to assist farmers affected by disasters. Such undertaking needs a partnership among the farmer communities, national governments, NGOs and international community.

4.1. USDA Seed Security Project

A pilot project on Seed Security Assessment in the Disaster Vulnerable Areas of the WANA region was implemented by ICARDA and funded by the Office of Foreign Disaster Assistance, Bureau for Humanitarian Response, Agency for International Development, USAID. From the mid of 1996, a case study was carried out and the report was finalized and accepted by donor in 1998.

The study was intended to include Eritrea, Ethiopia, Sudan and Yemen in the one hand and Afghanistan and Pakistan in the other hand in the WANA region. The original plan to cover Afghanistan was abandoned because the national consultant identified could not carry out the study due to security problems in the country. In the absence of a study in Afghanistan, the lessons learned from Pakistan have less relevance and the main focus is on the countries of the Nile Valley and Red Sea region.

The report covers the contribution of agriculture to the national economy and the extent of drought-prone areas in the countries under study. The national seed sector is reviewed in relation to crop research, variety development (release and registration), seed production and supply (quantity, pro-

cessing and storage facilities), seed quality control (seed certification), seed/grain trade (import-export) regulations and quarantine regulations. An attempt was made to provide lists of crop varieties, seed producers and available facilities; agencies responsible for seed quality control, seed/grain trade and quarantine; and NGOs involved in agricultural development and emergency seed supply. The role of government and NGOs was discussed focusing on the status of seed security for drought-prone areas. Moreover, the report also suggested possible future interventions and recommendations to strengthen seed supply in less favored and marginal areas prone to disasters.

Summaries of the findings were published in Seed Unit Annual Report 1996. The following measures were proposed to support a sustained seed security system in the countries studied:

(a) Develop a strong information system among WANA member countries on seed availability (crop, variety, source, etc).
(b) Conduct cooperative trials on varieties suitable for drier areas which are developed by IARCs, NARS and from other sources possibly coordinated by the IARCs.
(c) Keep a database of variety register by ICARDA including commercial and pedigree names of varieties used in the WANA region.
(d) Promote farmer-managed seed systems operating on a commercial basis serving localized farm community with a view for eventual transformation into formal small-scale seed enterprises.
(e) Maintain emphasis on local landraces in farmer-managed seed production and supply systems where improved varieties have not been developed.
(f) Develop or harmonize seed certification schemes by setting minimum field and seed standards to facilitate seed trade within the WANA region.
(g) Encourage more on-farm trials by NARS in drought-prone areas to gather more and better information on variety adaptation to farmers' conditions.
(h) Develop a mechanism for seed security in each country to overcome unpredictable shortage of seed on national or regional levels.

4.2. FAO Global Initiatives on Seed Security

ICARDA, being the Center which serves the most drought prone areas of the world, is expected to continue playing an important role both in crop genet-

ic resources and seed system development on a national, regional and global basis through its genetic resources and seed networks, which have very strong links to NARS and national seed systems. The Seed Unit also contributed to the global debate organized by the FAO in 1997 and 1998 in formulating strategies and policies in improving seed security within the wider context of achieving food security in most vulnerable environments.

Seed Security for Food Security: The workshop (December 1, 1997, Florence, Italy) was organized by Academia dei Georgofili in collaboration with FAO and was a 'brain storming' session to draw attention to emergency seed supply and develop a conceptual framework and strategy and recommendations on seed security worldwide. About 35 participants from Africa (6 countries), Asia (1), Oceania (1) and Europe (4) and international organizations (FAO, ICARDA) attended the workshop bringing together a large pool of experience on emergency seed supply.

The Seed Unit prepared and presented a paper on seed security from a regional perspective. The paper defined seed security and strategies that are required to ensure farmers' access to seed both in normal and disaster years. It reviewed policy and regulatory constraints of the formal seed sector that may hinder effective responses to emergency seed supply at national and regional level, drawing on the experiences of the WANA region.

The participants recognized that the issue of seed security exists both in normal and disaster situations and made the following specific recommendation: (a) seed security be recognized within the wider context of food security, (b) support given to community based practices to conserve crop genetic diversity and be integrated to national and regional seed security strategies, (c) involvement of the private sector in implementing national and regional seed security promoted, (d) the Seed Security Consultative Group (SSCG) established under the aegis of the FAO to provide policy and technical advice on the development and implementation of strategies to strengthen and maintain seed security for disaster prone countries; and (e) FAO to convene a follow-up meeting to address these issues.

Developing Institutional Agreements and Capacity to Assist Farmers in Disaster Situations to Restore Agricultural Systems and Seed Security Activities: This meeting (November 1998, Rome, Italy) was funded by the Government of Norway and organized by FAO as part of the Global Plan of Action 3 and a follow-up of the meeting in Florence and subsequent meet-

ings convened by FAO. The objectives of the workshop were to: (a) develop mechanisms which enable countries and their rural communities to identify, acquire, multiply and deliver seed of locally adapted varieties before, during and after disasters; and (b) determine mechanisms of collaboration for a continuing partnership between governments and institutions involved in the maintenance or restoration of agricultural systems in case of disasters.

The workshop was attended by over 50 experts representing Africa (15 countries), Asia (3), Caribbean and Latin America (2), Oceania (1), Europe (5), CGIAR centers (5 including ICARDA), UN specialized agencies (FAO, WFP), NGOs (World Vision, CRS, ICRC), regional organizations (APSA, SADC), development institutions, Universities and the donor community. The Seed Unit was invited to attend and contribute to the dialogue.

The presentations were structured to focus on three main themes on disasters: (a) prevention/preparedness (pre-disaster), (b) mitigation (during disaster), (c) and rehabilitation and recovery (post-disaster). Several issues were covered from characterizing disasters to country case studies (Afghanistan, Angola, Bosnia Herzegovina) and past experiences in disaster relief operation (Seed of Hope in Rwanda). Moreover, an in-depth analysis was made of issues related to plant genetic resources, farmer seed systems, seed regulation and seed stocks and multiplication during emergencies; and how emergency food and seed relief can be linked to rehabilitation and development.

The meeting identified that past international support to seed system recovery have sometimes been inconsistent and recommend specific actions to facilitate emergency situations taking into consideration the comparative advantages of various stakeholders to ensure seed security. The meeting made key recommendations as follows: (a) FAO explore options for the establishment of Seed Security Consultative Group under the aegis of FAO, (b) inventories of CGR be gathered and consolidated and stocks securely conserved, (c) explore methodologies for effective seed security needs assessment, (d) FAO explore the possibility to establish a mechanism that will encourage and coordinate regional harmonization of rules and regulations.

5. RESEARCH

Many of the Unit's activities have a significant research dimension including those activities already presented in Section 3 under Economics of Seed Production. The research activities discussed in this section are related to seed science and technology, and were largely postgraduate research projects that were partly supervised by the Unit.

5.1. Study on Wheat and Barley Seed Supply Systems

A national seed system is composed of formal and informal supply channels. At present a great amount of information is available on formal seed supply systems whereas there is little information on the informal seed systems. A study in Ethiopia (wheat) and Syria (barley and wheat) were initiated to get a better understanding of how informal seed systems operate at local level. Surveys have been conducted in both countries with objectives to assess: (a) farmers' perception, adoption and diffusion of modern varieties; (b) diversity of farmers' varieties; (c) quality of seed used by farmers; (d) farmers' seed sources and management practices; (e) distribution of seed-borne diseases and pests; and (f) constraints of adoption.

The survey and analysis of questionnaires is combined with an assessment of seed quality in the laboratory and subsequent field experiments. The questionnaires will be analyzed to study farmers' source of seed, management practices and their perception about modern varieties and seeds. The samples collected during the survey were tested for physical, physiological and health quality based on ISTA rules. A selected number of samples were identified and planted for each crop in designed field experiments with authentic or certified seed samples as controls to study the diversity of varieties collected.

Wheat Seed Supply System in Ethiopia: Four major wheat growing zones (regions) in Ethiopia (Arssi, West Shoa, North Shoa and East Gojam) were selected for the survey. A stratified sampling procedure was followed i.e. from higher to the lowest administrative level, farmers being the sampling units. In June-July 1997 a total of 300 farmers were interviewed distributed

in proportion to the area of wheat coverage in selected districts within each zone. All samples are tested for seed quality including seed health. The field experiments were planted in 1998 and 1999. The questionnaire, laboratory tests and field experiments are analyzed for final write up.

Barley and Wheat Seed Supply System in Syria: Three major barley and wheat production provinces (Aleppo, Raqqa and Hassakeh) were selected for the survey. A total of 200 farmers each for wheat and barley were interviewed each distributed in proportion to the area of barley and wheat in selected districts within each province in October-November 1997 and November-December 1998, respectively. All samples were tested for seed quality including seed health. The field experiments were also planted in 1997, 1999 and 2000. The questionnaire, laboratory tests and field experiments are analyzed for final write up.

5.2. Mechanical Damage and Seed Quality in Durum and Bread Wheat

The aim of this study was to investigate the reasons for low germination reported for some durum wheat varieties in Algeria, Morocco and Syria. Two durum (Acsad-65 and Cham-1) and two bread wheat (Mexipack and Cham-4) varieties were used in this study. The effect of three treatments (moisture content, variety, and speed of the threshing drum) on percentage of broken seeds and percentage germination were studied. A Heage 140-combine harvester was used for threshing at three drum speeds (880, 1200 and 1400 RPM) with a fixed concave clearance.

As measured by increased percentage of broken grains and decreased germination percentage, significant differences in susceptibility to mechanical damage were revealed in bread and durum wheat genotypes using 3 threshing drum speeds and a control. There was a significant variety effect, drum speed effect and moisture content effect. Several interactions were also found to be significant.

The percentage of broken grains increased significantly, while the germination percentage decreased at increasing drum speeds (Table 5.1). In fact, for the durum wheat variety Acsad-65, the germination percentages of samples threshed at 1200 RPM drum speed - the drum speed recommended by the combine manufacturer for wheat - were below 85%. This is alarming,

because the compulsory seed certification standards for wheat seed production in all 21 member countries of West Asia and North Africa (WANA) seed network prescribes a minimum germination percentage of 85 for seed to be marketed.

Table 5.1. Differences in germination percentage of two durum and two bread wheat varieties

Season	Crops varieties	Drum speed of combine harvester				Mean
		Hand	800 RPM	1200 RPM	1400 RPM	
1997/98	Mexipak (bread)	93.1	89.9	85.3	81.3	87.4
	Cham-4 (bread)	97.1	89.2	86.3	79.7	88.1
	Cham-1 (durum)	96.4	89.3	82.0	78.2	86.5
	Acsad-65 (durum)	96.1	83.0	72.9	59.3	77.8
	Mean	**95.7**	**87.9**	**81.6**	**74.6**	**85.0**
1998/99	Mexipak (bread)	98.0	97.0	92.8	89.2	94.3
	Cham-4 (bread)	98.8	96.7	92.7	87.3	93.9
	Cham-1 (durum)	99.0	98.2	89.4	85.3	93.0
	Acsad-65 (durum)	98.1	95.1	74.8	71.1	84.8
	Mean	**98.5**	**96.8**	**87.4**	**83.2**	**91.5**

5.3. Electrical Conductivity of Lentil Seed Leachates Using a Single Seed Analyzer

Seed lots of three promising lentil (*Lens culinaris* Medikus) lines harvested in 1993 and stored at ambient condition for 3 years were aged (40±0.5°C and +/- 100% RH for 3 or 5 days) and then soaked in de-ionized water for 3 or 5 hrs at 20°C before electrical conductivity - using a G-2000 Single seed Analyzer - was assessed. It was clear that electrolytes leakage was greater in seeds with low (7.8%) seed moisture and sharply increased with aging. The distribution of conductivity readings from individual seeds in all lines showed that low quality seeds tended to have higher conductivity values as aging increased.

Because of significant correlation between predicted and actual standard germination (r=0.92), the conductivity readings of 180 µS/cm was considered an acceptable separation between high and low quality seeds, despite the difficulties in identifying an absolute boundary.

5.4. Effect of Accelerated Aging on Germination and Vigor of Lentil (*Lens culinaris* Medikus) Seed

Three lentil varieties namely, ILL 5883, ILL 7012 and Precoz harvested in 1993 and stored for three years were aged (40±0.5°C; 100% RH) for 1, 2, 3, 4 and 5 days. Standard germination, speed of germination, coefficient of velocity of germination, seedling dry weight and vigor index were evaluated.

Increased aging led to a marked decline in germination in all three varieties. Precoz showed the most drastic reduction; its viability dropped to 29% when subjected to 2-days aging and to 0% after 5-days aging. The germination after 5-days aging was 4 in ILL 5883 and 0% in ILL 7012. The results of aging on speed of germination followed approximately the same trend as that of standard germination. Coefficients of velocity of germination were not consistent.

Aged seeds showed slower rate of seedling growth. After 4-days aging seedling dry weight of ILL 7012 and Precoz was 0 mg/seedling, whereas ILL 5883 recorded a value of 11.2 mg/seedling. Although the vigor index was higher prior to aging treatments in Precoz followed by ILL 5883, aging for 1-day causes a rapid decline in the vigor index in ILL 7012 (from 1440 to 487), whereas aging for 2-days causes the vigor index of Precoz to drop from 1279 to 278. Among the three cultivars, the highest value after 4-days aging was exhibited by ILL 5883 (242) while ILL 7012 and Precoz recorded zero value.

In summary: Among the three varieties, ILL 5883 and Precoz retained their viability higher after one-day aging. ILL 5883 seems to be the most tolerant variety to aging conditions and always superior compared to the others. Aging treatments for 4 to 5-days severely stressed the seeds and led to a complete death of seeds in ILL 7012 and Precoz. In general, prolonged aging causes a steady reduction in seed vigor and viability in three varieties.

5.5. Study on Potential Use of Native Grasses

The Seed Unit works closely with Arabian Peninsula Regional Program since 1998. There is a great interest in native forage species, which are adapted to periodic drought and low fertile soils.

Seed production and seedling establishment is a critical factor in the domestication of these species. Seed shattering is a main problem, resulting in low seed yield. Cleaning the seed is necessary to obtain adequate seed quality, but unfortunately, seed of most species of tropical pasture grasses have a reputation to be very difficult to clean. The purpose of the research is to:

1. Study germination behaviour of the seed harvested at different times to assess the optimum harvesting time and to ensure maximum germination potential.
2. Assess dormancy and investigate methods to overcome dormancy.
3. Determine the most appropriate techniques for threshing and cleaning seed and to identify appropriate equipment.

Material was collected in United Arabic Emirates (UAE) during early 1998 and samples were:

1. Cleaned at T. Hadya to identify appropriate cleaning procedures.
2. Tested in the seed laboratory at T. Hadya to study germination and dormancy.

The remaining seed were threshed and cleaned at Dhaid Research Station in the UAE.

A number of potential species of grasses and shrubs were identified in the Arabian Peninsula in terms of their feeding value for livestock. Of these species, the only one, which is domesticated widely - in Australia and South America - was *Cenchrus ciliaris* (Buffel grass).

Threshing: Two different threshers have been investigated, i.e. the Scarifier-Kamas Westrup and Kimseed thresher. Threshing behavior is described in Table 5.2. Some species were difficult to thresh because of strong attachment of palea and lemma to the caryopsis e.g. *Stipagrostis*, *Lasuirus* and *Cenchrus*.

Cleaning: After threshing the material was cleaned and the results of the cleaning of 6 grasses and 3 shrubs are presented in Table 5.3. It is clear that the recovery percentages of clean seed are very low for some of the grasses and shrubs.

Germination tests: Only *Cenchrus ciliaris* appears in ISTA rules for seed testing. For the other species, test conditions had to be investigated (Table

5.4). Germination results indicated that germination increased when the sample was harvested later (Table 5.5). The low germination in Cenchrus ciliaris is due to dormancy.

Dormancy breaking treatment: seeds may fail to germinate due dormancy, which occurs in many tropical and sub-tropical pasture grasses. The degree of dormancy can vary from year to year, from seed lot to seed lot and between seeds within the same seed lot. Dormancy can be overcome by exposing seed to certain conditions including temperature changes, light, washing, chemicals, scarification and exposure to high oxygen levels. An experiment was carried out to assess the effectiveness of two different chemicals to break the dormancy. The results (Table 5.7) indicated that among the different treatments, gibberelic acid is the most effective treatment to break the dormancy.

Conclusion: Based on these results the Kimseed thresher and the Kamas air-screen cleaner are appropriate for threshing and cleaning the seed of these species. Late harvest results in better germination percentages as compared with early harvests and giberellic acic can be used to break dormancy.

Table 5.2. Observation on threshing and cleaning using Kimseed tresher scarifier, fractionating aspirator and air-screen cleaner

Species	Cleaning Status
Grasses	
Cenchrus ciliaris	Difficult to thresh, but Kimseed thresher in 2001gave good results
Coelachyrum piercei	Easy to thresh
Lasuirus sindicus	Difficult to thresh, Kimseed thresher in 2001 gave excellent results
Panicum turgidum	Easy to thresh by Kimseed, empty floret, wide range of maturity, shed when ripe
Dichanthium foveolatum	Very easy, seed shatters and collects in bottom of bags, no threshing required
Pennisetum divisum	Easy to thresh
Stipagrostis plumosa	Very difficult, very few seeds and large hairy appendages
Shrubs	
Calligonum comosum	Very difficult, seed is a complete fruit
Dipterygium glaucum	Very difficult, hard seed coat, wide range of maturity
Rhanterium eppaposum	Moderate

Table 5.3. Cleaning results of 6 grasses and 3 shrubs

Species	Weight before threshing	Clean seed after cleaning	Recovery percentage
Dichanthium	155	6	3.9
Coelachyrum	165	12	7.3
Panicum	171	57	33.3
Cenchrus	52	17	32.7
Lasuirus	163	16	9.8
Pennisetum	89	17	19.1
Calligonum	64	39	60.9
Rhanterium	139	2	1.4

Table 5.4. Incubation period for the germination test of different species

Species	Incubation period (days) at 20/30°C (16h dark /8h light)
Grasses	
Cenchrus ciliaris	28 (according ISTA rules)
Coelachyrum piercei	44 (high percent of immature seeds), the mature seeds easy to germinate
Lasuirus sindicus	19 (easy to germinate)
Panicum turgidum	44 (high percent of immature seeds), the mature seeds easy to germinate
Dichanthium foveolatum	30 (easy to germinate)
Pennisetum divisum	10 (easy to germinate)
Stipagrostis plumosa	44 (very difficult to germinate, seeds are very small)
Shrubs	
Calligonum comosum	44 (mature seeds easy to germinate)
Dipterygium glaucum	very difficult to get the seeds, 33 days (1999)
Rhanterium eppaposum	26 (easy to germinate)

Table 5.5a. Germination percentage of different species in 1998

Species	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Grasses							
Cenchrus ciliaris	90	92	95	95	85	91	92
Coelachyrum piercei	26	37	41	28	15	74	6
Panicum turgidum	21	24	5	0	0	1	15
Pennisetum divisum	85	81	63	42	63	43	91
Stipagrostis plumosa	5	11	NS	3	37	13	NS

Table 5.5b. Average germination (%)

Species	1998	1999	2000
Grasses			
Cenchrus ciliaris (UAE-Oman)	91	97	41
Cenchrus ciliaris (Australia-Oman)			74
Coelachyrum piercei	32	17	44
Panicum turgidum	9	89	
Pennisetum divisum	67	70	
Stipagrostis plumosa	14	30	
Lasuirus sindicus		43	
Dichanthium foveolatum		48	
Shrubs			
Dipterygium glaucum		7	
Rhanterium eppaposum		76	
Calligonum comosum		9	

Table 5.6. Evaluation of some dormancy breaking treatments in 1999 (%)

Species	Germ (20°C)	Germ (20/30°C)	GA3 (0.05%) (20°C)	GA3 (0.05%) (20/30°C)	KNO3 (0.2%) (20°C)	KNO3 (0.2%) (20/30°C)
Lasuirus sindicus	52	58	70	62	52	47
Rhanterium eppa-posum	56	63	99	95	38	62

	Germ (20/30°C)	Sodium hypochlorite (20/30°C)	GA3 (20/30°C)	Prechilling (7d) (20/30°C)	Dry preheating (4d) (20°C)
Dichanthium foveolatum	40	63	63	40	10

5.6. Seed Size, Temperature and Water Potential Effects on Germination and Seedling Growth of Wheat

In Jordan, durum wheat is the most widely grown wheat species mainly under dry land conditions. The dry land areas are characterized by a high year-to-year variation in precipitation and temperature. Thus, durum wheat is grown in a high-risk area, and reduction in yield and crop failure are fre-

quent due to fluctuations in climatic conditions. Under rainfed conditions of arid and semi-arid regions, variable temperature and low moisture are often limiting factors during germination. There was no report on the combined effects of seed size, temperature and water stress on germination and seedling growth of durum wheat. Therefore, the study was designed to determine the effects of seed size, temperature, water potential and their interactions on seed water uptake, germination and seedling growth of two durum wheat genotypes under laboratory and green house conditions.

Seed water uptake was measured in two seed size classes (large and small) of the two wheat genotypes in growth chambers at temperatures of 5, 10 and 20°C. Rate of water uptake increased with increasing temperature and decreasing seed size. The rate of water uptake by the seed of both genotypes was not significantly different.

Accumulative germination percentage of various seed size lots of two wheat genotypes germinated in distilled water at temperatures 5,10,15, 20 and 30°C was determined. Germination started after 7, 4, 3 and 2 days for 10,15,20 and 30°C, respectively, but no germination was noticed at 5°C for one month from planting. Accumulative germination percentage for large seeds was significantly higher than that for small seeds. At 10°C the accumulative germination percentage was significantly higher for F8 than Hourani 27, with no significant differences between the two genotypes at 15°C, but at 20 and 30°C, the accumulative germination percentage tended to be significantly higher for Hourani 27.

In a growth chamber germination test using mannitol, germination percentage and shoot and root dry weights significantly decreased with decreasing water potential and seed size. Hourani 27 gave significantly higher germination percentage and shoot and root dry weights compared to F8. Large seeds gave significantly higher seminal root number than small seeds regardless of water potential. Seminal root number tended to decrease significantly with decreasing water potential and higher for Hourani 27 than for F8.

In greenhouse experiment, germination percentage, root and shoot dry weights were significantly decreased with decreasing seed size and water potential (Table 5.7). Hourani 27 produced significantly larger shoot and root dry weights with higher percentage of germination compared to F8.

Table 5.7. Effect of water potential, genotype and seed size on germination, root and shoot dry weights of wheat under green house condition

Treatment	Germination (%)	Root dry weight g plant^{-1}	Shoot dry weight g plant^{-1}
Water potential (kPa)			
-30	76.0a	0.163a	0.20a
-100	68.0b	0.149b	0.17b
-300	66.6b	0.146b	0.17b
-600	59.3c	0.139c	0.15b
-900	46.0d	0.122d	0.14b
Genotype			
Hourani 27	66.13a	0.152a	0.18a
F8	60.26b	0.136b	0.15b
Seed size			
Large	78.0a	0.166a	0.20a
Medium	61,2b	0.145b	0.16b
Small	50.4c	0.122c	0.14b

NB: means within the column for each treatment followed by different letters are significantly different at p# 0.05 according to Duncan Multiple Range Test.

The study concluded that early moisture and temperature stresses resulted in poor germination and seriously affected subsequent seedling establishment. Moreover, germination and early seedling growth were also affected by seed size. Therefore appropriate planting date and use of large uniform seed size is recommended to ensure good and uniform stand establishment. The study also found varietal differences in response to water and temperature stress in all traits studied, where the local landrace Hourani-27 was performed better than the improved variety F8 and thus widely grown by farmers in Jordan.

5.7. Studies on the Hardseedeness in Annual Medicago Species

The Mediterranean region contains many legumes with agricultural potential as self-regenerating pasture species, which are grown in rotation with cereals both in the region and elsewhere. Viable seeds that do not imbibe water and thus fail to germinate in an apparently favorable environment are commonly termed impermeable or hard seeds. The occurrence of hard seeds is a very common phenomenon among the majority of legumes including annu-

al medics where impermeable seed coat (exogenous dormancy) prevents water uptake essential for germination. Hard seeds become permeable to water only if the seed coat is abraded in some way. The objectives of the study were to: (a) assess the effectiveness of dormancy breaking treatments on seed characteristics (germination, germination rate and viability), (b) determine the variation in response to dormancy breaking treatments between genotypes and between seeds of different storage period, and (c) assess the effect of different dormancy breaking treatments on plant traits in the field.

The effect of various mechanical, chemical and physical treatments on softening the hard seeds of some freshly harvested and three-years post harvest *Medicago rigidula* and *Medicago rotata* was studied. Statistically highly significant differences ($p<0.05$) between the controls and the experimental samples were obtained in the treatments of the two *Medicago* species. Hand scarification with emery paper and soaking the seeds in sulfuric acid solution were more effective in increasing seed permeability and germination than exposure to dry heat treatment. The maximum germination was obtained by scratching the seeds of *M. rigidula* with coarse abrasive emery paper for 5 minutes. The germination was 96.25% compared to 8.60% with untreated seeds.

Differences in response between species were quite pronounced. Freshly harvested seeds were generally less responsive to seed softening treatments than three-years post harvest seeds. The interaction between time of dormancy breaking treatments and medic species was highly significant, which indicates that the optimum time for any treatment varies among *Medicago* spp.

Dormancy breaking treatments used on the two *Medicago* spp.do not produce any visible abnormalities in the resulting field plants. All treated samples commenced earlier emergence, flowering and maturation than untreated samples (Table 5.8). The greatest increase in number of seedling emerged was obtained with the three treatments used. These treatments were also superior in increasing fresh weight, leaf area and the yield of the two Medicago spp.

Table 5.8. Influence of seed dormancy breaking treatments on seedling establishment, plant growth and yield of Medicago sp.

Treatments	Days to 1st emergence	Plant Density m^{-1}	Days to 1st flowering	Days to 50% mature pods	Number of seeds pod^{-1}	1000 seed weight (g)	Pod yield kg ha^{-1}	Straw yield kg ha^{-1}
***M. rigidul*a**								
Control	21.25	121.88	85.75	142	6.3	5.2	8.01	7.68
Coarse abrasive scarification (5 minutes)	15.25	1348.75	81.75	132.75	6.33	5.22	29.29	27.38
Soaking in con. H_2SO_4 (30 minutes)	16	1180	82.25	133.25	6.48	5.22	27.49	25.05
Exposure to dry heat of 100°C (12 minutes)	16.25	805	83	133.5	6.53	5.22	24.8	21.45
M. rotata								
Control	24.25	83.13	87	139	4.3	5.82	7.48	3.65
Coarse abrasive scarification (8 minutes)	17.75	990.63	84.75	132	4.23	5.84	27.25	23.41
Soaking in con. H_2SO_4 (50 minutes)	17	1323.13	83.25	131	4.38	5.85	35.3	26.76
Exposure to dry heat of 100°C (16 minutes)	17.75	503.75	84	132.25	4.43	5.85	25.68	16.39
LSD	1.2	63.26	1.77	1.35	0.46	0.03	4.08	1.76

5.8. Effect of Seed Treatment on Wheat

In Jordan, 70% of the total cultivated area is planted with field crops. Wheat is the most important field crop used as staple food in Jordan. In 1995, the total wheat area was 51,232 ha with a production of 58,457 tons occupying 34% of the area devoted to field crops. The average yield ranged from 600-700 kg/ha, which is considered low to the world average of 2,570 kg/ha. The low yield is due to several factors including infection by diseases.

Common bunt caused by *Tilletia caries* is potentially one of the most destructive diseases of wheat. In recent years several systemic fungicides had been evaluated as seed treatments to control common bunt in wheat. However, there is limited information on fungicides available for seed treat-

ment in Jordan. The study was conducted at Maru Agricultural Research Station in north Jordan during 1995/96 growing season. The objective was to investigate the effect of fungicide seed treatment with different concentrations on germination and establishment of wheat 'Hourani 27' free of infection or infected with covered smut. Three types of fungicides each at two concentrations were used: Benomyl (0, 0.1,0.2g/100g seeds), Moncothane and Seed Guard (0, 0.2, 0.4g/100g seeds).

It was found that seeds treated with Benomyl (0.1 and 0.2g/100g seed) and Mancothane and Seed Guard (0.2. and 0.4 g/100g seed) increased total number of fertile tillers, number of kernels per spike, 1000 kernel weights and grain yield, and decreased number of spores per gram of seed significantly compared to infected untreated seed (Table 5.9). Seed treated with Benomyl (0.2g/100g seeds) and Mancothane and Seed Guard (0.4g/100g seeds) caused reduction in plant height. Therefore, all three fungicides can be used for control of covered smut infection of wheat.

Table 5.9. Effect of seed treatment on plant growth and yield of wheat

Type of seed	Seed treatment	Plant height (cm)	Fertile tillers plant^{-1}	No. of kernel spike^{-1}	Grain yield (kg/ha^{-1})	1000 seed weight (g)	No. of spores g^{-1} seed
Non-infected	Control	106	3.13	42.33	32.21	30.65	-
	A	106	3.19	37.43	32.76	32.86	-
	B	97	3.92	39.52	31.75	34.67	-
Infected	Control	95	2.23	10.67	10.93	20.85	146.58
	A	102	3.14	36.58	31.03	34.34	2.34
	B	95	3.13	38.39	30.11	32.87	1.43
LSD (0.05)		5.83	0.55	6.9	13.5	4.29	0.9

NB: A= Benomyal was used at 0.1, seed guard at 0.2 and Mancothane at 0.2g/100 g of seed; B= Benomyal was used at 0.2, Seed guard at 0.4 and Mancothane at 0.4g/100 g of seed

5.9. Survey of Lentil Seed Quality in Jordan

Lentil is an important legume crop in Jordan. However, the area planted to lentil decreased from 21,564 ha in 1974 to only 4,313 ha in 1995. A ten-year (1985-1995) average production was 3,153 tons with the yield of 790 kg/ha. The reduction in the area was due to high production costs, low yields and labor costs for harvesting where large quantity of lentil is imported. In 1995, for example 2380 tons was imported at the cost of 1.3 million Jordanian

Dinars. A number of lentil varieties adapted to local condition and suitable for mechanical harvesting have been released in collaborative research between ICARDA and Jordan. The availability of improved varieties and quality seed is expected to increase lentil production. However, there is little information available on the lentil seed system in Jordan. The objective of the survey was to study: (a) seed sources and quality of lentil seed used by farmers, (b) assess farmer's opinion of modern varieties and certified seed, and (c) identify seed quality problems experienced by farmers.

The study consisted of two main parts, a formal survey of lentil growers and laboratory analysis of seed samples collected from farmers. The study covered 100 lentil farmers representing lentil growers in northern (53%), central (23%) and southern (24%) regions of Jordan. The results indicated that the majority of lentil farmers in Jordan are still using traditional cultural practices for lentil production including hand broadcasting, low fertilizer application, higher seed rate than recommended and manual labor for crop harvesting.

From farmers surveyed only 8% are using improved lentil varieties whereas 85% are still using local landraces (Table 5.10). The major source of seed is mainly from their own saved seed from previous season (85%) or seed from their neighbors (12%) or certified seed (3%). In southern Jordan all farmers use their own seed.

Table 5.10. Farmers' adoption of improved lentil varieties, seed sources and quality in Jordan (n=100)

A: Lentil varieties grown and agronomic practices

Varieties grown	%	Fertilizer use	%	Planting method	%
Improved variety	8	In-organic fertilizer	36.8	Drilling	19
Local landraces	89	Manure	5.2	Broadcasting	81
Unknown	3	Not apply	58		

B: Farmers' seed sources and seed quality

Seed source	%	Purity (%)	Germination (%)	Varietal purity (%)	100 Seed weight (g)
Certified	3	98.7	97.3	100	4.28
Own saved	85	93.9	93.7	94.6	4.3
Neighbors	12	90.1	94.1	95.2	3.7

The certified seed used is of high quality and has high purity (pure seed fraction exceeding 98%) and germination capacity (97.3%). On the other hand, farmers' seed has high inert matter, and contain seed of more than ten weed species. Farmers own seed is a source for spreading weeds into new lentil fields. It was found that farmers in south Jordan are more conscious for quality and clean their seed before planting. Farmers in other areas should be encouraged to follow these practices and on-farm seed cleaning should be introduced to improve the quality for farmers using retained seed.

The study found that the two major constraints that limit the use of certified seed by farmers are the unavailability of the seed at the right time and place and the high seed price, which farmers cannot afford to pay. Therefore, proper strategy should be designed to increase the availability of improved varieties and use of certified seed by farmers.

5.10. Diffusion and Adoption of Improved Vetch Varieties (Hungarian Vetch) in Ankara Province, Turkey

Farmers in the Central Highlands of Turkey including the Cubuk County traditionally produce common vetch (*Vicia sativa*) for grain and straw as animal feed. Common vetch is well adapted, but has low seed and straw yields and usually planted in spring due to low cold tolerance. Hungarian vetch (*V. pannonica*) is recently introduced and promoted by extension service because it has a reasonable cold tolerance and can be planted in winter. In 1986, livestock import was liberalized and vetch production started to decline whereas cereal production started to increase. Similarly, the vetch seed export market that existed in the area started to decline.

The study was conducted from 1996 to 1998 to understand the functioning of the informal vetch seed system in Çubuk district. The study investigated the influence of socio-economic factors, information behaviors and relations between farmers and extension staff on diffusion and adoption of improved vetch (especially Hungarian vetch) varieties. It also examined the historical background of the new technology and the extension approach used. The study consists of informal contacts and formal surveys of 50 farmers and 32 vetch seed merchants in Çubuk district.

Agricultural extension to promote the diffusion and adoption of Hungarian vetch started under the Corum-Cankiri Rural Development

Project and focused mostly in the villages of Çubuk County because of the importance of livestock production in the area. In the 1990s the Provincial Directorate of Agriculture started field trials and demonstrations to promote Hungarian vetch. The extension service provides seed of Hungarian vetch for the demonstrations and farmers are expected to harvest and save their seed for next year. But after the support of the project is terminated the production of Hungarian vetch decreased accordingly.

Education, income, farm size and income from agriculture were investigated as socio-economic factors influencing farmer's adoption behaviors and an important relationship was found between these factors and adoption of Hungarian vetch.

Early adopters of Hungarian vetch could be classified in two groups: (a) farmers with more than 20 ha who could stabilize their income from other crops and would risk trying Hungarian vetch and (b) farmers whose main source of income mostly depend on livestock and their products (>15 to 20 cattle and 30 to35 sheep). Farmers indicated that extension staff provides valuable information on production techniques of Hungarian vetch. It is expected that the extension activities will encourage the adoption and diffusion of Hungarian vetch in mountain villages.

Çubuk is the main marketing center for vetch seed where production from other counties and provinces are collected and channeled for export. A survey of seed merchants showed that 8 of the 32 merchants are permanent suppliers of vetch seed while others are temporary working both as farmers and merchants. More than 60% of merchants buy 900-12000 tons of seed per year. The seed marketing channel consists of farmers, merchants and export firms. Merchants buy seed from farmers locally and deliver it to firms located in Mersin who export the seed. In the past vetch seed export market was thriving and functioning very well, but from 1990 the export market started to decrease because of less demand from importing countries and declining local production.

During the survey seed samples collected from the merchants were assessed for seed quality. The purity and germination of the seed lots showed some variation, with an average of 80%. It appears that most of the farmers use seed cleaners before selling seeds to the merchants. On the other hand farmers save their own seed and sometimes in case of production failure or shortage buy seed from neighbors (74%) or merchants (26%).

In promoting Hungarian vetch farmers with larger areas were selected and the diffusion and adoption of the technology was found to be very successful in the plains. In the future more focus should be given to the small-scale farmers as well and should be extended to the mountain villages where farm sizes are smaller and farmers depend mostly on livestock production.

Demonstrations were used as an extension approach, but it is expensive and difficult to establish in the mountain villages. Extension staff should use alternative and cheaper methods such as field days, etc to reach more farmers in shortest period of time.

Farmers should be informed of the importance of Hungarian vetch not only as a fodder crop, but its use as a rotation crop for maintaining soil fertility. Therefore, research should focus on cereals-Hungarian vetch demonstrations instead of single Hungarian vetch demonstrations.

5.11. Barley Seed Supply Systems in Ethiopia

In Ethiopia barley is the most important crop in terms of area and production. It is widely grown throughout the country and used as staple food crop and for the brewing industry. According to national statistics a total of 825,450 ha was planted and 872, 532 tons of grain was harvested in 1995/96 with an average yield of 1.1 tons/ha. Several reasons have been cited for the low productivity among which lack of adaptable varieties and seed is a major constraint. The objectives of the survey were to: (a) study the barley seed supply systems, and (b) evaluate the quality of seed used by farmers.

A seed survey was conducted during the 1998 crop season in northwestern and southeastern parts of Ethiopia to study barley seed supply system. Four zones, Arsi and Bale from Oromiya region and North Gondar and South Gondar from Amhara region were covered and a total of 300 farmers were surveyed and seed samples collected from each farmer. The questionnaires were used to analyze the seed supply systems and laboratory tests were conducted to evaluate varietal and analytical purity, germination and thousand seed weight.

The area allocated to barley production and the seed and fertilizer rates used by farmers is given in Table 5.11. The mean barley area is 0.6 ha (range 0.1 to 3 ha) whereas the mean seed rate is 161 kg ha-1(range 80-320 kg ha-

1). About 51.8% of farmers in Amhara region and 11.7% from Oromiya region allocated less than 0.5 ha for barley production (compared to 36.4% for the whole sample) showing regional differences. Similarly farmers in Amhara region tend to use lower seed rates where a mere17.5% used over 200 kg ha-1 as compared to 56.5% in Oromiya region. About 80% (n=180) of farmers in Ormiya region used fertilizer whereas none applied fertilizer in Amhara region for barley production.

Table 5.11. Area allocation and seed and fertilizer rates used by barley growers in Ethiopia

	Amhara region (n=120)		Oromiya region (n=180)		Total (n=300)	
	Farmers	**%**	**Farmers**	**%**	**Farmers**	**%**
Area in ha						
X<0.25	24	20	2	1.1	26	8.7
0.25=<X<0.50	62	51.8	21	11.7	83	27.7
0.50=<X<0.75	25	20.7	83	46.1	108	36
0.75=<X<1	7	5.8	17	9.4	24	8
X=>1	2	1.7	57	31.7	59	19.6
Total	120	100	180	100	300	100
Seed rate in kg/ha						
X<100	10	8.3	3	1.7	13	4.3
100=<X<150	41	34.2	52	28.9	93	31
150=<X<200	48	40	25	13.9	73	24.4
200=<X<300	21	17.5	94	52.2	115	38.3
X=>300	-	-	6	4.3	6	2
Total	120	100	180	101	300	100
Fertilizer (DAP) in kg/ha						
None	120	100	36	20	156	52.0
X =50			18	10	18	6.0
50<X<100			11	6.2	11	3.7
X =100			99	55	99	33.0
100<X<200			8	4.4	8	2.7
X=>200			8	4.4	8	2.7
Total	120	100	180	100	300	100

Farmers grow large number of improved varieties (6) and local landraces (14) showing higher on-farm diversity of barley crop (Table 5.12). The Amhara region has higher proportion of local landraces compared to the Oromiya region. From the total number of farmers surveyed, 33.4% (n=300) grow improved varieties with highest percentage in Arsi zone (52.7%;

n=180) of Oromiya region, which is also associated with higher percentage of malt barley production and fertilizer use (80%). No improved variety was found in Amhara region except for an obsolete malt barley variety grown by few farmers (1.3%). Although 85% of farmers confirm of exchanging seed only few purchased seed off-farm in the survey year. Seed was largely supplied informally and most of the farmers used their own crop as seed (95%) or from neighbors (4%) and others (1%). No farmer purchased seed from the formal sector and of those who used own seed 85% of the farmers recycled their seed for over nine years. Farmers clean their seed (90%) and practice pest control (63%).

Table 5.12. Barley varieties grown by survey farmers in Ethiopia (n=300)

	Amhara region	Oromyia region	Total	%
Improved varieties				
Beka	-	43	43	14.3
Holker	-	22	22	7.3
ARDU 1260 B	-	20	20	6.7
HB-42	-	8	8	2.7
HB-120	-	2	2	0.7
Bira gebs	4	1	5	1.7
Sub-total	4	96	100	33.4
Local landraces				
Arusso	-	64	64	21.3
Belga	44	-	44	14.7
Magi	24	-	24	8
Tsebel	16	-	16	5.3
Tikur gebs	4	5	9	3
Nech gebs	6	2	8	2.7
Ahya Asin	7	-	7	2.3
Elef	-	7	7	2.3
Abat gebs	-	5	5	1.7
Awra gebs	4	-	4	1.3
Bulle gebs	4	-	4	1.3
Wodego	-	4	4	1.3
Gorenji	2	-	2	0.7
Felebeya	-	2	2	0.7
Sub-total	111	89	200	66.6
Total	115	185	300	100

Although most of the modern varieties had off-types when compared against national seed standards, 89% of the samples found to be reasonably pure and not considered as mixtures of different cultivars. The results showed low seed quality in terms of analytical purity and germination (Table 5.13). The major problem of analytical purity was the presence of large number of noxious weed seeds. Germination test results were also low, maybe due to the unusual rainfall during the 1998 harvest season, which have caused sprouting of grains. Local varieties proved to have higher thousand seed weight values than improved varieties.

Marked differences were observed in seed quality among the four zones (Table 5.13). Seed samples from North Gondar and South Gondar were lower in analytical purity than those of Arsi and Bale zones. On the other hand, germination was very low in Bale and high in South Gondar while North Gondar and Arsi were found to be intermediate. Comparisons between seed sources were less valid due to the large differences between sample sizes. Moreover, significant differences were revealed only in very few cases.

Table 5.13. Quality of barley seed used by farmers in Ethiopia (n=300)

Region	Number of farmers	Purity %	Purity % of samples with >95%	Germination %	Germination % of samples with >85%	1000 seed weight (g)
Amhara						
South Gonder	60	94.36a	58.3	58b	11.7	43.63c
North Gonder	60	93.68a	41.7	65c	25	41.67b
Oromiya						
Arsi	100	97.54b	94	62c	9	38.01a
Bale	80	97.68b	96.3	46a	0	40.33b

NB: Figures followed by different numbers within the same column are significantly different at the probability level of 0.05

The study concluded that availability of adaptable varieties and proper marketing strategy are deemed necessary for the formal seed sector. The informal system requires some support and should be strengthened. Introduction of appropriate technology in seed cleaning, treatment and storage are recommended to improve the quality of seed in the informal sector.

6. HUMAN RESOURCES DEVELOPMENT FOR THE SEED SECTOR

Training has been a major activity of the Seed Unit since its inception. During the reporting period, the Unit had a generous funding from the Government of the Netherlands to carry out a major training program. The purpose of the Unit's training program is to strengthen the capacity of national seed organizations in the region by providing training in different aspects of seed technology. The target group is 'managers, professionals and technicians of both public and private seed sectors (as well as seed growers, development workers and farmers of the WANA region).

The focus of the training has evolved to pay more attention to (a) economic and management issues and the emerging private sector, (b) the changes which are taking place in the area of seed quality control, (c) forage seed production, including native forage species that play a role in efficient water use and (d) seed technology issues such as seed processing, seed health testing and variety management and description.

A key feature is the 'Train-the-Trainers' approach, consisting of a 'primary' course - in a specific topic - held at ICARDA Headquarters - with participation from seed program staff from different countries in the region. These participants then organize secondary or 'follow-up' courses in their home country.

During the reporting period a large number of training participants were exposed to the Unit's human development activities. This was largely due to the success of the 'Train the Trainers' approach, which provides training to a large numbers of staff in NARS. A cumulative list of all training activities is presented in Table 6.1. In Table 6.2 the geographical origin and gender distribution of trainees has been analyzed, while in 6.3 the geographical origin of workshop participants is shown.

6.1. Train-the-Trainers Courses

The Unit has made use of the 'Train-the-Trainers' approach, because of its merits:

- Efficiency in terms of total numbers trained.
- Opportunity to design the training program to fit specific needs of participants.

- Opportunities to address problems in the trainees' working environment
- Opportunities to train technical staff at local level who could not attend regional/international courses
- Reduced transport and accommodation costs.
- Bringing together staff from different national organizations and promoting dialogue.
- Promoting an 'in-house' training culture in the host organizations.
- Emphasizing the importance of quality seed in the national media.

Limitations of the Train the Trainers approach:

- The lack of control on the selection of participants for the follow-up courses.
- The dependence on local facilities, which were sometimes limited.
- The difficulty of allocating time to 'training methodology' within the primary 'Train -the-Trainers' courses.

Primary Courses and Follow-up Courses: The courses organized within this framework are summarized in Table 6.4. At ICARDA Headquarters, two Train-the-Trainer courses were conducted. One in Seed Processing, with 19 participants from 11 countries and one in Seed Health Testing with 11 participants from 7 countries.

The programs for the follow-up courses are developed jointly with the host organization and the Seed Unit provides one resource person to participate in the course as instructor/adviser, as well as training materials. In all cases, a major part of the local costs are covered by the host organization.

Six follow-up courses were conducted (6 countries) on Economics of Seed Production (The initial Train-the-Trainers course for this topic had been organized in 1996). For Seed Processing and Seed Health Testing seven and three follow-up courses were organized in the region, respectively. The Train-the-Trainers program thus trained, during the reporting period, 30 'trainers', who trained 259 national staff.

6.2. Regular and In-country Courses

In addition to the Train-the-Trainers and follow-up courses, a number of other courses have been organized. These courses are always in response to specific requests from individual countries or organizations (Table 6.5). During the period 1997-2001, four courses were organized at the ICARDA

Table 6.1. Summary listing of all courses and workshops

Year	Category	Course/ workshop title		Location	Participants	
1997	Train-the-Trainers	Seed processing		ICARDA	19	
	Follow-up	Economics of seed production		Egypt	11	
		Economics of seed production		Ethiopia	32	
	Headquarters	General seed production		ICARDA	12	
	In-country	Seed quality control		Iran	19	
		Seed testing		Egypt	25	
	Workshop	Pasture and forage seed production		Ethiopia	21	
Sub-total 1997			7			**139**
1998	Train-the-Trainers	Seed health testing		ICARDA	11	
	Follow-up	Seed processing		Iran	13	
		Seed processing		Egypt	15	
		Seed processing		Morocco	18	
		Economics of seed production		Morocco	13	
	Headquarters	Variety description, maintenance and breeder seed production		ICARDA	12	
	In-country	Seed production and technology		Oman	16	
	Workshop	Finance and management of small-scale seed enterprises		Ethiopia	45	
Sub-total 1998			8			**143**
1999	Follow-up	Seed health testing		Syria	12	
		Seed processing		Yemen	6	
		Economics of seed production		Yemen	8	
		Seed processing		Iraq	23	
		Seed health testing		Iraq	18	
		Seed processing		Sudan	20	
		Economics of seed production		Sudan	17	
		Variety description and breeder seed production		Morocco	18	
	Workshop	Plant variety protection: current status and implications		Egypt	31	
Sub-total 1999			9			**153**
2000	Follow-up	Seed health testing		Egypt	20	
		Seed processing		Syria	9	
	Headquarters	Forage and pasture seed production		ICARDA	19	
	In-country	Variety description and maintenance		Algeria	10	
		Economics of seed production		Algeria	24	
		Management of seed industry		Pakistan	51	
	Workshop	Seed quality assurance		Jordan	13	
Sub-total 2000			7			**146**
2001	Headquarters	Variety Management and seed quality		ICARDA	13	
	In-country	Seed production and marketing		Turkey	27	
Sub-total 2001			2		38	
Total courses and workshops			**33**			**619**
Individual trainees						**25**
MSc students						**2**
Grand total						**646**

Headquarters for 56 participants, while 7 courses were conducted in the region training 166 participants.

The General Seed Production course held at Tel Hadya in 1997 was organized for 12 participants from Kyrgyzstan. It was the first course of its kind for participants from the Central Asia and Caucuses and fully paid by the Kyrgzstan national program. The Seed Production and Technology course conducted in Oman, was a sub-regional course for participants from the Arabian Peninsula.

Table 6.2. Geographical origin and gender of participants on training courses (1996 - 2000)

Country	Number of participants		
	Male	Female	Total
Algeria	28	14	42
Bahrain	2	0	2
Egypt	94	18	112
Ethiopia	35	4	39
Ghana	2	0	2
Iran	50	5	55
Iraq	39	8	47
Jordan	8	2	10
Kuwait	0	1	1
Kyrgyzstan	10	2	12
Lebanon	2	1	3
Libya	5	0	5
Mauritania	4	0	4
Morocco	51	3	54
Oman	6	2	8
Pakistan	53	0	53
Qatar	2	0	2
Saudi Arabia	2	0	2
Sudan	35	7	42
Syria	28	9	37
Tunisia	4	0	4
Turkey	5	1	6
Turkmenistan	1	0	1
United Arab Emirates	3	1	4
Yemen	22	0	22
Total	**490**	**78**	**568**
Percentage	**86**	**14**	**100**

Table 6.3. Geographical origin of participants in workshops and seminars (1996 - 2001)

Country	Number of participants	Country	Number of participants
Algeria	5	Lebanon	3
Bahrain	1	Malawi	1
Benin	1	Mauritania	1
Cyprus	3	Morocco	12
Egypt	18	Nigeria	1
Eritrea	1	Oman	2
Ethiopia	28	Pakistan	5
Ghana	2	Sudan	6
India	1	Syria	5
Iran	3	Tunisia	4
Iraq	5	Turkey	10
Jordan	12	Uganda	2
Kenya	1	Yemen	7
Libya	2	Zambia	3
Total			**145**

6.3. Training Seminars

Training seminars address topics of wider concern and are specifically designed for senior (seed) staff. Table 6.6 provides a summary of the seminars organized during the reporting period. Four training seminars have been organized, which addressed specific regional needs such as: (a) Pasture and Forage Seed Production, (b) Finance and Management of Small-scale Seed Enterprises, (c) Plant variety Protection and (d) Quality Assurance.

The Pasture Seed Production course was jointly organized with ICARDA's sister institution ILRI to bring in experience from Africa. Several participants from outside the region participated. The Plant Variety Protection workshop and the Quality Assurance workshops were conducted in collaboration UPOV and ISTA, respectively.

The training seminars reached more than 100 seed staff in the region and beyond.

Table 6.4. Courses conducted in the framework of the Train-the-Trainer program

Date	Title	Location	Participants	
Primary Train-the-Trainer Courses				
1997	Seed processing	ICARDA	19	
1998	Seed health testing	ICARDA	11	
				30
In-country Follow-up Courses				
1997	Economics of seed production	Egypt	11	
1997	Economics of seed production	Ethiopia	32	
1998	Economics of seed production	Morocco	13	
1999	Economics of seed production	Yemen	8	
1999	Economics of seed production	Sudan	17	
2000	Economics of seed production	Algeria	24	
				105
1998	Seed processing	Iran	13	
1998	Seed processing	Egypt	15	
1998	Seed processing	Morocco	18	
1999	Seed processing	Yemen	6	
1999	Seed processing	Sudan	20	
1999	Seed processing	Iraq	23	
2000	Seed processing	Syria	9	
				104
1999	Seed health testing	Syria	12	
1999	Seed health testing	Iraq	18	
2000	Seed health testing	Egypt	20	
				50
Total				**289**

Table 6.5. Regional and in-country courses

Date	Title	Location	Participants	
Courses at Headquarters				
1997	General seed production (for Kyrgyzstan)	ICARDA	12	
1998	Variety description, maintenance and breeder seed production	ICARDA	12	
2000	Forage seed production	ICARDA	19	
2001	Variety management and seed quality	ICARDA	13	
				56
In-Country Courses				
1997	Seed quality control	Iran	19	
1997	Seed testing	Egypt	25	
1998	Seed production and technology	Oman	16	
1999	Variety description and breeder seed production	Morocco	18	
2000	Variety description and maintenance	Algeria	10	
2000	Management of seed industry	Pakistan	51	
2001	Seed production and marketing	GAP-Turkey	27	**166**
Total				**222**

Table 6.6. Regional workshops

Date	Title	Location	Participants
1997	Pasture and forage seed production	Ethiopia	21
1998	Finance and management of small-scale seed enterprises	Ethiopia	45
1999	Plant variety protection: Current status and implications for the development of the seed industry in WANA.	Egypt	31
2000	Quality assurance in seed testing	Jordan	13
Total			**110**

Table 6.7 Individual customized training programs held at HQ

Year	Subject matter	Countries	Participants
1997	Seed health testing	Syria	1
	Morphological variety description	Iran	2
		Morocco	2
		Syria	1
1998	Seed technology	Mauritania	1
	Seed health testing	Syria	1
		Iran	1
1999	Data management	Syria	1
	Morphological variety description	Syria	1
	Variety maintenance	Syria	1
2000	Seed quality management	Yemen	2
	Seed quality management	Ethiopia	1
	Morphological variety description	Iraq	2
	Morphological variety description	Syria	1
	Seed processing	Ghana	1
	Seed health testing	Algeria	1
2001	General seed technology	Palestine	1
	Seed health testing	Syria	2
Total			**23**

6.4. Individual/Small Group Training

The Seed Unit has the facilities to accommodate individual training participants from the national programs in the region. National programs submit requests for short-term training in a variety of topics and during the reporting period, a total of 23 staff participated in this program (Table 6.7).

6.5 Training of Seed Unit Staff

In May 1999, the Unit's Seed Production Manager participated in a course in Quality Assurance at the International Agricultural Center (IAC), Wageningen, The Netherlands. The knowledge and skills acquired during this training were useful in organizing the Quality Assurance regional workshop (Amman, Jordan, October 2000), and other related training activities.

6.6. MSc Research

To carry out more research and to contribute to senior staff development in the region, the Seed Unit encourages B.Sc. holders to conduct their MSc research with the Seed Unit. During the period 1997 - 2001, MSc students studying at the University of Jordan (1) and the Aleppo University (1) were supervised and supported by the Seed Unit. Details of the research have been provided in Chapter 5 of this report.

6.7. Training Material Development

Two workshop proceedings and two training manuals have been prepared and published (Table 6.7). The manual Cereal Variety Identification for Syria has English and Arabic text.

Table 6.7. Training and training-related publications

Author	Title	Year
L. Grass and M. Turner (eds.)	Pasture and Forage Seed Production in Africa and West Asia, 204pp. (Proceedings of workshop)	1999
A.A.Niane, A.W. Madarati, A. Abbas and M.R. Turner	Manual of Morphological Variety Description for Wheat and Barley, 106pp.	1999
S.Kugbei, M.Turner and P.Witthaut (eds)	Finance and Management of Small-scale Seed Enterprises, 200pp. (Proceedings of workshop)	2000
L. Grass and B. Gregg	Manual on Seed Processing, 184pp.	2000
S. Kugbei	Seed Economics: commercial considerations for enterprise management in developing countries. 200pp.	2000

7. PRODUCTION AND DISTRIBUTION OF SEED

Improved varieties are major outputs of agricultural research, but quality seed is the means for transferring this output from the research institutions to farmers. The aim of the seed production activities of the Seed Unit is to maintain limited stocks of high quality seed of ICARDA related varieties, as well as of promising lines, that may be released in the future in one of the national programs.

7.1. Production and Distribution

Table 7.1 summarizes seed production activities at T. Hadya between 1997 and 2001. Total seed production ranged from 12.8 MT in the 1999/00 season to 37.2 MT in 1997/98. On average 45%, 32%, 12%, 7% and 4% of the amount of seed produced is wheat, barley, chickpea, lentil and vetch, respectively. Very small amounts of seed of astralagus (84 kg in 1998), lathyrus (40 kg each in 1997 and 1998), medicago (4 kg in 1998) and faba bean (80 kg in 2001) were produced.

Table 7.1 also indicates the number of varieties that were used to produce seed. The largest number was wheat followed by barley, lentil, chickpea and vetch. The sharp increase in the number of wheat varieties in 2001 was because of the Seed Unit's involvement in producing all the entries for the international nurseries for the bread wheat program.

Annually an average of 22 MT of seed (ranging from 10.5 MT in 2000 to 33.0 MT in 2001) is made available for four different purposes (Table 7.2): (a) distribution to ICARDA's NARS partners (40%), (b) ICARDA research (33%), (c) farmers participating in participatory breeding and variety evaluation (16%), and (d) for planting the next generation of seed multiplication (11%).

7.2. Seed Cleaning and Treating

A 1-ton/hour seed processing line is used primarily to clean seed produced by the Unit. In addition, the seed plant is used to clean and treat seed pro-

duced by other ICARDA programs. The total amount of seed cleaned by the seed processing center (table 7.3) ranged from 155 MT in 2000 to 304 MT in 2001, with an average of 218 MT per year. On average barley, wheat, chickpea, vetch and lentil constituted 22% (48 MT), 19%, (41 MT), 9% (20 MT), 9% (20 MT) and 31% (67 MT) of seed cleaned per year, respectively. Other crops cleaned include cumin, safflower, oat, lathyrus, medic and maize.

For the Germplasm Program, Natural Resources Management Program, Station Operations, annually 27 MT, 13 MT and 145 MT were cleaned, respectively.

The seed cleaning laboratory with a wide range of small cleaning machines provides cleaning services for ICARDA's commodity programs. During the reporting period approximately 10,000 seed samples were cleaned annually (Table 7.4); more than 3000 samples for the Genetic Resources Unit (34%) and more than 6000 samples for Germplasm Program (63%). The remaining samples were cleaned for the Natural Resources Management Program and the Seed Unit. Crop-wise annually, 53% of the samples cleaned were barley, 32% wheat, 8% lentil and 7% chickpea. Some forage species, cumin and oats samples were also cleaned.

7.3. Quality Control

Table 7.6 provides a summary of the different seed quality tests that have been carried out in the seed testing laboratory. The majority of these tests were carried out for research purposes and to monitor the production and storage of seed.

7.4. Seed Storage

The Seed Unit also manages the ICARDA central store. A summary of the number of samples and the total weight of the different seed lots is provided in Table 7.5.

7.5. Development of a Seed Production and Storage Database SEEDMAN

CBSU and the Unit have developed the first version of a seed data management system named SeedMan-2000. A database handles all seed production, processing, storage, distribution and quality control activities. It provides possibilities for storing and retrieving information, generating reports and making queries. The system holds all information from planting to dispatch of the seed, including all agricultural inputs used, areas planted, production, yield, lot number.

Table 7.1. Seed production (in kgs) at T. Hadya from 1996/97 - 1998/99

	1996/97					1997/98					1998/99				
	1	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**
Wheat	29	65	2335	4895	7295	35	200	6100	12655	18955	40	341	9000	5035	14376
Barley	7	125	6700	4100	10925	3	25	3000	8350	11375	11	159		2350	2509
Chickpea	5		1775	780	2555	4	550	3450	200	4200	6	16	1400	650	2066
Lentil	4		2050	500	2550	3	28	325	810	1163	4	6	400	600	1006
Vetch	5			750	750	4			1420	1420	5			830	830
Astragalus						7			84	84					
Lathyrus	1			40	40	1			40	40					
Medicago						2			4	4					
Total	51	190	12860	11065	**24115**	59	803	12875	23563	**37241**	66	522	10800	9465	**20787**

	1999/00					2000/01				
	1	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**
Wheat	49	94	720	1216	2030	166	110	10390	4035	14535
Barley	18	239	4750	3260	8249	10	25	3870	4003	7898
Chickpea	12		550	147	697	10	48	3745	2125	5918
Lentil	6	71	350	830	1251	4		1650	1695	3345
Vetch	6			544	544	5			1523	1523
Faba bean						4	80			80
Total	91	404	6370	5997	**12771**	199	263	19655	13381	**33299**

Production (1=Number of Varieties; 2=Breeder Seed; 3=Basic Seed; 4=Quality Seed)

Table 7.2. Seed distribution (in kgs) from 1996/97 - 1998/99

	1996/97					1997/98					1998/99				
	1	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**
Wheat	1990	2260	200	225	4675	11410	2525	100	225	14260	8080	2377	1250	630	12337
Barley	3600	3550	2100	325	9575	8050	2000	1300		11350	550	500		515	1565
Chickpea	390	335	200	475	1400	150	160		200	510	1690	560	100	250	2600
Lentil	150	370	100	100	720	1800	200		200	2200	603	810	150	755	2318
Vetch		710			710		1120		300	1420		830			830
Lathyrus		40			40		40			40					
Total	6130	7265	2600	1125	**17120**	21410	6045	1400	925	**29780**	10923	5077	1500	2150	**19650**

Table 7.2. Seed distribution (in kgs) from 1999/00 - 2000/2001

	1999/00					2000/01				
	1	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**
Wheat		2718	275	780	3773	4470	4918	5895	1340	16623
Barley		550	2500	662	3712	200	5870	2650	1426	10146
Chickpea	202	200		350	752	200	260		2815	3275
Lentil	505	750		455	1710	25	200	900	220	1345
Vetch		544			544		1523			1523
Faba bean							80			80
Total	707	4762	2775	2247	**10491**	4895	12851	9445	5801	**32992**

Distribution (1=NARS; 2=Research; 3=Participating farmers; 4=Seed Unit Multiplication)

Table 7.3. Large-scale seed processing (in MT) at T. Hadya from 1997 - 1999

	1997					1998					1999				
	1	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**
Barley	31.2	9.9	15.7	11.4	68.2	6.4		19.4	11.9	37.7	18.0	3.2	21.8	2.7	45.7
Wheat	2.7	9.9	20.9	4.7	38.2		5.3	11.8	33.3	50.4	0.1		14.2	10.5	24.8
Chickpea		3.6	12.6	3.1	19.3		1.0	36.6	4.3	41.9			11.5	3.2	14.7
Vetch		0.8	16.3	0.7	17.8		0.5	32.6	2.1	35.2	1.6	6.1	4.2	1.3	13.2
Lentil	0.6	1.1	17.0	3.4	22.1	1.8		15.7	4.2	21.7	0.9	1.6	87.5	1.5	91.5
Cumin			0.3		0.3			14.0		14.0			21.3		21.3
Safflower		1.8	1.7		3.5			4.5		4.5			1.7		1.7
Oat			6.0		6.0			2.0		2.0			1.3		1.3
Lathyrus		0.5	1.0		1.5								1.7		1.7
Medic		0.6		0.2	0.8										
Total	34.5	28.2	91.5	23.5	**177.7**	8.2	6.8	136.6	55.8	**207.4**	20.6	10.9	165.2	19.2	**215.9**

	2000					2001				
	1	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**
Barley	17.0	2.2		8.6	27.8	37.1	1.8	14.3	5.8	59.0
Wheat	3.8	0.8	34.6	1.0	40.2		1.8	35.7	13.8	51.3
Chickpea			2.7		2.7			16.9	3.9	20.8
Vetch	0.7	3.2	10.2	0.6	14.7		8.2	10.8	1.8	20.8
Lentil	5.8	0.7	49.6	1.8	57.9	5.2		134.3	1.8	141.3
Cumin		9.0		9.0			1.0		1.0	
Safflower		0.4		0.4						
Oat			2.8		2.8			9.8		9.8
Maize				28.0						
Total27.3	27.3	6.9	109.3	12.0	**155.5**	42.3	11.8	222.8	27.1	**304.0**

1=Germplasm Program; 2=Natural Resources Management Program; 3=Station Operations; 4=Seed Unit

Table 7.4. Number of samples cleaned in the small-scale seed cleaning laboratory from 1997 - 1999

	1997					1998					1999				
	1	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**	**1**	**2**	**3**	**4**	**Tot**
Barley		3402	174		3576	0	3986	401	4	4391	610	6651	24	0	7285
Wheat		26	54		80	200	156	12	163	531	4000	2898	128	120	7146
Lentil	2900	74	7		2981	105	1			106	700				700
Chickpea	600	340			940	1250				1250	1500				1500
Forage sp			37		37			22	2	24					
Cumin				1	1										
Oat				3	3										
Total	3500	3842	272	4	**7618**	1555	4143	435	169	**6302**	6810	9549	152	120	**16631**

	2000				2001		
	1	**2**	**3**	**Tot**	**1**	**2**	**Tot**
Barley	700	3882	112	4694	409	6120	6529
Wheat	1870	20	281	2171	2068	3858	5926
Lentil			6	6			
Chickpea							
Total	2570	3902	399	**6871**	2477	9978	**12455**

1=Genetic Resources Unit; 2=Germplasm Program; 3=Natural Resources Management Program; 4=Seed Unit; 5= Station Operation

Table 7.5. Number of samples and seed lots in the seed store from 1997 to 2001

Type	GP		Seed Unit		NRMP		Total	
	No of Samples	Lots (weight in MT)	No of Samples	Lots (weight in MT)	No of Samples	Lots (weight in MT)	No of Samples	Lots (weight in MT)
Barley	75,000	5	12	11		2	75,012	18
Faba bean	21,152		18		3		21,173	0
Chickpea	2,000	2	6	7			2,006	9
Lentil	998	6	2	5	2		1,002	12
Bread wheat	232		8	5			240	5
Medic	100	5			100	5	200	9
Durum wheat			8	8			8	8
Vetch	3,500	6	5	1		6	3,505	13
Trifolium					60		60	
Total	**102,982**	**24**	**59**	**38**	**165**	**13**	**103,206**	**74**

Table 7.6. Number of samples analyzed for different tests in the seed quality control laboratory during 1997-2001

Type of Test	GP	NRMP	SU	Total
Germination	246	1,338	1,667	3,251
Speed of germination			426	426
Dry matter accumulation	536		426	962
Seedling growth rate			426	426
Analytical purity			931	931
Variety purity			259	259
Specific seed weight	4,085	166	1,100	5,351
Moisture content			64	64
Electrical conductivity			72	72
Total	**4,867**	**1,504**	**5,371**	**11,742**

8. INTERNATIONAL ACTIVITIES

8.1. Consultancy Missions

8.1.1. Egypt

As part of the objective of strengthening national programs, the Seed Unit participated in a three-week joint mission with the German Agency for Technical Cooperation (GTZ), and the United States Agency for International Development (USAID), to review the seed sector in Egypt, with a focus on privatization efforts. The Unit's Seed Economist participated with terms of reference relating to the determination of costs and financing of privatization, and analysis of present and future costing and pricing for certified seed. These findings were presented during a two-day symposium and workshop attended by over 100 representatives from the public and private sectors.

8.1.2. Turkey

The Mediterranean Exporters Union (MEU), a semi-autonomous body in Turkey that purchases grain legumes from farmers for export, supported a project on Food Legume Technology Transfer, which began implementation in 1998 in collaboration with the Unit. The primary objective of the project was to encourage the adoption of new high yielding and disease tolerant varieties of food legumes through the use of certified seed. The Seed Unit made a visit to the project area in the Konya and Karaman Provinces to view field activities and make recommendations on support mechanisms and institutional arrangements that could make the contract grower scheme commercially viable and attractive to small-scale farmers.

8.1.3. Central Asia

Kyrgyzstan: The Seed Unit participated in seed issues in Central Asia through consultancy to international development agencies. In 1988/99, SU

participated in the World Bank Mission, which followed the launch of the Agricultural Support Services Project in Kyrgyzstan and assisted in preparing the implementation report for the seed component.

Kazakhstan: In 1998 the Unit in association with the ICARDA Central Asia office in Tashkent, undertook a major review of the seed sector in Kazakhstan with the Danish consultancy company COWI. This study presented options for the revival and strengthening of the seed sector. In 1999 the Unit participated in a meeting called by the World Bank, to discuss various issues affecting the agricultural sector in Kazakhstan and a possible 'Agricultural Support Services Project'.

8.1.4. Consultancy Mission to Eritrea

The DANIDA Agricultural Sector Support Program provides both financial and technical assistance to agricultural research and national seed program development as well as training of human resources in Eritrea. The next phase of DANIDA support intends to strengthen the seed delivery mechanisms to farmers instead of crop improvement activities. This requires an expansion of seed production and distribution activities, which can no longer be accommodated within the research department of the Ministry of Agriculture. As a result there is an on-going dialogue on how to make seed production operational. On 14-21 November 2001 an ICARDA seed expert visited Eritrea to prepare a draft national seed policy document for presentation to the national seed workshop planned in 2002. During the mission, meetings were held with senior staff of the Department of Agricultural Research, Human Resource Development, and the Ministry of Agriculture. Visits were made to Halhale Research Station and to seed production plots in the vicinity of Dubarwa and Adi Blai to have first hand information on the seed activities in the country.

8.1.5. Consultancy Mission to INRA, Morocco

The main purpose of the consultancy mission to Morocco was to review the role of the Seed Service of the Institut National de la Recherche

Agronomique in national seed sector development including the mechanisms for exploiting varieties released by the research institute. During a one-week mission (2-9 September 2001) meetings were held with senior officials from the Ministry of Agriculture, agricultural research institutes and public and private seed sector representatives and visits to one of the main seed production centers of INRA. The mission reviewed the policy and institutional aspects of seed supply with less detailed technical or financial evaluation of the institutions and their activities. The mission made general recommendations for improvement of the seed sector such as the need for national seed policy (and vigorous national seed council), reappraisal of the national seed plan, review of the variety release system and seed standards, alternative seed supply systems and seed security in light of recurrent drought in the country. Specific recommendations were made regarding seed activities of INRA which include making the Seed Service as an autonomous cost center within INRA, separate costing of variety testing for official catalogue conducted by INRA, reviewing variety tendering system of INRA and transfer of production of G3 from INRA to seed companies, etc.

8.1.6. Barani Village Development Project Pakistan

The main purpose of the mission was to provide advice on the strengthening of the informal seed sector. Recommendations include: (a) options to carry out variety maintenance and early generation seed production of the BARI varieties in a location that has supplementary irrigation facilities. Without this, much of the breeders' effort is wasted and the diffusion of new varieties is limited; (b) reorganize the practice of distributing elite seed from the BARI stations to interested farmers to make much better use of this high value seed; (c) linking the existing on-farm trials program directly to community-based seed multiplication. It is proposed that a network of farmer seed-growers be established to provide seed at minimum cost within the community. This should be regarded initially as a research activity of the project aimed at strengthening the informal seed system at the three integrated research sites. It is important that this is a financially viable and a study of wheat seed/grain production economics should be carried out to devise a pricing structure, which is both realistic and equitable. The project

should initiate contacts with community organizations to define and implement this system for the next sowing season. Links should be strengthened with private companies operating within the Barani area/crops to create additional seed sources.

8.1.7. Matrouh Resource Management Project, Egypt

In 1999, the Unit provided expert consultancy services in forage seed production as part of rangelands improvement at the Northwest coast of Egypt. These included formulating guidelines for maximizing seed yield and procedures for post-harvest handling and seed testing, and providing advice on the establishment of a seed production center.

8.2. International Teaching

Participation in International Seed Courses: The International Course on Seed Production and Seed Technology is organized every year for nearly three months by the International Agricultural Center (IAC), Wageningen, The Netherlands. The objective of the course is to transfer relevant knowledge and experience through training seed technologists and managers from developing countries. During the past 10 years the Seed Unit has been a regular contributor to the course and also served as an advisory board member of the course. From 1997 and 2001, two staff members of the Seed Unit participated in the course for one week each as resource persons. The contributions include formal lectures, practical and open discussions focusing on practical application and relevance to the needs of national seed programs. Each year about 20 participants representing over 10 countries from developing countries of Africa, Asia and South America attended the course. All participants were qualified staff with long experience in seed technology and related disciplines in their respective countries.

8. 3. Conferences

Seed World and Turkey in 2000's, 20-21 February 1997, Izmir, Turkey: The seminar Seed World and Turkey in 2000s was organized by Seed Technology

Unit of Eðe University in cooperation with Turkish Seed Industry Association. The main objectives were to review progress and discuss the future directions of the seed sector to promote the Turkish seed industry. The meeting discussed issues related to seed trade, plant variety protection, membership in international organizations and human resource development for the expanding private sector. The Ministry of Agriculture and Agrarian Reform (MARA) and the Turkish Seed Industry Association gave presentations reflecting present government policies and the achievements and constraints of the private seed sector. Moreover, invited speakers from international organizations (FAO, FIS, ICARDA, ISTA, UPOV), national programs from Europe (France, The Netherlands), and donors (GTZ) presented their activities on the seed sector to an audience of over 100 participants from the public and private sector. The second day of the seminar was focused on general discussions and recommendations to position the Turkish seed industry in the global seed trade of the next century.

Enhancing Research Impact Through Improved Seed Supply: Options for Strengthening National and Regional Seed Supply Systems, 8-16 March 1997, Harare, Zimbabwe: The conference was the first inter-center seed meeting organized by ICRISAT, ICARDA and IITA in cooperation with South African Development Community (SADC) and through a financial support of GTZ (BMZ). The main objective was to outline national and regional action plans targeting the improvement of seed supply systems in developing countries with particular reference to West Asia and Africa. Within this context, the conference aimed to: (a) review policy, institutional, and regulatory constraints; (b) review the potential roles of public and private sectors, NGOs and farmer groups or cooperatives; (c) identify policy and regulatory changes required; and (d) outline possible national and regional strategies for improving seed supply systems. About 67 participants attended the workshop including senior policy makers from the public and private seed sectors, NGOs and farmer groups as well as seed policy analysts and staff from IARCs, World Bank, ODI (UK) and Universities. The conference thus brought together people with very diverse technical and practical background and experience in seed sector development. The conference was structured on five main themes for its deliberations with an ultimate objective of developing action plans at regional levels. The themes of the workshop were: (a) defining the problem of seed supply; (b) presenting con-

cept summary papers, (c) organizing working groups on seed strategy; (d) developing strategies for improved seed supply; and (e) formulating general recommendations.

The formal presentations were followed by six group sessions deliberating on key issues: (a) role of public and private seed sectors; (b) role of NGOs and farmers' groups; (c) role of national and international institutes; (d) seed policy and regulation; (e) emergency seed supply; and (f): seed information systems. Finally, three additional working group sessions were organized on a regional basis, to develop action plans that prioritize problem areas analyzed by the previous six working group discussions. Broad areas of intervention were identified as part of each action plan. The key recommendations and action plans for the WANA region focused on: (a) developing clear national seed policy; (b) providing greater support to the informal sector; (c) supporting national seed associations; and (d) promoting private seed sector.

AFSTA Preparatory Meeting (Lilongwe, Malawi, 8-10 April 1999) and First Congress (24-26 March 2001, Cairo, Egypt): From the outset the ICARDA Seed Unit participated and contributed to the debates of regional collaboration in the preparatory meeting in 1999 to establish the African Seed Trade Association. During the meeting a paper on the experiences of networking national seed systems in the WANA region was presented. Similarly in April 2001 the Seed Unit participated in the First AFSTA Congress. The Congress raised and discussed the most critical policy and regulatory reforms required to create an enabling environment to mobilize the potential resources of the commercial seed sector which include intellectual property rights, biotechnology, biosafety regulations, etc. The Seed Unit presented a paper on the role of IARCs in the changing global seed industry and contributed to these deliberations.

Third Egyptian National Seed Conference, 10-12 May 1999, Cairo, Egypt: The Seed Unit staff attended the Third Egyptian National Seed Conference and presented a paper on ICARDA's role in strengthening the national seed systems in the WANA region through its regional Network.

The International Conference on Seed Industry. 27-30 March 2000, Tripoli, Libya: The Conference was organized by the General Authority for

Agriculture, Animal and Marine Wealth in Libya and co-organized by international organizations including ICARDA. The Seed Unit was a member of the organizing committee and presented two papers during the workshop.

ISTA Congress (15-24 April, 1998, Pretoria , South Africa; 14-22 June 2001, Angers, France) and World Seed Congress (6-8 September 1999, Cambridge, UK): The ISTA Congress becomes a natural contact point both for the scientific and business community to keep abreast with developments in the global seed industry. It advances seed science and the application of the new technology on a wider commercial scale. The Seed Unit participates and contributes to sharing of knowledge and experiences by presenting papers during these congresses and maintaining contacts with international organizations dealing with varieties, seeds and development.

FAO Seed Policy Review (27June - 2 July 1999, Larnaca, Cyprus; January 2001, Budapest, Hungary): The Seed Unit participated in two of the FAO's Regional Seed Policy and Program review meetings for the Near East and North Africa (in Cyprus) and one for CEEC, CIS and Countries in Transition (in Hungary) and contributed by presenting invited papers. The Seed Unit is elected as a Coordinator of Working Group 2 dealing with harmonization of seed rules and regulations of the Consultative Forum for Seeds for the Near East and North Africa region established during the Larnaca meeting.

UPOV Regional Seminar, Jan 2000, Harare, Zimbabwe: In 2000, UPOV invited selected African institutions for roundtable discussions to advance dialogue on plant variety protection. Seed Unit staff was invited as resource persons to present the current status and regional perspective of PVP in the WANA region to contribute the on-going discussion.

International Symposium on Scientific Basis of Participatory Plant Breeding (PPB) and Conservation of Genetic Resources, 9-13 October 2000, Oaxtepec, Mexico: In recent years participatory approaches are gaining momentum in genetic resource conservation, plant breeding and seed supply systems to exploit farmer's indigenous knowledge. The limitations of conventional breeding have been recognized, especially for crops grown in more marginal environments, where farmers' requirements are more complex and

diverse. This has prompted interest in PPB strategies in which farmers can play a much more active role in the selection process. The PPB initiatives must be linked to a secure diffusion strategy within and beyond the participating communities if the technical and social benefits of this approach are to be fully realized. In this context, the Seed Unit presented a paper entitled Linking Participatory Plant Breeding to Seed Systems.

17th Panamerican Seed Seminar and International Forum on Biotechnology and Seed Marketing, 20-22 November 2000, Punta del Este, Uruguay: The Seminar is a forum where policy, regulatory, technical and commercial issues that affect the seed industry in the Americas is debated. The Seed Unit was invited to attend and presented a paper on prospects for small and medium size companies in a changing seed market to advance the dialogue.

Asian Seed 2001 Conference, 17-20 September 2001, Chiba, Japan: This is an annual meeting of Asia Pacific Seed Association, which is a commercially active regional association. The Seed Unit presented the status of the seed programs in the West Asia region.

9. STATUS OF COOPERATION WITH ICARDA PROGRAMS, WITH REGIONAL AND NATIONAL PROGRAMS

This section summarizes all what has been done during the five-year period from a HQ, regional and national perspective. Note that this section does not try to be 100% complete; some activities may only have been reported here or in the other chapters.

9.1. Other ICARDA Programs

- The Seed Unit has been collaborating actively with the Barley Breeding Project to develop relatively low-cost machines for processing farm-saved seed. This is a key 'downstream linkage' with participatory plant breeding.
- The Seed Unit works very closely with the ICARDA breeders. Annually, promising ICARDA-related varieties are identified and seed multiplied of bread wheat, durum wheat, lentil, chickpea and vetch.
- Variety maintenance of bread wheat, durum wheat, lentil and chickpea is carried out and morphological variety descriptions are prepared.
- Seed for the international nursery program of bread wheat was produced annually.
- The Unit provides seed cleaning, seed treatment and seed storage services to all programs and the Station Operations.

9.2. ICARDA Regional Programs

Arabian Peninsula Regional Program (APRP):

- There is a significant seed component in APRP related to native forage grasses and shrubs for rangelands. The Seed Unit is actively involved in this work. The Unit assisted in preparing a detailed protocol for cleaning seed of a wide range of native species both in UAE and at Tel Hadya and provided advice on seed processing equipment. The Unit has also been involved in investigating germination behavior of these native species and

developing seed germination protocols.
- In Oman, a regional course in Seed Production and Technology was organized for participants from the Arabian Peninsula.

Central Asia and Caucasus Region:
- Justification for a regional initiative among the five Central Asian countries remains as strong as ever, given the similar agro-ecology and shared economic circumstances. However, seed activities are not clearly distinguished from breeding (seed breeding).
- The Unit carried out Consultancy work in Tajikistan for GTZ; Kyrgyzstan for World Bank; Kazakhstan for DANIDA/WB.
- A special Seed Production course was organized at Tel Hadya for 12 participants from Kyrgyzstan.

Latin America Regional Program (LARP): In 2000 a project proposal related to legume seeds for the World Bank 'competitive research fund' was developed by LARP with technical guidance from the Seed Unit.

North Africa Regional Program (NARP): The new phase of the WANADDIN project will be implemented in Algeria, Morocco and Tunisia and it has a significant seed component. It is primarily a seed system issue, with strong economics dimensions, and has some affinities with the machinery development mentioned earlier, since similar equipment may be required.

West Asia Regional Program (WARP): The Economic and Social Commission for West Asia (ESCWA) launched initiatives to standardize the protocols for production, marketing and distribution of agricultural inputs such as fertilizers, pesticides, etc. in the region. Within this context ESCWA was interested to collaborate with the Seed Unit in supporting the harmonization initiatives related to seeds within the sub-region.

9.3. Individual CWANA Countries

Afghanistan:
Concept notes presented to IDRC and USAID on seed system support for Afghanistan following the long period of crisis and drought.

Algeria:

- The Unit carried out a significant amount of consultancy work for the GTZ seed project. A Draft Manual of Variety Description for Legumes was prepared, which is currently being translated into French.
- Under the WANA Seed Network, Algeria collected and prepared a seed production costs for major crops.
- Follow-up course in Economics of Seed Production in Algiers during 2000. An In-country course in Varity Description and maintenance was organized.

Cyprus:

- As a member of the WANA Seed Network, Cyprus prepared two special catalogues one on cultivated crop species and one on weed species in WANA region. The crop catalogue contains information on annual and perennial crops grown in WANA region. The catalogue of weed species is envisaged to strengthen cooperation among seed testing laboratories by exchanging and identifying seeds, particularly weed seeds associated with cereals, legumes, oilseeds, forage and vegetables crops in the WANA region. Some countries have exchanged weed seeds to the lead country to establish a regional weed seed collection.
- At present compiling literature/reference materials on weed seeds of WANA region.
- Cyprus is a member of the Steering Committee of the Network and hosted the Steering Committee meeting in 1997.

Djibouti:

It is a member of the WANA Seed Network and benefiting from sharing information and experience from member countries.

Egypt:

- Close collaboration with the seed agencies which have well-funded GTZ projects.
- As part of the WANA Seed Network activities, a WANA Seed Directory with complete information on national seed industry participants (agricultural research centers, public and private seed companies, seed import/export companies, seed policy and regulatory agencies) have been

prepared and circulated in WANA countries and beyond to facilitate contacts.
- Egypt is a member of the Steering Committee of the Network and hosted the Steering Committee meeting (1998 and 2001) and the WANA Seed Council meeting (1999).
- Very good contacts with Egyptian Seed Association
- Participation in the Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".
- Follow-up course in Economics of Seed Production, in Seed Processing and in Seed Health Testing.
- Participated in multi-agency (GTZ/USAID/ICARDA) mission to review Egypt seed sector in 1997.
- In-country courses on: Legume Field Inspection Methodology and in Seed Testing.

Eritrea:

Ongoing contacts with the DANIDA project - which has a strong seed component. Policy level input to the national program is needed before a second project phase gets underway. A draft national seed policy document has been prepared during the 2001 consultancy mission.

Ethiopia:

- Close cooperation with Ethiopian Seed Enterprise and ILRI. With ILRI a joint Pasture and Forage Seed Production course was organized.
- A review of the seed system in EARO; TOR has been prepared.
- Participation in the Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".
- A wheat seed system study with focus on informal sector is drawing to a conclusion.
- Follow-up course in Economics of Seed Production in 1997.
- Workshop on Finance and Management of Small-Scale Seed Enterprises in 1998.
- Ethiopia is a member of the WANA Seed Network and responsible for reviewing variety release and registration procedures.

Iran:
- Major new initiatives are in process on the seed front.
- In recent years Iran showed keen interest in human resource development in the seed sector and a number of courses were organized.
- National Seed Seminar and Workshop on Review of Seed Programs and Regulations planned later in 2002.
- Iran is a member of the WANA Seed Network and benefiting from sharing information and experiences from member countries.
- In-country courses on General Seed Production and Seed Quality Control; Follow-up course in Seed Processing.

Iraq:
- Intermittent contact with the FAO seed project and with Mosul University, mostly in the context of training.
- Iraq collated information on seed technology education in WANA region and information was circulated.
- Follow-up course in Seed Processing and in Seed Health Testing.

Jordan:
- Close links with the seed people and Seed Center in the University of Jordan (Workshop on Quality Assurance organized).
- Good collaboration in training including post-graduate training.
- Participation in the Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".
- Jordan is a member of the WANA Seed Network and collecting and summarizing regulations on seed trade (seed import/export).

Lebanon:
- Lebanon as member of the WANA Seed Network has compiled literature with the objective to develop a regional database on seed related documentation
- Lebanon is a member of the Steering Committee of the Network and hosted the Steering Committee meeting in 2000.

Libya:
- There is continuing interest in seeds both to strengthen their own national program, and in the wider political context. The Seed Unit was part of

the technical committee for organizing the international seed conference (2000), which generated a lot of interest.
- Concept note on possible contribution to the national seed program has been prepared and is being reviewed.
- A large FAO project is in preparation, in which we should have a share of the action.
- Libya is a member of the WANA Seed Network and benefiting from sharing information and experiences from member countries.

Mauritania:

Mauritania participated in plant variety protection workshop organized by the Seed Unit of ICARDA and UPOV and participated in WANA Seed Council as observer being a potential member from the region.

Morocco:

- Good contacts over the years with all the seed institutions, particularly SONACOS.
- There was a recent study of the INRA seed system.
- Morocco coordinates the WANA Variety Catalogue and WANA Referee Seed Testing. The catalogue covers varieties of cereals, legumes, oilseeds and forage crop varieties currently released or under commercial seed production including their synonyms and source of seed and their maintainers.
- Morocco is a member of the Steering Committee of the Network.
- Very good contacts with Turkish Seed Industry Association
- Participation in the Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".
- Morocco continues to coordinate the referee testing with the main objectives of standardizing seed testing procedures, upgrading skills and exchanging experiences. Since 1992, a series of Referee tests were conducted within the framework of the WANA Seed Network where results are analyzed and advises provided to participating countries.
- Good contacts with the Association Marocaine des Semences et Plants
- Follow-up courses in Economics of Seed Production and in Seed Processing in 1998.

- An in-country course in Variety Description and Breeder Seed Production was organized.

Pakistan:
- Good links with the seed organizations including, an innovative and highly successful training course on Management of the Seed Industry for the private sector in 2000.
- Consultancy to Barani VDP.
- Participation in the Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".
- Pakistan is a member of the WANA Seed Network and sharing information and its experiences to the benefit to other member countries.
- Pakistan Chamber of Seed Industry is leading Network activity on promoting the formation of seed trade associations in the region

Oman:
- Good contacts through APRP.
- As a member of the WANA Seed Network, Oman translated the draft seed certification scheme in WANA into Arabic, which could lay a foundation for regional harmonization of technical procedures.

Saudi Arabia:
- Good contacts with the forage work at Al Jouf through APRP.
- Member of the WANA Seed Network.

Sudan:
- Follow-up courses in Economics of Seed Production and Seed Processing at Sennar during 1999.
- As a member of the WANA Seed Network, Sudan is responsible for collecting information and develop a regional seed policy framework.

Syria:
- Excellent cooperation with GOSM.
- Collaboration with the FAO Rangeland Project in Palmyra to investigate some seed production problems on forage species for rangeland rehabilitation.

- Syria prepared a Catalogue of Field and Seed Standards for major cereal, legume, oilseed and forage crops. The catalogue could be a useful reference point for harmonization of seed regulation in WANA region.
- Syria is a member of the Steering Committee of the Network.
- Wheat and barley seed supply study with focus on informal seed sector is drawing to a conclusion.
- Collaboration in forage seed systems research in NE Syria.
- Participation in the GTZ Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".
- Follow-up course in Seed Processing and in Seed Health Testing.

Turkey:

- Major advisory role in the GAP 'On-Farm Variety Testing and Seed System Development Project', which is aiming at devising alternative ways of introducing new varieties of crops which the formal sector does not handle.
- A workshop on "Defining Sustainable Seed Production and Marketing Systems for Winter Cereals and Legumes in the GAP Region" was organized in Sanliurfa in 2000.
- A training course on 'Seed Production and Marketing' was organized at the Ceylanpinar State Farm during 2001.
- Under the umbrella of the WSN, Turkey collated and summarized the seed certification scheme in WANA region and developed a draft seed certification scheme for possible regional integration.
- Turkey is a member of the Steering Committee of the Network.
- Very good contacts with Turkish Seed Industry Association
- Participation in the Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".

Tunisia:

As a member of the WANA Seed Network, Tunisia prepared a database on seed import and export and the first issue was circulated during the third council meeting.

Yemen:

- Intermittent contact with the WB Seed and Agricultural Services Project (SASP) there - mostly in the context of training.
- The new World Bank 'Farming Community Development Project' currently in preparation should have a seed component to maintain the local seed initiatives started under SASP.
- Participation in the Seed Policy Project as one of the country case studies on "Raising Efficiency and Effectiveness of Seed Production and Marketing in WANA".
- Follow-up courses in Economics of Seed Production and Seed Processing in Dhamar during 1999.
- Yemen is a member of the WANA Seed Network and is responsible to collect and summarize information on regulations for establishing seed enterprises. Preliminary information was collected from some countries fro compilation.

9.4. International Seed Organizations

International organizations such as ISF (International Seed Federation), ISTA (International Seed Testing Association), OECD (Organization for Economic Cooperation and Development), UPOV (International Union for the Protection of New Varieties of Plants) and Food and Agriculture Organization (FAO) as well as the German Agency for Technical Cooperation (GTZ) are assisting us in strengthening the seed industries in the region. They are all observers in the WANA Seed Network.

10. SEMINARS, SEED UNIT STAFF AND EXTERNAL CONSULTANTS

10.1. In-house Seminars Presented by Seed Unit Staff

Turner M.	What is the Informal Sector and Does it Need Our Help? November 1997.
Kugbei S.	Contracting Smallholders to Produce Seed: The Case of Tef in Ethiopia. March 1998
Bishaw Z.	Seed Security: Mirage or Achievable Goal? March 1999
Turner M & A.A. Niane	Breeders and Seed People: A Fertile Relationship? December 1999
Turner M & Z. Bishaw	Plant Variety Protection: Current Status and Possible Impact on NARS March 2000
Turner M. & Z. Bishaw	Linking Participatory Plant Breeding to the Seed Supply System. January 2001
Kugbei S. & A.A. Niane	Economic Considerations in Organizing Forage Seed Production. April 2001

10.2. Seed Unit Staff

Michael Turner	Head of Seed Unit (July 97 until September 2001)
Samuel Kugbei	Seed Economist
Lahcen Grass	Training Officer (February 97 until April 2000)
Zewdie Bishaw	Seed System Specialist and WSN Coordinator
Abdoul Aziz Niane	Seed Production Manager
Sonia Noaman	Senior Secretary
Mohammed Makkawi	Consultant - Research

10.3. External Consultants

Peter Witthaut	GTZ, Germany: Economics of Seed Production Course, HQ 1996 and Follow-up courses -

	Ethiopia (1997) and Sudan (1999)
Bill Gregg	Freelance, USA: Seed Processing Course, HQ - July 1997
John Ferguson	Freelance, Australia: Forage Seed Workshop, Addis Ababa - Oct. 1997
Robert Rowling	Johnson's Seeds, UK: Forage Seed Workshop, Addis Ababa - Oct. 1997
Giles Laverack	Freelance, UK: Variety Maintenance Course, HQ April 1998
Don Loch	DPI, QLD, Australia: Plant Variety Protection Workshop, Cairo - May 1999
Huib Ghijsen	CPRO, The Netherlands: Plant Variety Protection Workshop, Cairo - May 1999
Mogens Lemonius	Freelance, Denmark; WANA Seed Council meeting, Cairo, May 1999
Heinz Schmid	ISTA, Switzerland: Quality Assurance Workshop, Amman - October 2000

10.4. MSc Students

Yonas Sahlu W. Selassie	University of Jordan: Status and quality of barley seeds used by Northern and Central Ethiopian farmers (1998-99)
Hossam Al-Deen Abedo	University of Aleppo: Investigation of genetic differences in seed/seedling vigor in barley varieties (2000-01)

11. PUBLICATIONS

11.1. Journal Articles

Grass L. and M. Tourkmani (1999). Mechanical damage assessment in rejected durum wheat seed lots in Morocco. Seed Science and Technology. 27(3) 991-997

Kugbei, S. and M. Turner (2000). Assessing the Potential of a Smallholder Contract Scheme to Diffuse Tef Varieties in Central Ethiopia. (International Herbage Seed Production Research, 32, p. 9-18. Institute of Grassland and Environmental Research, Aberystwyth, UK)

Makkawi, M., M. El Balla, Z. Bishaw and A.J.G. van Gastel (1999). The Relationship Between Seed Vigor Tests and Field Emergence in Lentil (Lens culinaris Medik). Seed Science and Technology: 27(2) 657-668

11.2. Book Chapter

Wright, M. and M. Turner (1999). Seed Management Systems and Effects on Diversity. In Agro-biodiversity: Characterization, Utilization and Management (eds. D. Wood and J.M. Lenne). pp 331-354. CABI Publishing, Wallingford, UK

11.3. Proceedings

Grass, L. and M. Turner (eds.). 1998. Forage Seed Production in Africa and West Asia. Proceedings of the Forage Seed Production Workshop, 27-31 October 1997, Addis Ababa, Ethiopia. ICARDA, Aleppo, Syria. vii + 203 pp. ISBN: 92-9217-079-2

Kugbei, S., M. Turner and P. Witthaut (eds). 2000. Finance and Management of Small-scale Seed Enterprises. Proceedings of a Workshop on Finance and Management of Small-scale Seed Enterprises, 26-30 October 1998, Addis Ababa, Ethiopia. ICARDA, Aleppo, Syria. iv + 191 pp. ISBN 92-9127-106-3

Rohrbach, D.D., Z. Bishaw and van Gastel, A.J.G. (eds.). 1997. Alternative Strategies for Smallholder Seed Supply. Proceedings of the International Conference on Options for Strengthening National and Regional Seed Systems in Africa and West Asia, 10-14 Mar. 1997, Harare, Zimbabwe. Patancheru 502324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics

van Gastel, A.J.G, G.R. Manners. and J. Wadsack (eds.). 1997. Privatization of the Seed Industry in West Asia and North Africa Region, 16-20 November 1995, Tunis, Tunisia. GTZ, Postfach 5189, 65726 Eschborn, Germany

11.4. Training Manuals

Grass L. and B.R. Gregg. 2000. Seed Processing - A Training Manual. ICARDA, Aleppo, Syria. viii +174. ISBN: 92-9127-103-9

Kugbei S. 2000. Seed Economics-Commercial Considerations for Enterprise Management in Developing Countries. ICARDA, Aleppo, Syria. viii + 182 pp. ISBN 92-9127-102-0

Niane A.A., A. W. Madarati, A. Abbas and M. R. Turner. 1999. Manual of Morphological Variety Description for Wheat and Barley with Examples from Syria. ICARDA, Aleppo, Syria. viii + 106 pp. En/Ar. ISBN 92-9127-089-M

11.5. Theses

Amjad Ab-Rashed. 1997. Studies and Evaluation of Hardseededness in Two Annual Medicago Species. University of Jordan, Amman, Jordan. xiv + 87 pp

Hussein Al-Quasim. 1997. Seed Size, Temperature and Water Potential Effects on Germination and Seedling Growth of Two Wheat Genotypes. University of Jordan, Amman, Jordan. xii + 54 pp

As'ad El Al Deen Abu Yahya. 1997. Effect of Seed Treatment with Fungicides on Germination and Establishment of Wheat 'Horani 27' Free or Infected with Covered Smut. University of Jordan, Amman, Jordan. xi + 51 pp

Tareq Mohammad Al-Faqeeh. 1997. A Survey of Lentil Seed Quality in Jordan. University of Jordan, Amman, Jordan. xi + 97 pp

Bora Sürmeli. 1998. Diffusion and Adoption of Improved Vetch Varieties (Hungarian Vetch) in Ankara Province. Ankara University, Ankara, Turkey. 77 pp

Yonas Sahlu W. Selassie. 1999. Evaluation of Status and Quality of Barley Seed Used by the Northern and Central Ethiopian Farmers. University of Jordan, Amman, Jordan. xi + 65 pp

Hossam Al-Deen Abedo. 2001. Investigation of Genetic Differences in Seed/Seedling Vigor in Barley Varieties. University of Aleppo

11.6. Network Publications

Tourkmani, M. 1997. WANA Referee Test - Alfalfa. WANA Seed Network Publication No. 16/97

Tourkmani M. 1999. WANA Referee Test - Clover. WANA Seed Network Publication No. 21/99. 13 pp

Tourkmani M. 2001. WANA Referee Test - Maize. WANA Seed Network Publication No. 22/01. 10 pp

WANA Secretariat. 1998. WANA Seed Directory. WANA Seed Network Publication No. 17/98

WANA Secretariat. 1998. WANA Catalogue of Crop Varieties. WANA Seed Network Publication No. 18/98

WANA Secretariat. 1999. WANA Catalogue of Field and Seed Standards. WANA Seed Network Publication No. 19/99

WANA Secretariat. 1999. WANA Catalogue of Crop Species. WANA Seed Network Publication No. 20/99

WANA Secretariat. 2001. WANA Catalogue of Weed Species. WANA Seed Network Publication No. 23/01

Focus on Seed Programs is a publication describing the national seed programs in the region. From 1997 to 2001, 9 issues were published featuring the seed industries of the following countries: Cyprus, Lebanon, Tunisian, Ethiopian, Oman, Pakistan, Jordan, Iraq and Algeria.

11.7. Articles in Newsletters

Bishaw, Z. 1997. Human Resource Development for Seed Sector at ICARDA: Train-the-Trainers Approach. Seed Info No .13: 6-9. ICARDA, Aleppo, Syria

Bishaw, Z. and N.P. Louwaars. 2000. Sterile Seeds: Reflections on the Terminator Technology. Seed Info No .19: 3-5. ICARDA, Aleppo, Syria

Dabi, G., G. Shaka and Z. Bishaw. 1998. The Ethiopian Seed Industry. ISTA News Bulletin 117. 26-31, September 1998

Kugbei, S. (2000). Challenges in Privatising the Seed Sector in Developing Countries. West Africa Seed and Planting Material: WASNET Newsletter, No. 5, p21. IITA/GTZ, Accra, Ghana

Kugbei, S. (2000). Can Small-scale Enterprises Strengthen the Informal Seed Sector? West Africa Seed and Planting Material: WASNET Newsletter, No. 5, p21. IITA/GTZ Accra, Ghana

Kugbei, S. and A. Fikru (1997). The Injera Initiative. Caravan 6, ICARDA, Aleppo, Syria

Kugbei, S. and L. Grass (1998). Planting the Seeds of a Training Program. Caravan 8, ICARDA, Aleppo, Syria

Kugbei, S. and M. Turner (1999). Women: The Mothers of Seed? West African Seed and Planting Material Newsletter. IITA/GTZ/CRI Seed Project, Accra, Ghana. Kugbei, S. (1998). Seed Economics: Why? SeedInfo 14, ICARDA, Aleppo, Syria

Kugbei, S., M. Turner and Z. Bishaw (2001) African Seed Sector Challenges: Building Seed Systems for Greater Food Security through Partnerships. Caravan 15, p. 18-20. ICARDA, Aleppo, Syria

11.8. Papers in Proceedings

Bishaw, Z. and S. Kugbei. 1997. Seed Supply in the WANA Region: Status and Constraints. In Alternative Strategies for Smallholder Seed Supply. Proceedings of the International Conference on Options for Strengthening National and Regional Seed Systems in Africa and West Asia, 10-14 Mar. 1997, Harare, Zimbabwe (Rohrbach, D.D., Bishaw, Z., and van Gastel, A.J.G. Eds.), Patancheru 502324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. pp 18-33

Bishaw, Z. and M. Turner. 1998. A Regional Perspective on Seed Security. In Contribution for the Development of Seed Security Strategies in Disaster-prone Regions. Proceedings of an International Workshop on Seed Security for Food Security, FAO, Rome, Italy. pp 23-41

Bishaw, Z. and M. Turner. 2001. The Role of Agricultural Research Centers in a Changing Seed Industry pp 119-128. In Proceedings of African Seed Trade Association held 24-26 March 2001, Cairo, Egypt

Bishaw, Z., A.J.G. van Gastel and G. Manners. 1997. Seed Sector Scientist's Perception of and Recommendations for the Privatization of the Seed Industry in West Asia and North Africa. In Proceedings of the Privatization of the Seed Industry in West Asia and North Africa Region, 16-20 November 1995, Tunis, Tunisia. (van Gastel, A.J.G, Manners, G.R. and J. Wadsack, eds.) GTZ, Postfach 5189, 65726 Eschborn, Germany. pp 28-39

Bounejmate M., L. Grass, and S. Christiansen. 1998. ICARDA's Approach to Promoting Forage and Pasture Seed Production in West Asia and North Africa. In: Forage Seed Production in Africa and West Asia. Proceedings of the Forage Seed Production Workshop pp 18-25. (eds. L. Grass and M. Turner). ICARDA, Aleppo, Syria

Grass L., M. Bounejmate and F.A. Feniche. 1999. Hardseededness in Medicago aculeate. pp 218-222. In Herbage Seed as a Key Factor for Improving Production and Environmental Quality: Proceedings of the Fourth International Herbage Seed Conference (eds. M. Facinelli and D. Rosellini), University of Perugia, Italy, 23-27 May 1999, Italy, University of Perugia, Italy

Kahsay, M. and S. Kugbei. 2000. Alternative Seed Supply Systems in Ethiopia. pp 143-149. In Proceedings of a Workshop on Finance and Management of Small-scale Seed Enterprises, 26-30 October 1998, Addis Ababa, Ethiopia (Sam Kugbei, Michael Turner and Peter Witthaut (eds). ICARDA, Aleppo, Syria

Kugbei, S. 2000. Managing Risk in Small-scale Seed Enterprises. pp 19-28. In Proceedings of a Workshop on Finance and Management of Small-scale Seed Enterprises, 26-30 October 1998, Addis Ababa, Ethiopia (Sam Kugbei, Michael Turner and Peter Witthaut (eds). ICARDA, Aleppo, Syria

Kugbei, S. and A. Aziz Niane. 2001. Potential Impact of Privatization on

Seed Use by Small Farmers. The International Conference on Seed Industry. 27-30 Mar 2000, Tripoli, Libya. pp 361-382. ISBN 9959-30-019-6. General Authority for Agriculture Animal and Marine Wealth, Tripoli, Libya

Kugbei, S. and M. Turner. 2000. Structure and Establishment of Small-scale Enterprises in Seed Industries of Developing Countries pp 9-14. In Proceedings of a Workshop on Finance and Management of Small-scale Seed Enterprises, 26-30 October 1998, Addis Ababa, Ethiopia (Sam Kugbei, Michael Turner and Peter Witthaut (eds). ICARDA, Aleppo, Syria

Kugbei, S. and M. Turner. 2000. Assessing Costs and Margins within the Seed Production and Distribution Chain pp 29-35. In Proceedings of a Workshop on Finance and Management of Small-scale Seed Enterprises, 26-30 October 1998, Addis Ababa, Ethiopia (Sam Kugbei, Michael Turner and Peter Witthaut (eds). ICARDA, Aleppo, Syria

Kusmenöglu, I. and S. Kugbei. 2000. Developing Small-scale Seed Enterprises for Food Legumes in Turkey. pp 123-128. In Proceedings of a Workshop on Finance and Management of Small-scale Seed Enterprises, 26-30 October 1998, Addis Ababa, Ethiopia (Sam Kugbei, Michael Turner and Peter Witthaut (eds). ICARDA, Aleppo, Syria

Talug, C., B. Sürmerli, S. Christiansen, H. Firincioglu, Z. Bishaw, S.P.S. Beniwal and V. Uzunlu. 1998. A study on the informal seed system of vetch spp. in the Central Highlands of Turkey. In: Forage Seed Production in Africa and West Asia. Proceedings of the Forage Seed Production Workshop pp 145-150. (eds. L. Grass and M. Turner). ICARDA, Aleppo, Syria

Turner, M., 1998. Current Status of Seed Program Development and Implications for Forage Seed Supply. In: Forage Seed Production in Africa and West Asia. Proceedings of the Forage Seed Production Workshop pp 7-17. (eds. L. Grass and M. Turner). ICARDA, Aleppo, Syria

Turner, M. 1999. Prospects for Privatization of the Seed Sector in Developing Countries. pp 241-256. In Proceedings of the World Seed Congress, 6-8 September 1999, Cambridge, UK. ISTA, Zurich, Switzerland

Turner, M. and Z. Bishaw. 1999. The Regional Seed Network for West Asia

and North Africa: A Review of Experiences and Issues. pp 108-112. In Proceedings of the Preparatory Meeting for the Establishment of an African Seed Trade Association Lilongwe, Malawi, 8-10 April 1999. FIS, Nyon, Switzerland

Turner, M. and Z. Bishaw. 1999. The WANA Seed Network- An Overview. In Proceedings of the Third Egyptian National Seed Conference, 10-12 May 1999, Cairo, Egypt. (eds. Mohamed I. El-Hawary and Mohamed Salah Abd El Wanis). CASC, Cairo, Egypt

Turner, M. and Z. Bishaw. 2000. Strengthening the Regional Dimensions in Seed Industry Development. Paper presented in Expert Group Meeting on Coordination of Technology Policies to Increase Productivity and Competitiveness within the Global Context: Capacity Building Initiatives for the 21stCentury held 1-3 November 2000, Beirut, Lebanon. E/ESWCA/TECH/2000/WG.1/26, ESCWA, Beirut, Lebanon

Turner, M. and Z. Bishaw. 2001. Benefits of Regional Collaboration in Seed Program Development. Proceedings of the International Conference on Seed Industry: The International Conference on Seed Industry. 27-30 Mar 2000, Tripoli, Libya. pp. 649-666. ISBN 9959-30-019-6. General Authority for Agriculture Animal and Marine Wealth, Tripoli, Libya

Turner, M., S. Kugbei and Z. Bishaw. 2000. Privatisation of the Seed Sector in the Near East and North Africa. pp 125-136. In Seed Policy and Programs in the Near East and North Africa. Proceedings of the Regional Technical Meeting on Policy and Programs in the Near East and North Africa. Larnaca, Cyprus, 27June - 2 July 1999. FAO Plant Production and Protection Paper 159. FAO, Rome, Italy

van Gastel, A.J.G., Z. Bishaw and E. Asiedu. 1997. The Role of International Agricultural Research Centers in Supporting the Seed Sector. In Alternative Strategies for Smallholder Seed Supply. Proceedings of the International Conference on Options for Strengthening National and Regional Seed Systems in Africa and West Asia, 10-14 Mar. 1997, Harare, Zimbabwe (Rohrbach, D.D., Bishaw, Z., and van Gastel, A.J.G. Eds.), Patancheru 502324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. pp 71-79

11.9. Newsletters

SEEDINFO is the official newsletter of the WANA Seed Network and aim at stimulating communication and information exchange among seed staff in the West Asia and North Africa (WANA) region. Between 1997 and 2001, 9 issues have been published in English (No 12 - 21) and 8 issues (14-21) in Arabic

المركز الدولي للبحوث الزراعية في المناطق الجافة
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ص. ب. 5466 حلب ، سورية

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