VERIFICATION AND ADOPTION OF IMPROVED WHEAT PRODUCTION TECHNOLOGY IN FARMERS' FIELDS IN THE SUDAN

Proceedings of the Third
National Wheat Coordination Meeting
4-6 September 1988, Wad Medani, Sudan

ARC-ICARDA-OPEC/Pilot Project
Verification and Adoption of Improved Wheat Production Technology in Farmers' Fields in the Sudan

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International Center for Agricultural Research in the Dry Areas
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FOREWORD

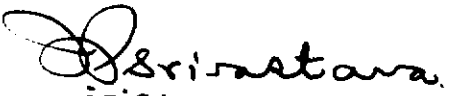
The 1987/88 season was a third successful year for the ARC/ICARDA/OPEC Pilot Project. The overall objective that was set at the launch of the Project in 1985 was to make improved wheat production technology available to the Sudanese farmers, with an aim to boost production and narrow the gap between actual and potential yield. At the end of this season we believe that much of this objective has been met, owing to the unfaltering coordinated efforts of farmers, extension staff, and scientists.

Indeed, it was gratifying to see conclusions and recommendations emerging from research plots, back-up research, and researcher-managed trials flow from scientists to extension staff to the ultimate recipients, the farmers. The reports in the following pages clearly indicate that a substantial increase in wheat yields has been achieved within a relatively short period. The impact of the Project was evident in farmer-managed trials where yields reached 3.6 t/ha in some fields, two- to three-folds higher than those obtained with traditional technologies.

We wish to see more and more farmers accept and adopt these packages which have been carefully designed to fit their conditions, improve their income, and, thus, enhance their welfare. We confidently leave this task in the hands of the Sudanese extension staff who form the indispensable bridge between research and field production at the farmer's level. On the other hand, we also hope these recommendations will be constantly upgraded and refined as wheat production in the Sudan steadily finds its way to more farmers.

The success of the ARC/ICARDA/OPEC Pilot Project manifests itself through the encouraging results that aroused larger interest of the Sudanese authorities who, with the financial support of the Government of the Netherlands and ICARDA, decided to expand the work to a much larger area than was possible within the scope of the present project.

We would like to thank all scientists, extension staff, and farmers who took part in the Project, as well as the concerned authorities at all levels, without whose enthusiasm, devotion, cooperation, and full support, the Project would have never born fruit. The support provided by the OPEC Fund to the Project is gratefully acknowledged.



J.P. Srivastava
Acting Deputy Director General,
International Cooperation

PREFACE

The Third National Wheat Coordination Meeting was funded by the ARC/ICARDA/OPEC Project for the Verification and Adoption of Improved Wheat Production Technology in Farmers' Fields in the Sudan. The meeting was held at the Headquarters of the Agricultural Research Corporation in Wad Medani, 4 to 6 Sept 1988, to review the work done during the 1987/88 season, and to develop a workplan for the 1988/89 season.

OPEC provided financial support for ARC to verify research results through a system of on-farm trials in the major wheat-producing areas (Gezira, New Halfa, and the Northern Region) with the full participation of farmers, extension workers, and production staff. These on-farm trials provided an excellent tool for extension activities, and a number of field-days were organized for farmers and field staff.

The project activities also included some back-up research at Gezira, New Halfa, Hudeiba, and Shendi Research Stations in the areas of crop improvement, nutrition, water requirement, crop production, and protection. Promising results are further tested in researcher-managed on-farm trials to assess their economic viability. Once the improved practices are verified, both technically and economically, they will be included in the farmer-managed trials. These farmer-managed trials assume the role of on-farm demonstrations, and are a final test of the farmers' acceptance of any new practice.

The encouraging results and good achievements obtained during the past three seasons, could never have been possible without the full cooperation and enthusiasm of the farmers, the management, and the field and extension staff in the Gezira Scheme and in New Halfa and the Northern Region Production Corporations.

We are grateful to OPEC for financial support, and to ICARDA and CIMMYT for technical backing.

Osman A.A. Ageeb
National Coordinator, Wheat Research
ARC, Sudan

WELCOMING ADDRESS

Professor Osman I. Gameel
Director General
Agricultural Research Corporation

Your Excellency, Minister of Agriculture and Natural Resources,
Honorable Guests,
Dear colleagues,

It gives me great pleasure to welcome you to the Third National Wheat Coordination Meeting for the OPEC-funded Sudan/ICARDA pilot project aimed at the verification and adoption of improved wheat production technology in farmers' fields.

During the first two days of the meeting, and over five sessions, 16 scientists from four research stations will present results of experimental work carried out during the 1987/88 season. Twenty research papers covering most aspects of wheat production will be discussed. The third day will be devoted to the development of a workplan for wheat and cool-season legumes (faba bean, lentil, and chickpea) for the new Nile Valley Regional Project, embracing Egypt, Ethiopia, and the Sudan. We are very grateful to the Netherlands Government for agreeing to finance the project activities in the Sudan.

The ARC/ICARDA/OPEC Wheat Pilot Project started in 1985 to focus primarily on transfer of improved technologies to farmers' fields, to test the economic viability of the improved technology packages, and to strengthen weak areas of wheat research. With minimal assistance from ICARDA, the project mobilized 17 scientists from four research stations to constitute multidisciplinary research teams, and conduct on-farm trials, for the first time, in the major wheat-producing areas. On-station back-up research was motivated to seek solutions to specific problems identified during the on-farm research activities. The participation of extension workers, field staff, and farmers in the on-farm trials and pilot production plots has been a key factor in the success of this project. The project enabled scientists and extension workers to test to what extent can yield improvement in research plots be realized in farmers' fields and also to demonstrate to farmers that through the adoption of improved technologies they will be able to increase their wheat production and improve their income.

Over the last three seasons, 200 farmers participated in the production and demonstration plots. Average seed yield from these plots was two- to three-fold greater than average yield in the respective production schemes. Yields of more than 15 sacks per *feddan* (3.6 t/ha) were obtained by some collaborating farmers in the Gezira Scheme. The economic analysis of the improved production packages showed the high profitability and good stability of these packages. High marginal rates of return (200-500%) were attained by most participating farmers.

The project has also generated a wealth of scientific information which, if applied, will further boost wheat production. The proceedings of the two previous coordination meetings were published by ICARDA, and distributed to research workers, universities, adminstrators, policy makers, and others. In the area of training, five senior scientists visited ICARDA, each for a period of 3 months, to work closely with their colleagues in the cereal improvement program.

I would like to take this opportunity to express our gratitude to OPEC for financing all the project activities, and to ICARDA and CIMMYT for their unfailing efforts in securing and managing these funds. We are also grateful for the highly-needed backstopping provided by ICARDA and CIMMYT scientists through their frequent visits to the project areas and participation in coordination meetings.

I would like to extend my thanks to you all for the trouble you took to be with us here, and to member of the organizing committee for their diligence to make this meeting a success. I wish the participants fruitful deliberations.

OPENING ADDRESS

His Excellency
Dr. El Fatih El Tigani
Minister of Agriculture and Natural Resources

In the name of God, Most Gracious, Most Merciful.
Honorable guests,
Brother participants,
May God's Peace, His Mercy, and His Blessings be upon you.

I am happy to be amongst you today to open the sessions of the Third National Wheat Coordination Meeting in which you will discuss results obtained last season, and present your programs for the coming season.

You are of course aware that wheat has become a primary nutritional commodity in the country, a consequence of the tremendous social changes that occurred during the last two decades. Urban populations grew at an ever-increasing rate because of the exodus from rural areas accentuated by widespread drought, the war in the south, and the incessant flow of refugees who now constitute about 10% of the inhabitants. Furthermore, the rising income of many social groups led to transformations in dietary habits and more wheat consumption.

Because of the accelerating rates of wheat consumption, a big gap between production and consumption was created. Consequently, dependence on importation increased and now imported wheat constitutes up to 80% of the country's needs. This, in my view, is a very sad state of affairs. The Sudan, with its vast land and water resources is amply qualified to be self-sufficient in staple commodities, especially wheat. With patriotic resolve and with the availability of material inputs, self-sufficiency will be achieved. In this regard, the Sudan has been the subject of studies by several reputable regional organizations, and by several local and foreign consulting firms. The Government, in its Four-year Plan for Salvation, Reform, and Development, is taking a serious move to attain self-sufficiency in wheat within the coming four years, starting this season. Coordination and planning meetings to prepare a detailed program are underway.

It has become clear that -- despite the accumulation of scientific knowledge which made possible the attainment of up to 3.6 t/ha in research plots and even higher yields in some of the progressive farmers' fields --

yields in our production schemes are not more than 1.2 to 1.4 t/ha, i.e. about 40% of research yields. The main reason for such low yields in the production schemes is that recommendations of the Agricultural Research Corporation (ARC) for wheat production are not adopted by farmers. Furthermore, utilization of production inputs provided annually by the government is not scientifically guided, especially in the Gezira Scheme which contains about 70% of the country's wheat acreage. To extend research results to farmers quickly and effectively, a new methodology involving researchers, extension and field staff, members of village production councils, and administrators needs to be adopted.

I understand that ARC in cooperation with the International Center for Agricultural Research in the Dry Areas (ICARDA), and with generous financial support from the Organization of the Petroleum Exporting Countries (OPEC), had undertaken during the last three seasons, and with full participation of production administrators, a pilot project for the transfer of modern production technology to farmers' fields. In the process, technical problems facing wheat production were identified and subjected to appropriate disciplinary research. The outstanding success of participating farmers in achieving very high yields convinced some of us that commercial wheat production in the Sudan is economically feasible, and proved to skeptics that with appropriate technology, successful wheat production in the tropical environment of the Sudan is possible. Furthermore, when farmers realize substantial economic returns by growing wheat, they will continue to grow the crop and will be more receptive to the Government's policies aiming at expanding wheat production.

We are gratified to see that ICARDA and ARC joined efforts to secure the continuity of this applied research endeavour over the coming few years. The favourable response of the Netherlands Government to finance the Sudan component in the Nile Valley Regional Program for Wheat and Grain Legumes, is greatly appreciated, and we hope the support will cover all aspects: research, production, transfer of technology, and training. Any efforts aimed at improving the productivity of our agricultural crops, and at decreasing their production costs will have the support and blessings of the Ministry of Agriculture and Natural Resources. When farming becomes a remunerative enterprise, farmers will remain on land, and perhaps more sectors of the community may be attracted to agriculture.

We extend our sincere thanks to ICARDA and OPEC for their cooperation in this project. I wish those who came from afar, a happy return home and I wish you all every success in your deliberations.

May God's Peace, His Mercy, and His Blessings be upon you.

EXECUTIVE SUMMARY

I. On-Farm Research

A. Pilot Production and Demonstration Plots

Gezira

The package of improved practices in the Gezira comprised good land preparation, mechanical sowing, mechanical application of 86 kg N and 43 kg P_2O_5/ha, efficient water management, watering at 14-day intervals, and growing the wheat cultivar Condor. Forty-seven farmers from four blocks collaborated. Unfavourable conditions encountered during the season included poor water management and infestation by weeds in few locations; high temperatures; and delayed harvest. Nonetheless, the yield advantage of the improved package was 1.14 and 1.34 t/ha over neighboring farmers and the block average, respectively. Collaborating farmers obtained up to 3.66 t/ha and averaged 2.75. Marginal rates of return were, where calculated, over 500%.

New Halfa

Components of the improved technology package in New Halfa were good land preparation, application of 86 kg N/ha, growing the cultivar Condor, sowing on 15 Nov, and watering every 14 days. In addition, mechanical sowing and application of 43 kg P_2O_5/ha were tested in half the tenancies. Twenty-four farmers adopted the package and obtained yields ranging from 1.20 to 2.64 t/ha in comparison with 0.43 to 1.87 in neighbouring farms. On average, improved practices increased yield by 62%. Irregular and inadequate watering and delayed harvest reduced benefits from the improved package.

Northern Region

In the Northern Region, the package of improved practices consisted of growing the cultivar Wadi El Neil, applying 86 kg N/ha, watering every 14 days, and controlling aphids. Nine farmers at Zeidab and two at Hassa participated in testing the package. Inadequate irrigation water at Zeidab precluded adherence to the 14-day watering interval; yields were much below those of last season. The yield advantage of the improved practices at Zeidab varied between 0.01 and 0.79 t/ha and averaged 0.40. There was no clear advantage in the package at Hassa.

B. Researcher-Managed Trials

Gezira

The response of wheat to NPK fertilization in farmers' fields was investigated at four blocks in the Gezira and Managil. Addition of 43 kg P_2O_5/ha, in conjunction with the recommended 86 kg N/ha, increased yield by 52% at two locations, and by 30% at a third location. In all test sites highest yields were obtained with the application of 129 kg N and 64.5 kg P_2O_5/ha. On the basis of these results and those of previous studies, a recommendation to apply 86 kg N and 43 kg P_2O_5/ha to wheat was passed by the Crop Husbandry Committee of the Agricultural Research Corporation.

In the crop improvement program, twelve cultivars, including three checks, were evaluated in nine locations spread over the major wheat-growing regions. Two elite lines were identified as possible candidates for release.

New Halfa

The response of the improved cultivars, Debeira and Condor, and the commercial cultivar, Giza 155, to early (5 Nov) and late (5 Dec) sowing was evaluated at two sites in New Halfa. Higher yields were obtained with early sowing at both locations. The improved cultivars maintained their superiority over the commercial variety at both sowing dates at the two locations.

Northern Region

The effect of sowing date, level of nitrogen fertilizer, and variety on yield was investigated at three locations. At Shendi and Hassa, early planting (10 Nov), low nitrogen level (43 kg/ha), and growing the cultivar Condor resulted in highest yields. At Zeidab, however, alternative treatments (planting on 10 Dec, 86 kg N/ha, and growing the cultivar Wadi El Neil) gave better yields.

II. Back-up Research

A. Crop Improvement

Variety trials were conducted at the Gezira, New Halfa, and Hudeiba Stations to identify elite wheat genotypes. A total of 59 lines were evaluated in advanced trials and 113 new lines were tested in preliminary

trials. Breeding lines with yield superiority of up to 20% over the check cultivars were identified. Promising lines will be advanced for further testing.

Thirty-six lines and cultivars were evaluated for resistance to rust. All the commercial cultivars had good or fair field resistance.

Also, a total of 436 bread wheat and 292 durum wheat accessions were screened for resistance to aphids. Many lines with some resistance were identified.

B. Production Practices

Results of the variety and sowing date experiment conducted at the three research stations of Gezira, New Halfa, and Hudeiba confirmed the adverse effects of early planting on Condor cultivar. The period 12-26 Nov was optimum for Debeira and Wadi El Neil.

The water management experiment at the Gezira Research Station (GRS), indicated the superiority of the 14-day watering interval throughout the growing period for Condor and Debeira cultivars. At Hudeiba, Wadi El Neil cultivar gave its best yield with watering every 28 days from emergence to panicle initiation, and every 10 days thereafter.

Of the tillage operations evaluated at GRS, harrowing twice resulted in the best crop establishment and highest yield.

C. Plant Nutrition

Response to nitrogen and phosphorus fertilization was investigated at Hudeiba, New Halfa, and Shendi Stations. Combined application of nitrogen and phosphorus at highest levels gave best yield at New Halfa, Hudeiba (on Karu Soil only), and at Messaiktab site in Shendi area (Terrace soils).

Split application of nitrogen, half at 50% tillering and half at the boot stage resulted in best yields at Hudeiba, on Karu soil, and at Shendi, on Terrace soils.

Condor and Debeira yielded best with 86 kg N/ha at Hudeiba, but Debeira gave highest yield with 129 kg N/ha. In Shendi area (Messaiktab site with Terrace soils), there was a significant response of all varieties to 43 kg N/ha. On Terrace soil at Hubeida, and on "Gureir" soil at Shendi Station, response to nitrogen was small and nonsignificant.

D. Crop Protection

Plant Pathology

Disease surveys at the Gezira and Hudeiba Stations indicated minor disease incidence. At New Halfa, where stem rust is an important disease. twenty-five resistant lines and a susceptible variety were rated for disease resistance. Seven genotypes showed good resistance to the rust races of this season.

Entomology

The natural build-up of the prevalent aphid species and their natural enemies was monitored at Gezira, New Halfa, and Hudeiba. Lowest numbers of aphids were recorded at Hudeiba. Because of their late appearance, natural enemies played a negligible role in controlling aphids.

Four insecticides were advanced to the large-scale level of testing, and need to be tested for another season before they can be proposed for official release.

Commercially grown cultivars and elite new selections were equally susceptible to aphids on the basis of average counts over the season.

III. Concluding Remarks

Concluding remarks were presented by Professor H.M. Ishag (ARC) and Professor Osman A.A. Fadl (University of Gezira). Both speakers commended the efforts being made to transfer improved wheat production technology to farmers, and called on the Government to facilitate large scale adoption of verified technology. The beneficial role of review panels was pointed out.

IV. 1988/89 Workplan

The program for 1988/89 was put in a final form as part of the Nile Valley Regional Project for wheat and cool-season legumes. Scientists from Ethiopia, the Sudan, Egypt, and ICARDA formulated the project during meetings held in Cairo.

The workplan covers on-farm as well as on-station research and contains a training component. In addition, a study on the impact of the OPEC-funded Pilot Project will be carried out.

SUMMARY OF RESEARCH REPORTS

I. ON-FARM RESEARCH

A. Pilot Production and Demonstration Plots

The primary objective of pilot production plots is to demonstrate to farmers that they can obtain substantially higher wheat yields by adopting improved production technology. In addition, these plots serve to show administrators and policy makers, that with timely delivery of inputs in the required quantities, wheat production can economically be improved. To research scientists, the pilot plots provide a final and crucial assessment to their recommendations.

As in previous seasons, pilot production and demonstration plots were conducted in the major wheat-producing areas: Gezira, New Halfa, and the Northern Region (Fig. 1).

Gezira Scheme

Osman A.A. Ageeb, Cesar A. Guvele, I. Khalid, I.O. Elmekki, A. Musa, and A. Babiker*

Technology components

The improved production technology package for the Gezira Scheme comprised the following:

1) harrowing twice with an offset disc harrow, and leveling with an automatic land leveller;
2) mechanical spreading of urea to give 86 kg N/ha;
3) seed drilling at the rate of 140 kg/ha in conjunction with placement of 43 kg P_2O_5/ha;
4) dividing the farmer's field (2.1 ha) into 60 equal plots to facilitate irrigation;
5) watering the crop every 4 days; and
6) growing the cultivar Condor.

Aphids were controlled by aerial spraying with Ekatin. Mechanical harvest was accomplished by early Apr, two months after physiological maturity.

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* Full addresses of contributors are listed in the Appendix.

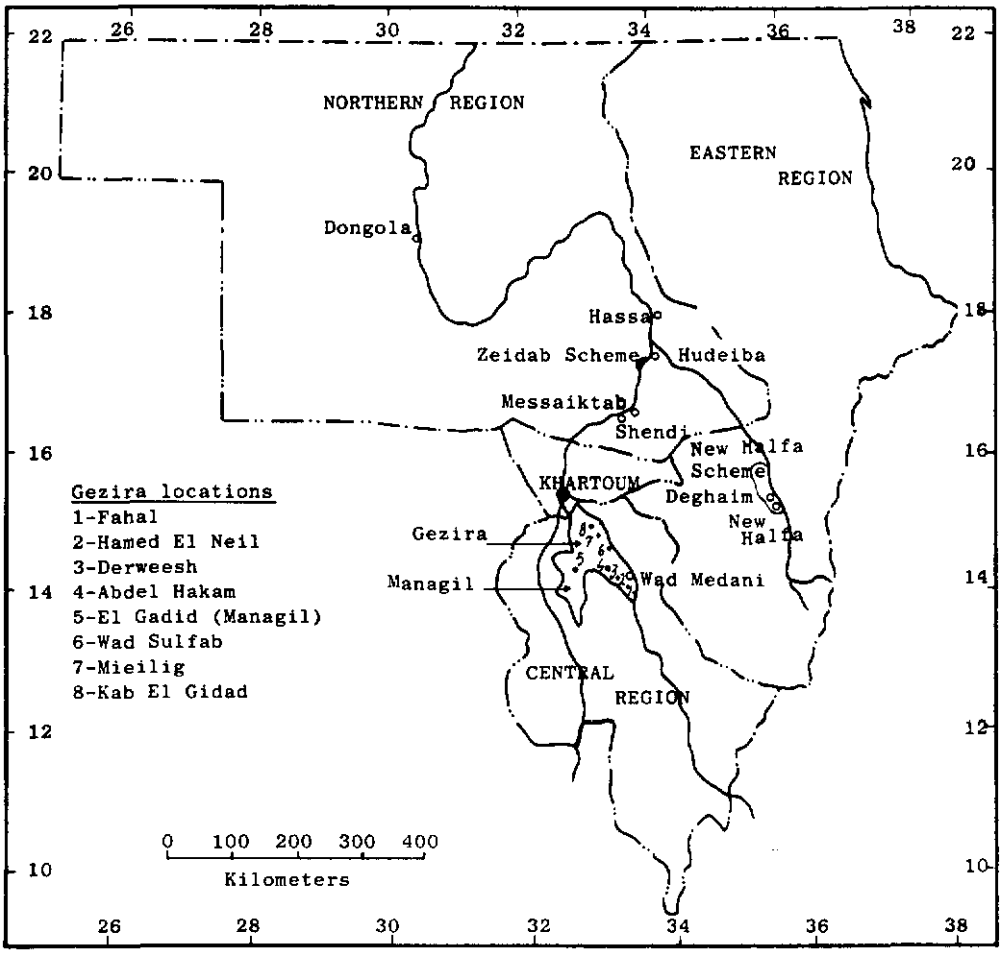

Fig. 1. Wheat-growing regions showing locations of project activities.

Forty-seven farmers from seven locations in four blocks participated. The total area increased from about 57 ha last season to 124 ha this season. At each location, participating farmers had contiguous plots.

In Dec, three field-days were conducted for farmers to observe the favorable effect of improved land preparation on crop establishment.

Results

Crop establishment was excellent in most fields except in two locations where the first watering was poorly managed. Weeds were a problem in few fields, and were removed manually. Dec and early Jan temperatures were higher than those of last season, and adversely affected crop development.

Table 1. Benefits of improved wheat production technology in the Gezira, 1987/88.

Block*	Production technology	Yield (t/ha)	Net revenu (L.S./ha)	Marginal rate of return(%)
Derweesh	Improved	3.66	2816	
	Neighboring farmers			
	Block average	1.67		
Abdel Hakam	Improved	2.47	1717	
	Neighboring farmers			
	Block average	1.45		
Wad Sulfab	Improved	2.55	1704	589
	Neighboring farmers	1.61	662	
	Block average	1.05		
Mieilig	Improved	2.65	1806	546
	Neighboring farmers	1.60	840	
	Block average	1.48		

* For locations of experimental sites see Fig. 1.

Compared with last season, Condor headed five days earlier and produced appreciably lower grain yield. The belated announcement of wheat prices delayed harvest; and because of shattering, yields were reduced by up to 15%.

Despite the foregoing, average wheat yields ranged from 2.42 to 3.66 t/ha and averaged 2.75 with the adoption of improved technology. The increase in yield over the average yield of neighboring farmers and the block average was 1.14 and 1.34 t/ha, respectively (Table 1, Fig. 2). Marginal rates of return for Wad Sulfab and Mieilig were comparable to those obtained at Derweesh last season.

Conclusions and recommendations

1) Adopting the package of improved technology substaintially and economically increased yield of wheat in the Gezira.
2) Basin irrigation of wheat, as practised in the Gezira, needs to be critically analysed, and an easily manageable system developed.
3) A survey of weeds to assess their economic importance in wheat needs to be conducted in farmers' fields.

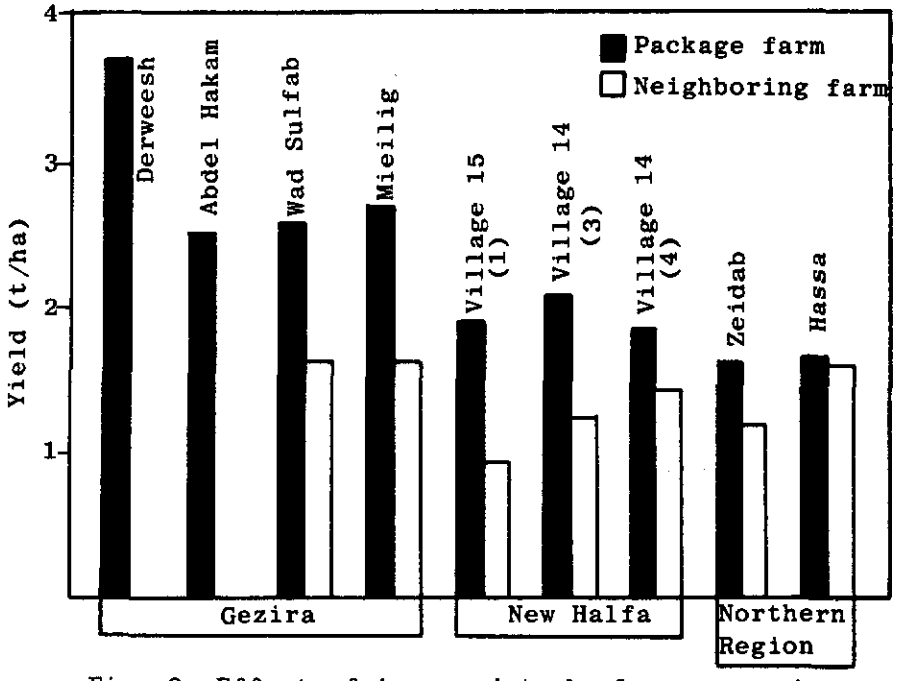

Fig. 2. Effect of improved technology on grain yield at nine locations.

New Halfa Agricultural Production Corporation

M.S. Mohammed, A.B. Omer, M.A. Salama, G.A. Arman, and S.M. Ibrahim

Technology components

The improved technology package for New Halfa tenants included the following components:

1) optimum land preparation through disking, pre-watering, harrowing, and levelling;
2) nitrogen application at the rate of 86 kg/ha;
3) growing the cultivar Condor;
4) planting on 15 Nov; and
5) watering every 12-14 days.

In addition, mechanical seed drilling and phosphorus application at the rate of 43 kg/ha were tested in half the tenancies. Twenty-four farmers from Deghaim block adopted the package.

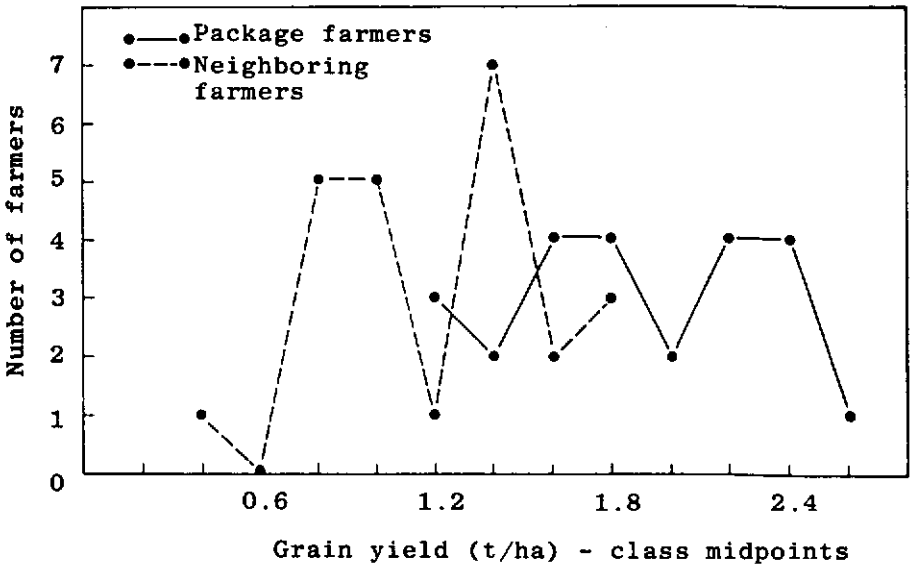

Fig.3. Distribution of yields obtained by 24 package farmers and 24 neighboring farmers (Degaim block, New Halfa).

Results

Yields obtained by farmers adopting improved practices ranged from 1.20 to 2.64 t/ha, compared with 0.43 to 1.87 obtained by neighboring farmers (Fig. 3). On the average, improved practices increased yield by 62% (Table 2, Fig. 2). Irregular and inadequate watering reduced benefits from the package, and the situation was probably aggravated by the sensitivity of Condor cultivar to moisture stress. Advice to farmers on the critical moisture requirements of that cultivar was unheeded. Delayed harvest resulted in up to 20% yield loss of Condor. Giza 155, grown by over 90% of the farmers, sustained much less harvest losses.

Conclusions and recommendations

1) Irrigation practices followed by New Halfa tenants need to be improved.
2) Seed drilling and phosphorus application improved emergence and crop establishment.
3) Harvest should be accomplished as early as possible after maturity, especially when the cultivar Condor is grown.

Table 2. Mean grain yield (t/ha) obtained by package and traditional farmers at three locations in Deghaim block, New Halfa Corporation, 1987/88.

Location	No. of farmers	Grain yield	
		Package farms	Traditional farms
Village 15 (No.1)	8	1.90	0.91
Village 14 (No.3)	4	2.07	1.22
Village 14 (No.4)	12	1.83	1.42

Northern Region

Musa B. Taha

Technology components

In the Northern Region, the improved package consisted of four components:

1) growing the cultivar Wadi El Neil;
2) applying nitrogen at the rate of 86 kg/ha;
3) watering the crop at 14-day intervals; and
4) chemical control of aphids with Ekatin.

Nine farmers at Zeidab Scheme and two at Hassa Scheme adopted the package; irrigation constraints at Zeidab, and weed infestation at Hassa precluded involving more farmers. The plots covered an area of 6.7 ha at nine locations at Zeidab, and 1.3 ha at two locations at Hassa. Farming practices of an equal number of neighboring farmers were monitored for comparison.

A field-day was arranged at Zeidab and was attended by farmers and extension staff.

Results

Because of inadequate irrigation water, adherence to the 14-day watering interval was not possible at Zeidab. The actual watering interval ranged from 11 to 47 days. Yields were, therefore, very low and amounted to less than half the yields obtained last season. But, in spite of the constraints imposed by irrigation at Zeidab, adoption of the package significantly increased yield over that obtained by neighboring farmers

Table 3. Effect of improved technology package on wheat yields at two locations in the Northern Region, 1987/88.

Location	No. of farmers	Grain yield (t/ha)	
		Improved package	Neighboring farms
Zeidab	9	1.59	1.19
Hassa	2	1.64	1.58

(Table 3, Fig. 2). The gain in yield ranged from 0.01 to 0.79 t/ha and averaged 0.40. The reduced yields obtained by neighboring farmers were associated with delayed planting, fewer waterings, abscence or inadequacy of nitrogen fertilization, and lack of measures to control aphids.

At Hassa, results were inconsistent: adoption of the package increased yield by 417 kg/ha at one location but reduced it by 312 kg/ha at the other.

Conclusions and recommendations

1) Results obtained this season and previous seasons showed that improved technology significantly increased wheat yields in farmers' fields at Zeidab.

2) At Hassa, component technology research on methods of sowing and weed control is needed for the formulation of an appropriate production package.

B. Researcher-Managed Trials

Gezira

On-farm verification variety trial

Abdalla B. El Ahmadi, M.S. Mohammed, Gaafar E. Mohammed, and A.I. Sheikh Mohammed

The on-farm verification variety trial this season comprised three lines from the Gezira breeding program, six lines from New Halfa program, and three check cultivars: Condor, Debeira, and Wadi El Neil. A randomized complete block design with four replications was used. The experiment was conducted at nine locations, five in the Gezira area, two in New Halfa, and two in the Northern Region (Table 4). Recommended cultural practices, including the application of 43 kg P_2O_5/ha, were followed.

Table 4. Grain yield (kg/ha) at on-farm verification variety trials conducted at Gezira, New Halfa, and the Northern region, 1987/88.

Cultivar	Gezira					New Halfa		Northern Region	
	Fahal	Derweesh	Wad Medani	Wad Sulfab	El-Gadid	Village 15	Research farm	Shendi	Hudeiba
Debeira	3063	3717	2678	3094	2439	4341	4481	4039	3332
Condor	2796	4105	2513	3598	2468	4291	4086	4220	3122
S948-A-Se7	2899	3629	2601	3391	2661	3970	4182	3772	3438
Wadi El Neil	3375	3108	2678	3672	2275	3632	3629	3848	3194
Jup 73/Fury x Cno's'	3063	3539	3184	3658	2170	4086	4098	3975	3658
Yt54A(E)^3 x Yt (A4)	2706	3034	2839	3168	1918	4079	4270	4003	3869
Nd Sel 101-Pv's'	2811	3748	2796	2066	1873	4570	4696	3765	3182
Sel 129 F6 78-79	2737	4088	3080	1992	2082	4503	4710	3520	2761
Sel 73 F7 79-80	2751	3658	2961	2320	1621	4662	4574	3527	3155
Vee's' CM 33027-F-15M	3077	4120	2768	3629	2006	4381	4753	4077	2542
Vee's' CM 33027 OM-87B	2856	3941	2708	3570	2289	4800	4681	4086	2457
Vee's' CM 33027 OM-89B	2542	3539	2230	2023	1873	4208	4324	3801	2376
SE +	272	226	189	278	197	202	233	231	236
CV %	19	12	13	18	18	9	11	12	15

Results

Variation in yield among cultivars was significant at all locations except Fahal and Shendi. Debeira was significantly outyielded by Jup 73/Fury x Cno's' at Wad Medani (Gezira Research Station) and Wad Sulfab, by Vee's' CM-30027-F-15M at Derweesh and Wad Sulfab, and by Vee's' CM-33027-OM-87B at Wad Sulfab and Village 15. Nd Sel 101-Pv's' and S984-A-Se7, which were superior to Debeira last season, gave yields similar to it this season. Seed shattering was evident in Nd Sel 101-Pv's' in early Mar when dry and windy weather prevailed.

Conclusions

The lines S948-A-Se7 and Jup 73/Fury x Cno's' are very similar agronomically and either may be recommended for release.

The response of wheat to NPK fertilization in farmers' fields in the Gezira

Osman A.A. Ageeb and Hassan H. Abdalla

The heavy cracking vertisols of the Gezira are very low in available (sodium bicarbonate-extractable) phosphorus; values range from 1.4 to 4.5 ppm. Nevertheless, response of wheat to phosphorus application in on-station experiments was low and varied between seasons and locations. To arrive at more appropriate recommendations, a series of trials to investigate the response of wheat and select combinations of NPK fertilizers in farmers' fields was initiated. The trial this season comprised six fertilizer combinations arranged in a randomized complete block design. Nitrogen and potassium were broadcast, but phosporus was placed with the seed. The experiment was conducted at four locations (Table 5).

Table 5. Effect of NPK fertilizer on the mean grain yield (kg/ha) of wheat at four locations in the Gezira, 1987/88.

Fertilizer rate (kg/ha)	Derweesh	Wad Sulfab	Kab El-Gidad	El-Gadid
86 kg N	4567	2347	2625	1747
129 kg N	4741	2287	2968	1468
43 kg N + 43 kg P_2O_5	3146	2839	3249	2597
86 kg N + 43 kg P_2O_5	4446	3061	3982	2658
86 kg N + 43 kg P_2O_5 + 43 K_2O	4482	3139	3929	2420
129 kg N + 64.5 kg P_2O_5	5267	3370	353	3001
SE ±	257	86	200	93

Results

Response to phosphorus varied with locations and was highly significant at three locations. Addition of 43 kg P_2O_5/ha in conjunction with the recommended 86 kg N/ha increased yield by 52% at El-Gadid in Managil and at Kab El Gidad in northern Gezira, and by 30% at Wad Sulfab. In all locations the highest yield was obtained with 129 kg N and 64.5 kg P_2O_5/ha (Table 5).

Conclusions and recommendations

1) There was a marked response to phosphorus in the Gezira and Managil Extension; response increased from central to northern Gezira.
2) Phospohorus application improved response to nitrogen.
3) There was no response to potassium fertilization.

(Note: On the basis of these results and those of previous studies, a recommendation to apply 86 kg N and 43 kg P_2O_5/ha to wheat in the Gezira and the White Nile area was passed by the Crop Husbandry Committee of ARC in its meeting of 22 May 1988).

New Halfa Corporation

Response of three commercial wheat cultivars to optimum and late sowing at two sites in New Halfa Corporation

Ahmed M. Gorashi

The three commercially-grown wheat cultivars Debeira, Condor, and Giza 155 were tested at two sowing dates, 5 Nov (optimum) or 5 Dec (late). Experimental plots were arranged in randomized complete blocks and replicated four times. The experiment was conducted at two sites, Village 21 and Village 24; a third site was abandoned because of damage caused by the residual effect of a herbicide. Recommended cultural practices were followed.

Results

Differences in yield among cultivars were significant at Village 21 but not at Village 24. At both sites Debeira gave the highest yield, followed by Condor (Table 6). Early planting resulted in significantly higher yields. The cultivar x sowing date interaction for yield, was not significant at both sites.

Conclusions

1) Debeira and Condor maintained their yield advantage over Giza 155 with late planting.

Table 6. Effect of cultivar and sowing date on the mean grain yield (kg/ha) of wheat at two villages in New Halfa.

Treatment	Village 21	Village 24
Cultivar		
Condor	1639	1910
Debeira	1916	2017
Giza 155	1398	1794
SE ±	71.4	69.0
Sowing date		
5 Nov	2767	3127
5 Dec	2187	2594
SE ±	47.6	57.1

2) In future trials, response of these cultivars should be evaluated at sowing dates later than 5 Dec.

Northern Region

Effect of sowing date, nitrogen fertilizer, and variety on grain yield of wheat in the Northern Region

Musa B. Taha and Gaafar E. Mohammed

The treatments in this trial comprised three factors, each at two levels, combined in a factorial plan as follows: sowing on 10 Nov or 10 Dec, nitrogen application at the rate of 43 or 86 kg N/kg, and the wheat cultivar Wadi El Neil or Condor. A randomized complete block experimental design with four replications was used. The trial was conducted at Zeidab, Shendi, and Hassa. Optimum cultural practices were followed except for watering at Zeidab where, because of irrigation problems, watering intervals were occasionally extended to 25 days.

Results

Earlier planting resulted in yields significantly higher than those obtained with late planting at Shendi and Hassa, but not at Zeidab (Table 7). The higher level of nitrogen significantly increased grain yield only at Zeidab. The average yield of Condor was higher than that of Wadi El Neil at Hassa and Shendi, the difference was significant at the latter site; Wadi El Neil, however, significantly outyielded Condor at Zeidab.

Table 7. Effect of sowing date, nitrogen fertilizer, and variety on grain yield of wheat at three locations in the Northern Region, 1987/88.

Treatment	Zeidab	Hassa	Shendi
Sowing date			
10 Nov	2185	3137	3788
10 Dec	2237	2538	2853
Nitrogen level			
86 kg/ha	2453	2821	3253
43 kg/ha	1969	2855	3387
Cultivar			
Wadi El Neil	2401	2759	3009
Condor	2021	2915	3631
SE ±	57.2	99.0	91.5

Conclusions

1) Treatment effects varied with locations.

2) Average response to sowing date and nitrogen application at Zeidab and Shendi was similar to that of last season.

II. BACK-UP RESEARCH

Abstracts of back-up research, along disciplinary lines, are presented. Most of the experimental work, but not all of it, was carried out at research stations: Hudeiba and Shendi Stations in the Northern Region, Gezira Research Station in the Central Region, and New Halfa Station in the Eastern Region (Fig.1).

A. Crop Improvement

Wheat variety trials at the Gezira Research Station

Abdalla B. El Ahmadi

Two wheat variety trials were carried out at the Gezira Station: an advanced trial of 10 cultivars, and a preliminary trial comprising 46 lines. In both trials the commercially grown cultivars, Condor and Debeira, were included

as checks. In the advanced trial, the grain yield of 2649 kg/ha obtained from Condor, the better check, was surpassed by all the new cultivars. Superiority of some lines over Condor exceeded 15%, but differences were not statistically significant. Outstanding lines will be advanced to the on-farm verification trials.

Severe termite damage and poor growth of lines in the preliminary trial precluded obtaining meaningful data. The trial will be repeated next season.

Wheat variety trials at New Halfa Research Station

Mohammed S. Mohammed

Two advanced trials and a preliminary trial were carried out at New Halfa Station. Advanced Trial I comprised 24 entries, including the check cultivars Condor and Debeira. Three lines gave yields significantly higher than that of Debeira; the best line attained a yield of 5330 kg/ha, exceeding those of Debeira and Condor by 15 and 10%, respectively. In Advanced Trial II, 22 new lines and the two check cultivars Debeira and Condor were evaluated. The highest yields of 4548 and 4458 kg/ha, obtained from two new lines, were significantly higher than that of Debeira by 15% and 12%, respectively. Six lines significantly outyielded Condor which produced 3731 kg/ha . The preliminary trial comprised 48 entries including Condor and Debeira. Eighteen lines outyielded Debeira, the better yielding check. One line significantly outyielded Debeira by 671 kg, a yield advantage of about 18%.

Wheat variety trials at Hudeiba Research Station

Abdalla I. Sheikh Mohammed

Two variety trials were conducted at Hudeiba: an advanced trial of nine lines and the released cultivars Condor, Debeira, and Wadi El Neil; and a preliminary trial comprising 23 lines and Wadi El Neil. In the advanced trial, Debeira gave the highest yield of 2965 kg/ha; Condor and Wadi El Neil were both outyielded, though not significantly, by five lines. None of the new lines in the preliminary trial significantly outyielded Wadi El Neil, but two lines gave yields 20% higher.

Screening wheat germplasm for resistance to rust

M.S. Ahmed and M.S. Mohammed

Thirty advanced breeding lines and six commercial cultivars were evaluated for resistance to stem rust (*Puccinia graminis* f. sp. *tritici*). The entries were grown in four blocks, each surrounded by the susceptible "Beladi" cultivar, and nitrogen was applied at the rate of 190 kg/ha. Observations

on rust were made on 3 Mar 1988; scoring was based on disease severity and infection type. Compared with last season, stem rust started earlier and spread more slowly, whereas leaf rust was more noticeable this season. Twenty-nine cultivars, including Debeira, Condor, Giza 155, and Mexicani showed good resistance to stem rust; Wadi El Neil showed fair resistance. Twenty-four entries including Debeira, Condor, and Wadi El Neil showed good resistance to leaf rust. Mexicani and Giza 155 were fairly resistant.

Screening wheat germplasm for resistance to aphids

Nasr Eldin Sharaf Eldin

In search of new sources of resistance to aphids, 436 bread wheat and 292 durum wheat accessions, were evaluated at the Gezira, New Halfa, and Hudeiba Research Stations. Plots were unreplicated single rows, 2.5-m long and spaced 40 cm apart. Three counts were made during the season. A total of 79 bread wheat and 17 durum accessions with some resistance were identified at either Gezira or New Halfa. Because aphid infestation this season was less than normal, these resistant accessions will be evaluated again next season.

B. Production Practices

1. Sowing Date

Response of three wheat cultivars to sowing date at Gezira, New Halfa, and Hudeiba

Osman A.A. Ageeb, Ahmed M. Gorashi, and Musa B. Taha

The experiment investigating the response of the commercially-grown wheat cultivars Condor, Debeira, and Wadi El Neil to sowing date was repeated this season at the Gezira, New Halfa, and Hudeiba Research Stations. Sowing started on 15 Oct and continued at 14-day intervals until 10 Dec. As in last season, a significant variety x sowing date interaction was detected only at the Gezira Research Station (GRS). Condor, being sensitive to high temperatures, gave the lowest yield at all locations when planted on 15 Oct, but outyielded the other cultivars with late planting on 10 Dec. Optimum time of planting for Debeira and Wadi El Neil in the three locations was Nov 12-26; at GRS, however, planting Wadi El Neil 14 days earlier or later than 12 Nov, significantly reduced yield.

2. Water Management

Effects of different irrigation intervals at two stages of development on the performance of two wheat cultivars at the Gezira Research Station

Saeed M. Farah

The cultivars Condor and Debeira were subjected to two watering intervals at two stages of development: (1) every 14 or 21 days from planting to the boot stage, and (2) every 14 or 10 days from the boot stage to harvest, resulting in a combination of four watering regimes. Condor and Debeira performed best with shorter watering intervals at both development stages, yielding 2427 and 2992 kg/ha, respectively; yields were reduced to 1802 and 2037 kg/ha, respectively, with the longer watering intervals. The other two watering regimes gave similar yields. Longer watering intervals at crop establishment stage, however, has the advantage of relieving irrigation constraints which usually occur at that time in the Gezira cropping system.

Effects of different irrigation intervals at three stages of wheat development on yield and water-use efficiency

Hassan S. Ibrahim

The effects of different watering intervals at specific phenological stages on the development of the cultivar Wadi El Neil were studied at Hudeiba Research Station. The irrigation treatments were (1) watering every 14, 21, or 28 days from emergence to panicle initiation; (2) every 10 or 14 days from panicle initiation to 50% heading; and (3) every 10 or 14 days from 50% heading to maturity. Watering at 28-day intervals from emergence to panicle initiation stage, and at 10-day intervals thereafter, resulted in the highest yield of 4061 kg/ha which exceeded that obtained with the shortest irrigation interval at all stages by 333 kg/ha. With the former irrigation regime nine waterings were applied, and water-use efficiency attained the highest value of 0.69 kg/m^3/ha, whereas with the latter regime, 10 waterings were applied, and water-use efficiency was reduced to 0.57 kg/m^3/ha.

3. Mechanization

Effect of different tillage systems on wheat establishment and grain yield

Ahmed A. Salih and Ahmed Musa

Four tillage methods were tested for their effect on the establishment and grain yield of the wheat cultivar Condor at the Gezira Research Station. The treatments consisted of (1) disc plowing, harrowing, and levelling; (2) ridging, harrowing, and levelling; (3) harrowing twice and levelling; and (4) ridging, split-ridging, and levelling. The treatments were replicated four times in a randomized complete block design. Significant differences in grain yield were detected among treatments. Harrowing twice resulted in the highest grain yield of 1800 kg/ha and the best crop establishment. Disc-plowed fields yielded 15% less than harrowed ones and involved L.S. 119/ha more in production cost.

C. Plant Nutrition

Varietal response to nitrogen fertilizer on the major soil types in Hudeiba area

Hassan S. Ibrahim

The response of the cultivars Condor, Debeira, and Wadi El Neil to nitrogen application on "Karu" soil at Hudeiba Research Station (HRS) and on high Terrace soil was investigated for the second season. The "Karu" soils are of medium fertility; the sandy "Terrace" soils are poor and frequently alkaline and saline, but constitute the bulk of land available for future expansion in the region. Four levels of nitrogen were applied: nil, 43, 86, and 129 kg/ha. At HRS nitrogen application increased grain yield significantly. Condor and Wadi El Neil gave the highest yields of 4241 and 4362 kg/ha, respectively, with the application of 86 kg N/ha -- an increase of more than 200% over the control. Debeira gave its best yield of 3992 kg/ha with 129 kg N/ha -- an increase of 178% over the control. In contrast, the response of all cultivars to nitrogen application on the Terrace soil was small and nonsignificant.

Varietal response to nitrogen fertilization under two major soil types in Shendi area

Gaafar E. Mohammed

The treatments in this experiment were identical to those in the experiment that had been carried out at Hudeiba with similar objectives (these proceedings). The trial was conducted at Shendi Research Farm ("Gureir" soil) and at Messaiktab (high Terrace soil). The three cultivars yielded similarly at both locations. Response to nitrogen at the Research Farm was small and nonsignificant. At Messaiktab, 43 kg N/ha raised the yield significantly from 467 to 856 kg/ha as an average over cultivars; yield, however, did not increase with more nitrogen application.

Effects of time and rate of nitrogen application, and phosphorus fertilization on wheat yield and nitrogen and phosphorus uptake under two soil types in Hudeiba area

Hassan S. Ibrahim

The effects of nitrogen and phosphorus and time of nitrogen application on grain yield and uptake of nitrogen and phosphorus by Wadi El Neil cultivar were investigated at Hudeiba Research Station (HRS) and "Gabir Farm" (high Terrace soil). Three levels of nitrogen, 0, 86, and 129 kg N/ha were applied as follows: (1) in one dose at sowing; (2) split, with one half at sowing, and the other half either at 50% tillering, or at the boot stage; (3) split, with one half at 50% tillering and the other half at the boot

stage. The nitrogen treatments were combined with two levels of phosphorus: nil or 43 kg P_2O_5/ha applied in one dose at sowing. Grain yield was increased significantly by nitrogen application on the "Karu" soil but not on the Terrace soil. Split application of nitrogen, half at 50% tillering and half at the boot stage, resulted in the highest yield of 4.8 t/ha with both levels of nitrogen; the highest nitrogen level of 129 kg/ha, however, produced its effect, in conjunction with phosphorus. Uptake of nitrogen and phosphorus was also best with split application at tillering and at the boot stage.

Effect of nitrogen level and time of application in relation to phosphorus fertilization on wheat grain yield under two soil types in Shendi area

Gaafar E. Mohammed

The treatments in this trial were identical to those in the previous trial conducted at Hudeiba Station (these proceedings). The trial was carried out at Shendi Research Farm on silty clay loam soil ("Gureir") and at "Messaiktab" on a high Terrace soil. The eight nitrogen treatments and the control occupied whole plots in a split plot design where the phosphorus treatments occupied the subplots. Nitrogen addition on "Gureir" soil reduced yield significantly; the highest grain yield, 3879 kg/ha, was obtained from the control. Similar results were obtained at this site last season. In contrast, orthogonal comparisons of "Messaiktab" results showed that nitrogen addition resulted in considerable increase in yield as compared with the control; the difference between the two nitrogen levels was not significant. Split-application was superior to single-dose application. The highest yields of 1336 and 1177 kg/ha were obtained with 86 and 129 kg N/ha, respectively, both applied half at 50% tillering and half at the boot stage. The control resulted in the lowest yield of 398 kg/ha. Phosphorus increased yield significantly on the Terrace soil, but not on the "Gureir" soil.

The response of wheat to different levels of nitrogen and phosphorus at New Halfa

Ahmed M. Gorashi

The response of the wheat cultivar Condor to various levels of nitrogen and phosphorus was investigated in a trial conducted at "Village 24" in New Halfa. Four nitrogen levels, 0, 43, 86, and 129 kg/ha were applied in combination with three levels of phosphorus: nil, 43, and 64.5 kg P_2O_5/ha. At planting, urea was broadcast and triple superphosphate was applied as side dressing. Results showed that neither the main effects nor the interaction effects on yield were statistically significant. Application of both fertilizers at the highest levels, however, increased yield substantially from 2422 to 3165 kg/ha.

D. Crop Protection

1. Plant Pathology

Disease survey of wheat in the Gezira

Gaafar Ibrahim Mohammed

The wheat crop at the Gezira Research Station and several out-of-station experimental sites, was surveyed for disease incidence. *Helminthosporium spiciferum* was consistently isolated from leaves showing expanded leaf spots. A positive reaction to pathogenicity testing was obtained on a local cultivar, but not on the cultivars Condor and Debeira.

A survey of wheat diseases at Hudeiba Research Station

Mohammed El Fatih K. Ali

All the experimental wheat plots at Hudeiba Research Station were regularly surveyed for disease incidence from crop establishment to harvest. The crop was free from diseases except for a very low incidence of symptoms resembling wheat streak mosaic and wheat spot mosaic viruses. The situation in the main wheat-producing areas in the Northern Region, however, may be different because many farmers still grow local wheat cultivars.

An investigation into the race virulence of stem rust natural inoculum on differential varieties and resistant lines of wheat

Mohammed S. Ahmed

Twenty lines, each with a single and different gene conditioning stem rust resistance, four differential cultivars, a resistant cultivar, and a susceptible cultivar were rated for resistance to stem rust at New Halfa Research Station. The 26 genotypes were grown in single unreplicated rows, and the trial was surrounded by a belt of the susceptible cultivar "Beladi". The rating of genotypes was based on coefficient of infection (CI), the product of disease severity (%), and numerical values assigned to infection type. Good resistance (CI = 0-5) was found in seven genotypes including the resistant entry and two differential ones. Two lines showed fair resistance (CI = 6-10), four lines were marginal (CI = 11-20), and the rest were poor (CI > 20).

2. Entomology

Population dynamics of aphids and their natural enemies in the field

Nasr Eldin Sharaf Eldin

The natural build-up of the aphid species, *Rhopalosiphum maidis* Fitch and *Schizaphis graminum* Rond, was monitored at Gezira, New Halfa, and Hudeiba

Research Stations in plots grown to the cultivars Debeira, Giza 155, or Wadi El Neil. The percentage of infested plants, the number of aphids per plant, and the number of natural enemies were recorded. At the peak of infestation, the percentage of affected plants was 32 at the Gezira Station, 47 at New Halfa, and 14 at Hudeiba; the corresponding numbers of aphids per plant were 10, 24, and 13. Aphid numbers started to decline late Dec at Hudeiba, late Jan at the Gezira Station, and late Feb at New Halfa. The role of natural enemies -- mostly Coccinellids, Chrosopa, and Syrphids -- was negligible; they appreared late in the season when aphid numbers were already declining because of rising temperatures and senescence of the host plant.

Chemical control of aphids on wheat in the Gezira

Nasr Eldin Sharaf Eldin

Results obtained last season confirmed the superiority of some insecticides in controlling aphids. This season, four insecticides were advanced to large-scale testing; Dursban (E.C. 4%), Redlan (E.C. 50%), Danitol-S (E.C. 50%), and Pirimor (DP 50%). The first two were applied at the rate of 297.5 cc/ha; Danitol-S was applied at the rate of 952 cc or 1428 cc/ha; and Pirimor DP at the rate of 238 g/ha. Ekatin (E.C. 25%) at the rate of 595 cc/ha was the control. The six treatments were replicated four times over an area of 24 *numbers* (one *number* = 37.8 hectares) at Hamad El Neil block. Spraying was by aircraft. Data obtained on the percentage of infested plants and number of insects per hundred plants after spraying showed that all treatments provided effective control of the pest with one application. Percentage of infested plants was reduced from 23-28 to 6-7, and the number of insects from 21-31 to 2-7 per hundred plants. Proposal for official release of these chemicals for commercial use, however, requires another season of large-scale field testing.

Relative susceptibility of wheat cultivars to aphids

Nasr Eldin Sharaf Eldin

The susceptibility of the commercial wheat cultivars Condor, Debeira, Giza 155, and Wadi El Neil, and two promising breeding lines, S-948-A-Se7 and Nd Sel 101-Pv's' was evaluated at the Gezira, New Halfa, and Hudeiba stations. Natural infestation was assessed from the proportion of infested plants and number of insects per plant. Results showed that the cultivars and lines had similar average (over counts) percentage of infestation and number of aphids per plant at each location. The line Nd Sel 101-Pv's', however, showed the highest percentage of infested plants at the Gezira Station (26.1%) and at Hudeiba (28.81%) and was second to Debeira at New Halfa (15.7%). Also, plants of this line sustained the highest number of aphids at Hudeiba and, with Condor, also at Gezira and New Halfa. The line S-948-A-Se7 had the lowest infestation percentage at Gezira and New Halfa, and was second to Debeira at Hudeiba.

CONCLUDING REMARKS

Prof Hassan M. Ishag
National Coordinator, Groundnut Research, ARC

- First of all, I must congratulate Dr Osman Ageeb, National Coordinator for Wheat Research, and his colleagues for the excellent and fruitful work they are doing.

- Now that wheat production in the irrigated Gezira Scheme proved to be successful under farmers' conditions, what are the Government plans to procure required inputs such as land-preparation equipment, seed drills, combine harvesters, fertilizers, seeds, etc.

- Back-up research should be more refined. An in-house review team, including scientists not working on the project, can help in improving the program.

- There is an urgent need for new cultivars combining early maturity, tolerance to delayed harvest, yield stability, and -- since under our semi-arid conditions tillers contribute little to yield -- the uni-culm character.

- Studies on factors affecting crop establishment and effect of cultural practices on quality are urgently needed.

- Because irrigation is a critical factor in wheat production, a multi-disciplinary team from the Ministry of Irrigation, Hydraulics Research Unit, University of Gezira, Sudan Gezira Board, and ARC should be formed to tackle the technical matters of availability of water, indenting, etc. for wheat production.

- Since 1974, when a workshop on cereals in the Sudan was held, no workshop was organized for wheat. Now we have a wealth of information on wheat production -- a workshop needs to be held and its proceedings published.

Prof Osman A.A. Fadl
Faculty of Agricultural Sciences, University of Gezira

- The reports, quite understandably, adopted the metric system to be consistent with international publications. However, it should be remembered that the Project addresses the local needs of production. It is therefore appropriate to use the widely understood terms like the *feddan* rather than the hectare.

- Care should be exercised on yield data obtained from tiny plots e.g. yield data from 1/100 or 1/200 *feddan*. No matter what arguments support such data, they should not be used to judge farmers' yields. Farmers' yields are taken from whole plots -- good spots and poor spots. Sampling small spots from a field is most convenient, but most misleading.

- The overwhelming consideration in the back-up research of this program should be guided by real production interests rather than scientific interests. It is reassuring to find the growing role of economics in the Program's research. The role of economics needs to be expanded and sometimes should be guiding. One would like to see economic studies in the planning stages of the experimental work.

- Reports need to give adequate explanation of the experimental conditions.

- Despite the high standard of papers delivered in the last two days, perhaps the idea of a panel to review the experimental workplan might be considered. The panel members should be of wide experience, and of various professional backgrounds to critically evaluate the experimental program. This is to avoid repetitive work along lines already done 20 or more years ago. The need for "openness" has been well demonstrated during this meeting.

- Participants and ARC leadership have shown seriousness, concern, and devotion to takcle problems which face producers. The leadership of the Program has been commendable in implementing the objectives of the project: verification and adoption of technology to upgrade wheat production in the Sudan. Donors have been generous to support the Program. There remains a need for an equivalent political determination and will to explore ways and means to give farmers "the tools to do the job".

WORKPLAN 1988-89

The last day in the coordination meeting was devoted to a detailed discussion of the 1988-89 program. Subsequently, the program was discussed again and brought to its final form during the Nile Valley Regional Project meetings held in Cairo from 21 to 24 Sept 1988. The meetings were attended by scientists from Ethiopia, the Sudan, Egypt, and ICARDA. In what follows, an abridged form of the workplan will be presented.

I. IMPACT OF THE PILOT PROJECT ON VERIFICATION AND ADOPTION OF IMPROVED WHEAT PRODUCTION TECHNOLOGY IN FARMERS' FIELDS

The objective of this study is to quantify and analyse actual adoption by farmers of the technology packages developed and tested over the last three seasons. The study will cover the three wheat-producing areas: Gezira, New Halfa, and Northern Region. A consultant will be employed.

Scientists i/c

Dr Hamid H. El Feki
Prof Murid G. Mansi
Dr Osman Ageeb

II. ON-FARM RESEARCH

A. Gezira

A.1. Pilot production and demonstration plots

In accordance with the national development plan to attain self-sufficiency in wheat, the Sudan Gezira Board (SGB) will prepare 60 000 *feddans* (approximately 25 210 ha) as specified in the package, and half the area will be machine-planted. All other inputs will be provided to farmers at the required levels. A multi-disciplinary task force, headed by the National Coordinator for Wheat Research, will monitor the progress of this activity and provide on-site advice.

Reference plots within the pilot area will be planted during the second week in Nov and harvested within four weeks from physiological maturity;

other operations will be as for the recommended package used this season. Data will be subjected to economic analysis.

Steering Committee

Dr Osman A.A. Ageeb, National Coordinator, Wheat, GRS
Dr Hamid H. El Faki, Economist, GRS
Agricultural Manager, SGB
Sayed Ahmed Musa, Agricultural Engineer, SGB
Director, Extension Department, SGB
Director, Seed Propagation Department, SGB

A.2. Researcher-managed trials

A.2.1. Wheat differential fertilizer programs

The objective is to study interrelationships between the amounts of fertilizer in the soil, added fertilizer, and fertilizer uptake, with a view to predict crop requirements with better accuracy. Nitrogen at four levels, 0, 43, 86, and 120 kg/ha; and phosphorus at three levels 0, 43, and 86 kg P_2O_5/ha will be considered.

Scientists i/c

Dr Mohamed A.E. Satti, Agronomist, GRS
Dr Hassan H. Abdalla, Soil Chemist, GRS

A.2.2. Crop establishment studies

These studies are conducted with the objective of verifying previous results from on-station research where seed rates from 50 to 200 kg/ha had no effect on yield. Seed rates of 95, 125, 145, and 170 kg/ha will be tested.

Scientists i/c

Dr Osman A.A. Ageeb, Agronomist
Dr Abdel Gabbar E. Babiker, Weed Scientist
Dr Hamid H. El Faki, Economist

A.2.3. On-farm verification trial

This is a multilocation trial involving 10 new high-yielding breeding lines from the Gezira, New Halfa, and Hudeiba programs.

Scientists i/c

Dr Abdalla B. El Ahmadi, Gezira
Dr Mohammed S. Mohammed, New Halfa
Dr Gaafar E. Mohammed, Shendi
Sayed Abdalla I. Sheikh Mohammed, Hudeiba
Sayed Dafalla A. Dawoud, Dongola

A.2.4. Yield reference plots in Blue Nile Agricultural Corporation

The production package developed for the Gezira will be tested in the Blue Nile Pump Schemes for the first time. Three reference plots each 2.1 ha will be established.

Scientist i/c

Dr Mohamed E. Omer, Agronomist, Sennar

B. New Halfa

B.1. Pilot production and demonstration plots

Thirty farmers in three locations will be involved. The package will be similar to that of last season except for few changes: ridging on the dry instead of disking, seed drilling or broadcasting followed by bedding, planting the cultivar Condor or Debeira, and timely harvest.

Steering Committee

Dr Mohammed S. Mohamned, Breeder, New Halfa Station
Dr Ahmed M. Gorashi, Agronomist, New Halfa Station
Dr Hamid El Faki, Economist, GRS
Sayed Abdel Rahman Bushara, Agricultural Engineer
In addition to members from New Halfa Corporation

C. Shendi Research Station (Northern Region)

C.1. Farmer-managed trial in Shendi area

The improved package will consist of proper levelling, growing the cultivar Wadi El Neil, irrigating at 10- to 14-day interval, sowing during the first half of Nov, application of 86 kg N/ha, and proper aphid control. The trial will be conducted at five locations in Keli Scheme.

Scientists i/c

Dr Gaafar E. Mohammed, Agronomist
Dr Hamid H. El Faki, Economist

D. Hudeiba Research Station (Northern Region)

D.1. Researcher-managed trials

D.1.1 Testing improved cultural practices in farmers' fields at Hassa and Zeidab Schemes

The treatments at Hassa Scheme will comprise planting on ridges or on the

flat, presowing irrigation or dry seeding, and growing the cultivar Wadi El Neil or the local cultivar. At Zeidab, the treatments will include planting on 10 Nov or 10 Dec, growing the cultivar Wadi El Neil or Condor, and applying 43 or 86 kg N/ha.

Scientist i/c

Dr Musa B. Taha, Agronomist

D.1.2 Performance of the proposed improved package at Dongola Research Substation

The recommended variety, sowing date, seed rate, method of planting, nitrogen fertilization, and irrigation management for wheat will be assessed, and the effect of the absence of each component determined.

Scientists i/c

Sayed Dafalla A. Dawoud, Agronomist, Dongola
Dr Hamid H. El Faki, Economist, GRS

III. BACK-UP RESEARCH

This is disciplinary on-station research specifically conducted to find solutions to problems faced during the on-farm research phase.

A. Plant Breeding

The wheat breeding programs at the Gezira Research Station and New Halfa aim at the development of cultivars with the following attributes: high and stable yield, good quality grain, resistance to black stem and leaf rust, early maturity, heat tolerance, tolerance to moisture stress, resistance to lodging and shattering, and tolerance to aphids.

The two primary sources of variability, introduction and hybridization, will be expanded. Germplasm will be evaluated in a series of trials: preliminary, advanced, and, finally, multilocation verification trial. At each stage only elite genotypes are retained.

A.1. Preliminary yield trials

Forty-six newly developed and introduced cultivars which showed desirable agronomic characters will be tested. Two check cultivars will be included.

A.2. Advanced yield trials

One advanced trial comprising 10 cultivars and 2 checks will be conducted at

GRS and Hudeiba. At New Halfa, the advanced trial will consist of 24 cultivars including 2 checks.

A.3. Identification and development of high-yielding bread wheat germplasm with early maturity and tolerance to heat stress

The existing germplasm and accessions in the international nurseries from CIMMYT, ICARDA, and other sources will be intensively evaluated under the natural high-temperature environment of the Sudan. Emphasis will be directed towards the identification and selection of short duration (90-100 days) bread wheat germplasm. The trial will be conducted at GRS, New Halfa, and Hudeiba.

A.4. Identification and development of bread wheat germplasm with high yield under limited moisture conditions in the Sudan

Available germplasm will be evaluated under limited moisture conditions at GRS, New Halfa, and Hudeiba; material with good performance will be used in the national crossing programs.

A.5. Seed increase and variety maintenance

Breeder's seed and pre-foundation seed of the released cultivars will be produced to meet the demands of the National Seed Administration, production schemes, and research scientists.

Scientists i/c

Dr Abdalla B. El Ahmadi, Gezira Research Station
Dr Mohammed S. Mohammed, New Halfa Research Station
Sayed Abdalla I. Sheikh Mohammed, Hudeiba Research Station

B. Agronomy

B.1. Response of three wheat cultivars to sowing date at Gezira, New Halfa, and Hudeiba

The response of the three cultivars Condor, Debeira, and Wadi El Neil will be evaluated at five sowing dates starting 15 Oct and at 14-day intervals thereafter.

Scientists i/c

Dr Osman A.A. Ageeb, Agronomist, Gezira Research Station
Dr Ahmed M. Gorashi, Agronomist, New Halfa Research Station
Dr Musa B. Taha, Agronomist, Hudeiba Research Station

Cooperating Scientists

Dr Nasr Eldin Sharaf Eldin, Entomologist, GRS

Dr Gaafar Ibrahim, Pathologist, GRS
Dr Mohammed S. Ahmed, Pathologist, New Halfa Research Station
Dr Faisal M. Ibrahim, Entomologist, New halfa Research Station
Dr Abel Gadir Bushara, Entomologist, Hudeiba Research Station
Dr Mohammed El Fatih Khalid, Pathologist, Hudeiba Research Station

B.2. Effect of land preparation and irrigation methods on crop establishment

The objective of the experiment is to identify land preparation and irrigation methods that will optimize plant density and minimize cost of crop establishment. Three land preparation methods: (1) harrowing and levelling; (2) chisel-plowing, harrowing, and levelling; and (3) ridging, split-ridgind, and levelling; and two irrigation methods, basin and furrow, will be evaluated in the Gezira.

Scientists i/c

Dr Saeed M. Farah, Agronomist, GRS
Dr Ahmed A. Salih, Soil Scientist, GRS
Sayed Ahmed Musa, Agricultural Engineer, SGB

C. Plant Nutrition

C.1. Wheat varietal response to fertilizer nitrogen on two soil types in the Northern Region

The response of the three cultivars Condor, Debeira, and Wadi El Neil to four levels of nitrogen (0, 43, 86, and 129 kg/ha) on "Karu" or High Terrace soil will be examined at Hudeiba and Shendi.

Scientists i/c

Dr Hassan S. Ibrahim, Hudeiba Research Station
Dr Gaafar E. Mohammed, Shendi Research Station

C.2. Effect of time and rate of nitrogen, and rate of phosphorus application, on yield and nitrogen and phoshorus uptake by wheat under two soil types in the Northern Region

The trial conducted last season will be repeated at the same locations. Nitrogen will be added at three rates: 0, 43, and 86 kg/ha applied all at sowing, half at sowing and half at tillering, half at sowing and half at booting, or half at tillering and half at booting. Phosphorus at 0 or 43 kg P_2O_5/ha will be applied at sowing.

Scientists i/c

Dr Hassan S. Ibrahim, Hudeiba Research Station
Dr Gaafar E. Mohammed, Shendi Research Station

D. Entomology

Aphids are the major economically important insect pest on wheat in the Sudan. Two species are prevalent: the maize aphid *Rhopalosiphum maidis* Fitch and the green bug *Schizaphis graminum* Rond. Both are controlled, at present, by aerial spraying with chemicals. Anticipating the dangers of total reliance on insecticides, an integrated pest-management program to reduce degradation to acceptable levels is being implemented.

D.1. Population dynamics of aphids and their natural enemies in the field

This is the final season of a 3-season study. Systematic surveys of aphids and their predators will be carried out at the Gezira, Hudeiba, and New Halfa Research Stations.

Scientists i/c

Dr Nasr Eldin Sharaf Eldin, Gezira Research Station
Dr Abdel Gadir Bushara, Hudeiba Research Station
Dr Faisal M. Ibrahim, New Halfa Research Station

D.2. Biological control of wheat aphids

Aphid populations will be monitored after augmenting populations of Coccinellid predators in wheat fields. The experiment will be conducted at the Gezira Research Station.

Scientist i/c

Dr Nasr Eldin Sharaf Eldin, GRS

D.3. Screening and incorporation of aphid resistance in wheat and barley

Germplasm from ICARDA, CIMMYT, and the national programs will be screened for resistance to aphids. Resistant lines will be handed to breeders after further confirmatory testing. The trial will be carried out at GRS, Hudeiba, and New Halfa Stations.

Scientists i/c

Dr Nasr Eldin Sharaf Eldin, GRS
Dr A. Bushara, Hudeiba Research Station
Dr Faisal M. Ibrahim, New Halfa Research Station

D.4. Chemical control of wheat aphids

The objective is to identify insecticides with good performance against aphids, but with mild effect on their natural enemies.

Scientists i/c

Dr N. Sharaf Eldin, Gezira Research Station

Dr A. Bushara, Hudeiba Research Station
Dr Faisal M. Ibrahim, New Halfa Research Station

D.5. Determination of the economic threshold of aphids at New Halfa

Aphids will be sprayed when infestation levels reach 15, 25, 35, or 45%, and the infestation level at which spraying prevents any economic loss will be determined.

Scientist i/c

Dr Faisal M. Ibrahim, New Halfa Research Station

E. Plant Pathology

The most important wheat diseases in the Sudan are stem rusts caused by *Puccinia graminis* f. sp. *tritici* and leaf rust caused by *Puccinia recondita.* Another important disease is root and foot rot caused by *Helminthosporium* spp and *Fusarium* spp. *Helminthosporium* leaf diseases and barley yellow dwarf virus occur, but are not important.

E.1. Screening of the commercial and promising varieties and lines of wheat to stem rust and leaf rust diseases under artificial epiphytotics

About forty cultivars and lines will be rated for resistance after artificial inoculation. The trial will be carried out at New Halfa.

Scientist i/c

Dr Mohammed S. Ahmed, Pathologist, New Halfa Research Station

Cooperating scientist

Dr Mohammed S. Mohammed, Breeder, New Halfa Research Station

E.2. Stem rust race virulence on stem rust differential varieties of wheat, "adult field stage"

Twenty-nine stem rust differentials and other commercial cultivars, will be rated to determine the level of resistance conferred by single genes, and to determine any changes in the stem rust race spectrum in the natural inoculum at New Halfa.

Scientist i/c

Dr Mohammed S. Ahmed, Pathologist, New Halfa Research Station

E.3. National survey of wheat diseases

Selected sites within the major wheat-growing regions will be visited for disease identification and assessment. Disease maps will be prepared.

Scientists i/c

Dr Mohammed S. Ahmed, New Halfa Research Station
Dr Gaafar Ibrahim, Gezira Research Station
Dr Mohammed El Fatih Khalid, Hudeiba Research Station

E.4. Crop loss assessment trial

A few cultivars will be assessed for performance after inoculation with the disease and under conditions where chemical control of the disease is provided.

Scientist i/c

Dr Mohammed S. Ahmed, Pathologist, New Halfa Research Station

F. Weed Control

F.1. Weed survey in the Gezira and Northern Province

One location in the Gezira and two locations in the Northern Region will be surveyed during Dec to mid-Jan. Dominant weed species will be identified and their abundance and geographic distribution documented. Researchable problems will be specified. In addition, the importance of weeds will be ascertained through a simple questionnaire to farmers.

Scientists i/c

Dr Abdel Gabbar E. Babiker, Weed Scientist, GRS
Prof Abdalla M. Hamdoun, Botanist, GRS
Prof Murid G. Mansi, Statistician, GRS
Dr Hamid H. El Faki, Economist, GRS

IV. REGIONAL NETWORKS

A. Breeding

A.1. Development of wheat and barley germplasm adapted to the heat-stressed environments of the Nile Valley

The stress screening laboratory in Egypt, the short growing season in the Sudan, the high-temperature environments of upper-Egypt, and the warm humid Ethiopian low-lands will be utilized to screen national germplasm and germplasm from CIMMYT and ICARDA for heat tolerance. Appropriate screening techniques and morphophysiological selection criteria will be developed. Findings of a similar program at ICARDA will be utilized. Studies to identify cultural practices that minimize heat effect will be conducted.

Lead country: the Sudan
Countries involved: Egypt, Ethiopia, and the Sudan

Leading scientist: Dr Abdalla B. El Ahmedi, the Sudan
ICARDA scientists: Dr E. Acevedo, Dr G. Ortiz-Ferrara, and Dr M. Nachit

A.2. Development and management of early-maturing wheat and barley varieties for limited-water conditions

Wheat and Barley germplasm from the cooperating countries and from CIMMYT and ICARDA will be screened to identify early-maturing cultivars tolerant to limited-water conditions. Material with best performance will be assembled and distributed to cooperating countries. Optimum agronomic practices for the material developed will be identified.

Lead country: Egypt
Countries involved: Egypt, Ethiopia, and the Sudan
Leading scientist: Prof Mousa M. Mousa
ICARDA scientists: Dr E. Acevedo
Dr G. Ortiz-Ferrara
Dr M. Nachit

B. Entomology

B.1. Screening for resistance to aphids

B.1.1 Germplasm development

Germplasm from the three cooperating countries and international centers will be screened for aphid resistance in the laboratory at Giza and ARC; material with potential resistance will be tested in the field.

Countries: Egypt, the Sudan, and Ethiopia
Regional coordinator: Dr Galal S. Youssef. Egypt
Participating scientists: Dr N. Sharaf Eldin, the Sudan
Dr Fekadu Alemayehu, Ethiopia

B.1.2 Biological control

Results and techniques developed in the Sudan will be provided to scientists in Egypt and Ethiopia (See III-D.2.).

Lead country: the Sudan
Regional coordinator: Dr N. Sharaf Eldin, the Sudan
Participating scientists: Dr Ahmed El Henedy, Egypt
Dr Fekadu Alemayehu, Ethiopia
Dr Ross Miller, ICARDA

C. Pathology

C.1. Virulence analysis of the wheat stem rust pathogen in the Nile Valley countries

The objectives are to identify the physiological races and determine the race spectrum of the pathogen in Ethiopia, the Sudan, and Egypt. Leaf specimens will be collected from each country for identification of races against differentials.

Coordinating scientist: Dr Ahmed Basioni, Egypt
Cooperating scientists: Dr Mohammed S. Ahmed. the Sudan
Dr Omar F. Mamluk. ICARDA

C.2. Seedling test for promising wheat lines

Wheat lines developed in Egypt and the Sudan will be tested at the seedling stage against the predominant races of stem rust in the two countries. About a hundred lines from each country will be tested annually.

Scientists: Dr Ahmed Basioni, Egypt - Coordinator
Dr Mohammed S. Ahmed, the Sudan
Dr Omar F. Mamluk, ICARDA

C.3. Sources and pathway of primary inoculum of wheat stem and leaf rusts in the Nile Valley

The main objectives are to determine the source of inoculum, alternate hosts, and progression of the stem and leaf rust diseases during the cropping season.

Lead country: Ethiopia
Participating scientists: Dr Mohammed S. Ahmed, the Sudan
Dr Ahmed Basioni, Egypt
Dr Omar F. Mamluk, ICARDA

V. EDUCATION AND TRAINING PROPOSALS

Training will be provided for scientists and assistant scientists as follows:

A. Visiting Scientists

One scientist (Ph. D. holder) will be nominated to spend one year with scientists working on heat tolerance at ICARDA; another will be nominated to spend three months at ICARDA to work on crop simulation studies.

B. Training at ICARDA

Residential courses

One B. Sc. holder will be nominated for the residential training course in cereal improvement.

Short courses

Two B. Sc. holders will be nominated for short courses (2 weeks) on cereal diseases and cereal insect pests.

Graduate research training program

- One assistant scientist will be nominated for M.Sc. degree in Plant Breeding (two years).
- One scientist will be nominated for a Ph. D. training (three years).

C. Training at other Institutions

Egypt

- One assistant scientist to be trained for three months on rust inoculation and evaluation methodology.
- One assistant scientist to be trained on screening for aphid resistance for three months.

CIMMYT

One assistant scientist to get training on wheat breeding and pathology for eight months.

APPENDIX

LIST OF PARTICIPANTS

Ministry of Agriculture and Natural Resources
Headquarters, P.O. Box 285, Khartoum

H.E. Dr El Fatih El Tigani*	Minister of Agriculture and Natural Resources
Mr Kamel Mansour	Consultant to the Minister of Agriculture
Dr Abdel Moneim El Sheikh	Director, Agric. Planning Administration

Central Region Government, Wad Medani

Sayed Ibrahim Rudwan	Deputy Governor
Dr Abdel Moneim A/Razig	Director of Agriculture
Sayed Abdel Mahmoud Ahmed Ali	Extension Officer
Sayed Abdel Azim Osman	Extension Officer

Ministry of Irrigation

Sayed Tag Elsir M. Ahmed	First Under Secretary, MOI
Sayed Kamal M. Abdu	Under Secretary, Gezira and Managil

Tenants Union

Sheikh El Tayeb El Obeid	Chairman
Sayed Abdel Galil H. A/Galil	Secretary
Sayed Abdel Rahim Abu Seneina	Member, Central Committee

Individual Tenants

Sayed Gasm Elseed Faragalla
Sayed Fadl Alla Farag Alla
Sayed Mohammed Ibrahim El Hag
Sayed Mohammed Babiker El Awad
Sayed Musa Dereisa Yousif
Sayed Yousif Musa
Sayed El Amin El Mubarak
Sayed Ahmed Abdalla El Shafie

Sudan Gezira Board

Sayed Abdalla M. El-Zubeir	Managing Director
Sayed Izz Eldin O. El Mekki*	Agricultural Manager
Sayed Galal Osman	Deputy Agric. Manager
Sayed Wageeh Samuel	Manager, Plant Propagation Department
Sayed A. El Beshir	Deputy Manager, Plant Propagation Department
Sayed Ali El Nur	Manager, Extension Department

Sayed Ali Babiker	Deputy Manager, Extension Department
Sayed Mohammed Sidahmed	Deputy Manager, Extension Department
Sayed El Fatih Satti	Manager, Center Group
Sayed Omer Ali Mohammed	Extension Officer
Sayed Abdalla Babiker Marie	Extension Officer

National Seed Administration

Dr Ahmed Abu El Gasim	Director General
Dr Omer Abdel Fadeel	Director, Plant Propagation

Soil Survey Adminstration

Dr Abdel Karim Obeid	Director
Sayed Abdel Moneim Kafeel	Deputy Director
Dr Osman Abdel Rahman	Head, Land Evaluation Section
Dr Omer Khodary Eissa	Head, Soil Classification and Correlation Section
Sayed Abdel Rahman Abdalla	Applied Research and Investigation Section
Dr Shama El Amin	Soil Scientist

Global 2000 Inc.

Dr Marcos A. Quinones	Asst. Director, Sasakawa African Association, P.O. Box 7071, Khartoum

New Halfa Agricultural Production Corporation

Sayed A. Bushara Omer*	Agricultural Engineer
Sayed Mohammed Ali Salama*	Manager, Agric. Eng. Unit
Sayed Gamal Hussein Mohammed	Agricultural Economist
Sayed Mohammed Suleiman Amin	Manager, Extension
Sayed Gaafar A. Arman*	Extension Specialist

University of Gezira

Prof Osman A. Sidahmed	Dean, Faculty of Agric. Sciences
Prof Osman A.A. Fadl*	Soil Scientist
Dr Muddathir A. Ahmed	Agricultural Economist
Dr Fathi M. Khalifa	Agronomist
Dr Adam Suleiman	Agronomist

Agricultural Research Corporation, Headquarters
P.O. Box 126, Wad Medani

Prof Osman I. Gameel*	Director General
Prof Musa M. Musa	Deputy Director General
Prof El Tigani M. El Amin	Director, Adm. and Finance
Prof Abdel Mageed Yassin	Director, Publication and Training

Prof Hassan M. Ishag*	National Coordinator, Groundnut Research
Prof Abdalla M. Hamdoun	National Coordinator, Botany and Plant Pathology
Prof N. Eldin Sharaf Eldin*	National Coordinator, Entomology
Prof Hassan H. Abdalla*	National Coordinator, Soil Science
Prof Osman A.A. Ageeb*	National Coordinator, wheat
Prof Ibrahim El Jack	National Coordinator, cotton
Prof Ahmed Ali Geneif	National Coordinator, Hort.

Gezira Research Station, P.O. Box 126, Wad Medani

Prof Ibrahim A. Babiker	Soil Scientist and Director of Station
Dr Mirghani K. Ahmed	Head, Hort. Research Section
Dr Ahmed S. Fadl Alla	Head, Cotton Breeding Section
Prof M. Badr A. Saleem	Agronomy and Plant Physiology Section
Prof Faisal M. Ali	Agronomy and Plant Physiology Section
Prof. Saeed M. Farah*	Head, Agronomy and Plant Physiology Section
Dr Magboul E. Lazim	Agronomy and Plant Physiology Section
Dr Mohammed A.M. Khair	Agronomy and Plant Physiology Section
Dr Mohammed A.E. Satti	Agronomy and Plant Physiology Section
Sayed El Asha A. El Asha	Agronomy and Plant Physiology Section
Prof Nuri O. Mukhtar	Head, Soil Science Section
Dr El Naeim A. Ali	Soil Science Section
Dr Ahmed A. Salih*	Soil Science Section
Prof. Ahmed N. Balla	Entomology Section
Prof. Asim A. Abdel Rahman	Entomology Section
Dr Ibrahim Barakat	Entomology Section
Dr Hassan A. Farrag	Entomology Section
Prof M. El Hilu Omer	Head, Botany and Plant Pathology Section
Dr Gaafar Ibrahim Mohammed*	Botany and Plant Pathology Section
Dr Abdel Gabbar E. Babiker	Botany and Plant Pathology Section
Sayed Kheir Eldin Abdel Galil	Botany and Plant Pathology Section
Prof Abdel Moneim B. El Ahmadi	Plant Breeding Section
Dr Abdalla B. El Ahmadi*	Head, Plant Breeding Section
Dr Abdel Latif M. Nur	Plant Breeding Section

Hudeiba Research Station, P.O. Box 31, Ed-Damer

Dr Hassan S. Ibrahim*	Soil Scientist and Director of Station
Dr Musa B. Taha*	Agronomist
Dr M.E. Khalid*	Plant Pathologist
Sayed A.I. Sheikh Mohammed*	Plant Breeder

New Halfa Research Station, P.O. Box 17, New Halfa

Dr Mohammed S. Ahmed*	Plant Pathologist

Dr Mohammed S. Mohammed*	Plant Breeder
Dr Ahmed Mohammed Gorashi*	Agronomist
Dr Faisal Mohammed Ibrahim	Entomologist

Shambat Research Station, P.O. Box 30, Khartoum North

Prof Farouk Ahmed Salih	Breeder and Director of Station
Prof Mustafa Mohammed Hussein	Plant Pathologist

Shendi Research Station, P.O. Box 33, Shendi

Dr Gaafar E. Mohammed*	Agronomist

Dongola Research Station

Sayed Daffala A. Dawoud	Agronomist

* Contributors to the proceedings.

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