PN-ADI-378

המכונים למחקר שימושי

THE INSTITUTES FOR APPLIED RESEARCH

BEN-GURION UNIVERSITY OF THE NEGEV

אוניברסיטת בן-גוריון בנגב

ANNUAL REPORT

Covering Period: June. 2002 - May 31. 2003

Submitted to the U.S. Agency for International Development:
: Global Programs, Field Support and Research: Center for Economic Gro

GERMPLASM COLLECTION, EVALUATION AND IMPROVEMENT OF AFRICAN LEAFY VEGETABLES

Principal Investigator (Israel): Dr. S. Mendlinger
Grantee Institution: The Institutes for Applied Research.
Ben-Gurion University of the Negev. Israel

Principal Investigator (Tanzania): Dr. M.L. Chadha

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Beer-Sheva, Israel

באר-שבע, ישראל

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Grantee Institution: The Institutes for Applied Research,
Ben-Gurion University of the Negev, Israel

Principal Investigator (Tanzania): Dr. M.L. Chadha
AVRDC-African Regional Program, Tanzania

Addition researchers: Ms. Hassan Mndiga and Sheryl Mendlinger

Project Number: 87019101, 87019201

Grant Project Officer: Boaz Ayalon

Project Duration: June 2002-May 2006

Beer-Sheva, Israel July 2003

EXECUTIVE SUMMARY

The aim of this project is the conservation, evaluation and improvement of African leafy vegetables found in Tanzania and other countries in Africa in order to improve their agromanagement, variety selection, leaf yield and nutrition. In the first year of the program we: (a) conducted a ten day collection trip through northern and central Tanzania where we collected 15 accessions of *Brassica carinata* (Ethiopean kale), 19 accessions of *Solanum scabrum* (nightshade) and 3 accessions of *Cleome gynandropsis* (spider flower). In addition during the trip we interviewed 7 women and 5 men for our indigenous knowledge study; (b) in Tanzania two field trials were conducted. The first examined 8 accessions of nightshade from AVRDC's permanent collection. Considerable and significant differences in yield were found among the accessions. The second field trial examined the collected accessions; (c) in Israel a field trial was conducted on the collected accessions to examine maximum growth and leaf yield under high irrigation and fertilization. Considerable genetic variation for leaf production was found among the accessions of Brassica and Solanum. One accession, Br9, showed promise for future selection/breeding programs as it combined large leaf biomass with small stem biomass.

Two junior students obtained training in the first year. A Tanzania scientist, Ms. Rose Shayo spent six months in Dr. Mendlinger's laboratory learning how to conduct field trials in a greenhouse and statistical analysis. An Israeli, Ms. Mendlinger obtained training in interviewing for indigenous knowledge.

SECTION I

A). RESEARCH OBJECTIVES: The overall aim of this project is the conservation, evaluation and improvement of indigenous plant genetic resources of three important leafy vegetable species in East Africa in order to improve their agromanagement, variety selection, leaf yield and nutritional quality. Our specific research objectives are:

1. to make a systematic collection over each species' range in Tanzania;
2. determine the extent and structure of genetic variation of each species in order to determine how best to conserve their genetic resources;
3. evaluate the collection for important agronomic and nutritional traits;
4. begin a selection/breeding program for improved varieties;
5. obtain indigenous knowledge on each species before it is lost.

In the first year our main objectives was to start the collecting and indigenous knowledge programs and begin agronomic evaluations.

B). RESEARCH ACCOMPLISHMENTS:

1. Tanzanian Collection Trip - Between September 6-21, a joint Israel-Tanzanian collecting team collected accessions of the three targeted species in northern and central Tanzania (Table 1). The team consisted of Dr. Samuel Mendlinger (the Israeli P.I.), Ms. Sheryl Mendlinger (an Israeli Ph.D. student who is specializing in qualitative analysis of interviews) and Mr. Hassan Mndiga of AVRDC. The three of them together with Dr. Chadha (the Tanzanian P.I. who was not able to go on the collecting trip) planned the trip and the areas where collections were to be conducted. The provinces covered were Kilimanjaro, Tanga and Morogoro. Seeds were collected from 21 farms or individuals over the three provinces. As most farms had relatively few if any plants with mature seed pods, at most sites we collected seeds from the farmers' seed stock. Due to this, we collected accessions and not populations. We collected 15 accessions of *Brassica carinata* (Ethiopean kale), 19 accessions of *Solanum scabrum* (nightshade) and three accessions of *Cleome gynandropsis* (spider flower).

During the trip Dr. Mendlinger and Mr. Mndiga jointly chose the farms where seed were to be collected and Mr. Mndiga and Ms. Mendlinger conducted all interviews. The interviewers used a questionnaire that Dr. Mendlinger, Ms. Mendlinger, Mr. Mndiga and Ms. Shayo developed. Seven females and five males were interviewed. Each interview was conducted in Swahili, recorded on tape and later translated into English.

Table 1. The collection sites and relevant data from the 2002 collecting trip in Tanzania.

Collection site	Latitude	Longitude	Elevation (feet)	Brassica	Solanum
Site 1 - Masawi	3°18'129S	37°08'129E	3260	no	yes
Site 2 - Masiande	3°18'335S	37°07'730E	3300	no	yes (2)
Site 3 -Hadija	3°18'361S	37°07'757E	3306	yes	yes
Site 4 Amando Koola	3°11'387S	37°03'222E	4235	yes	yes
Site 5 - Mush	3°11'875S	37°13'633E	5171	yes(2)	yes
Site 6 - Engerasia	3°17'464S	37°10'305E	3385	yes	yes
Site 7 - Aluseta	3°17'432S	37°10'120E	3370	no	yes
Site 8 - Himo	3°22'429S	37°32'172E	3100	yes	yes
Site 9 - Himo	3°22'444S	37°32'109E	3109	yes	no
Site 10 - Mwanja	3°39'009S	37°36'214E	2825	yes (2)	yes
Site 11 - Soni	4°49'177S	38°21'264E	3852	no	yes
Site 12 - Lesotho	4°50'171S	38°19'597E	3872	no	yes
Site 13 - Bombani	5°07'948S	38°42'189E	634	yes	yes
Site 14 - Pangwe	5°07'650S	38°42'280E	789	yes	yes
Site 15 - Judith John	5°07'538S	38°42'235E	689	yes	yes
Site 16 - Extension Service Officer - unknown origin				no	yes
Site 17 - Mkata	5°47'033S	38°17'359E	1349	no	yes
Site 18 - Ugoro Mt.	7°03'506S	37°34'506E	3703	yes	no
Site 19 - Ugoro Mt.	7°05'046S	37°34'764E	5461	no	yes
Site 20 - Bigora Sisters	6°48'015S	37°43'113E	1712	yes	yes
Site 21- Mkata	5°47'064S	38°17'814E	1403	yes	no

Site	Cleome	Interview	Main crops
Site 1	no	yes (woman)	maize, banana, vegetables
Site 2	yes	yes (woman)	maize, banana, cowpeas, vegetables
Site 3	no	no	maize, banana, coffee, beans, vegetables
Site 4	no	no	family garden plot
Site 5	no	yes (woman)	banana, coffee, maize, vegetables
Site 6	no	no	maize, beans, vegetables
Site 7	no	no	poorly maintained farm
Site 8	no	yes (man)	vegetables, banana, beans, maize, fruit trees
Site 9	no	no	banana, vegetables, beans and fruit trees
Site 10	no	yes (2 women)	vegetables, banana, fruit trees, beans
Site 11	no	yes (woman)	vegetables, banana, beans, fruit trees
Site 12	no	yes (woman and man)	vegetables, maize
Site 13	no	yes (man)	vegetables, banana, trees
Site 14	yes	yes (man)	vegetables, trees
Site 15	no	no	banana, trees, vegetable
Site 16	no	no	-
Site 17	no	yes (man)	vegetables, banana
Site 18	no	no	vegetables, potatoes, maize, banana
Site 19	no	no	research station
Site 20	no	no	vegetables
Site 21	yes	no	seed given to us by several farmers

2. Tanzania - field trials 2002-2003

During the first year of the program we conducted two field trials in Tanzania: (a) before the collections were conducted we examined 8 nightshade lines which are part of our permanent collection; (b) preliminary field trials of the 2002 collection.

a. Field trial #1. Eight nightshade lines from our permanent collection.

The field trial was conducted for the evaluation of yield characteristics of eight promising nightshade lines. The experiment was conducted at the Madiira Research and Training Center of AVRDC- World Vegetable Center from July 2002 - January 2003. The design was a RCBD with three replications. The lines of nightshade were evaluated in plots with a spacing of 75cm between rows and 40cm between plants in a row. Every two rows made one plot with 30 plants per plot. Weeding was done four times during the growing season and selectron was applied to control pests such as aphids. Furrow irrigation was used to water the plants. The eight lines tested were *Solanum villosum* (SV), *Solanum scabrum* (SS47), *Solanum americanum* (SA), *Solanum scabrum* (SS04.2), *Solanum scabrum* (SS52), *Solanum scabrum* (SS49), *Solanum scabrum* (SS40), and *Solanum scabrum* (Ex-Hai Kilimanjaro) (Table 2). Line SS52 showed the highest leaf yield followed by SS49, and SS04.2. The lowest yield was *Solanum villosum.*

Table 2. Evaluation of yield characteristics of 8 promising nightshade lines. AURDC-RCA, 2002-January 2003

Line	Leaf Yield (kg/plan t)	Leaf Yield(T/ha)
Solanum scabrum (5552)	0.28a	9.44a
Solanum scabrum (5542)	0.25 ab	8.34 ab
Solanum scabrum (4440)	0.18 bcd	5.87 bc
Solanum scabrum (45504.2)	0.20 abc	6.74 ab
Solanum scabrum (Ex-Hai)	0.11 de	3.56 cd
Solanum americanum (SA)	0.191 bcd	6.39 bc
Solanum scabrum (55447)	0.09 e	2.88d
Solanum villosum (SV)	0.111 de	3.73 cd
LSD	0.08	2.68
F-test	**	**
CV (%)	26.67	26.10

b). Preliminary field evaluation of collected lines -

The accessions of the first collection season in Tanzania was sown in our nursery and later transplanted in the field at isolated locations within the field; i.e. they were sown for preliminary evaluation and not within a true field trial. This was because we had relatively few seed in many lines and before a true field trial could be conducted, we needed to multiply seed. The characterization and bulking of the seed is continuing for *Brassica carinata* and Nightshades. The collected germplasm of *Brassica carinata* were sown on 16th February, 2003 and transplanted on 26th March, 2003. Fifteen accessions were sown:

Brassica carinata - S - 8
Brassica carinata - S - 9
Brassica carinata - S - 4
Brassica carinata - S - 10 A
Brassica carinata - S - 14
Brassica carinata - S - 3
Brassica carinata - S - 5B - failed to germinate
Brassica carinata - S - 13A
Brassica carinata - S – 5A - had mixed seedlings
Brassica carinata - S - 6
Brassica carinata - S - 18
Brassica carinata - S - 20B
Brassica carinata - S - 15
Brassica carinata - S - 14B
Brassica carinata - S - 10B

The night shade accessions were sown on 16th February, 2003 and transplanted on 1st April, 2003. Nineteen accessions were sown:-

Nightshade - S- 5B - Failed to germinate
Nightshade - S- 7
Nightshade - S- 13
Nightshade - S- 1
Nightshade - S- 12A
Nightshade - S- 3
Nightshade - S- 18
Nightshade - S- 14
Nightshade - S- 11B
Nightshade - S- 2A
Nightshade - S- 19 - Failed to germinate
Nightshade - S- 10 - Failed to germinate
Nightshade - S- 20 - Failed to germinate
Nightshade - S- 16
Nightshade - S- 9
Nightshade - S- 2 Local
Nightshade - S- 11
Nightshade - S- 17
Nightshade - S- 4B - Failed to germinate

The plants were still growing at the end of the first year's reporting date. We will present the results in next year's report. From preliminary analysis S20B was highly susceptible to Turnip Mosaic viral infection.

3. Israel 2002-2003

In November, 2002, we established a field trial in a greenhouse in our Institute in Beer Sheva to examine water requirements and genotype X environmental interactions in the collected accessions. Due to limited space in the greenhouse, we randomly chose seven accessions of *Brassica* (Br 3,8,9,10,15,17 and 18) and *Solanum* (NS 1,4,7,11,12,13 and 19) for the field trial. The accessions covered the collection area and all three provinces. The field trial was established as a randomized block design with two treatments in each block (high and low water amounts) with three plants/accession/treatment/block with three blocks. Plants were irrigated and fertilized through drippers. Unfortunately, during the growing season the irrigation system for low water treatment malfunctioned over a long weekend and many of the plants did not receive irrigation for several days and subsequently either died or suffered serious wilting. We therefore stopped the low water treatment and continued only with high water, i.e. optimum irrigation and fertilization. The results in Table 3 and 4 present important growth and yield parameters for Brassica and nightshade.

Table 3. Important leaf and stem parameters in collected lines of *Brassica carinata*, Ethiopean Kale. Results are a mean of 9 plants.

Parameter	Accession Line						
	3	8	9	10	15	17	18
Fresh plant weight* (g)	455ab	597a	406b	577a	414b	410b	466ab
Fresh leaf weight (g)	171b	155bc	319a	350a	79c	76c	169b
Number of leaves	26ab	43a	20.9b	22.2b	32.9ab	36ab	22b
Weight of 10 top leaves	90bc	40c	131ab	180a	34c	21c	72bc
Leaf area of 10 top leaves	178c	1143b	2496a	2330a	857bc	787bc	1567ab
Dry leaf weight (g)	10.5bc	18.4bc	41.8a	27.7ab	7.3c	8.9c	8.6c

fresh stem weight (g)	235ab	417a	102b	245ab	286ab	306a	313a
dry stem weight (g)	44.5b	78.5a	22.5c	34.3bc	70.5a	69.5a	45.5b

* stem, leaf and fruit

Table 4. Important leaf and stem parameters in collected lines of *Solanum scabrum*, nightshade. Results are a mean of 9 plants.

Parameter	Accession Line						
	1	4	7	11	12	13	19
Fresh plant weight* (g)	452a	434ab	423ab	378ab	378ab	371ab	337b
Fresh leaf weight (g)	166a	101b	118b	160a	135ab	156a	118b
Number of leaves	326a	227b	255b	220b	366a	224b	320a
Weight of 10 top leaves	14.7bc	10.4c	13.3bc	21.1a	14.6bc	17.6ab	9.9c
Leaf area of 10 top leaves	562b	486bc	633ab	709a	701a	622ab	380c
Dry leaf weight (g)	16.6ab	10.1bc	16.6ab	20.4a	11.4bc	16.1ab	9.2c
fresh stem weight (g)	201	194	189	197	167	194	175
dry stem weight (g)	40.6ab	43.3ab	46.3a	42.0ab	36.6b	40.8a	29.9c

*stem & leaf & fruit

In *Brassica* (Table 3) we found significant differences in all important leaf traits. Most interestingly, we found major differences in leaf production among lines with

fresh leaf weight ranging from a low of 76 g (Br15) to a high of 350 g (Br 10) per plant. The most promising line for a selection/breeding program that we found was Br 9. This accession had the second highest total leaf weight, the highest leaf area but the lowest stem weight. It appears to put most of its growth into leaves and thus is promising for both low water regimes that many farmers are forced to use due to lack of available water during the growing season (see indigenous knowledge section) as well as for optimal growing conditions. No significant correlations were found between total leaf area and number of leaves (data not shown). Leaf size was more important in determining total leaf area and leaf weight than number of leaves.

In nightshade we also found differences among lines in important leaf traits. These traits will be examined in year two's field trials. Ns11 had the highest leaf weight. We had few significant correlations among the traits (data not shown).

4. Indigenous Knowledge interviews.

1. Interview Methodology

Access to population -Our plan was to interview at least one or two farmers in each of the ecogeographical regions where seeds were collected. Only those farmers who grew the leafy vegetables and provided us with seeds were selected for interviews. At each site, the research team first went to see the fields, collected the seeds and only after that conducted the interview with the farmer.

Interviews - Each of the interviews was conducted one on one with the interviewers and the interviewee. All interviews were in Swahili, the official languages of Tanzania. The interviews took place either at the interviewee's home or in the fields where the crops were growing. All interviews were audio taped. Very often the interview became a family or village undertaking with many children and other people gathering to hear what was going on. Field notes and comments were made about various aspects of the interview (e.g. standing near the car, kids approaching the jeep)

2. Preliminary Analysis

The tapes were transcribed verbatim, in Swahili and translated into English. The first step in the analysis began by reading the transcripts. Notations were made that summarize each category. Presented below is the first preliminary synthesis of the data from the in-depth interviews.

In-Depth Interviews - Once the interviews were completed and transcribed the next step was to conduct the in-depth analyses. The Israeli principal investigator together with the project coordinator began the first level general thematic analysis of meaningful units. Themes were extrapolated from the interviews and sub-categories were developed.

There are several goals of the analysis. First it is important to gain a better understanding of how the individual farmers speak about and what they mean in relation to their understanding of cultivating the crops, their problems during cultivation and harvest, the quality of the present lines vs. previous lines and variation vs. purity of lines. As the interviews were analyzed more in-depth from a global perspective, the individual voices were consolidated into a collective voice.

In order to begin with the general analysis it was necessary to choose a method that is appropriate for this data. We chose to begin by doing a general thematic analysis looking for the major themes and patterns that were prevalent throughout the

interviews. Some of the topics were part of the structured interview and others became evident during the analysis.

First Level Coding - Thematic Analysis and Categories

General Theme Categories	General Topic Areas Included in Each Theme
Comparison to past	types of crops grown, quantities, reasons for differences in past and present
Access to Seeds	purchase, exchange, self, preservation, selection, desire for new types
Home Consumption	nutrition, taste, preparation, medicine
Problems in Cultivation	drought, water, disease, pests, market
Agromanagement of Crops	weeding, irrigation, fertilizers, spacing
Preservation of Traditional Vegetables	role of farmer, government, researchers

Comparison to past - One farmer noted that his parents never cultivated leafy vegetables or had a reliable home garden but only harvested wild and weedy species. This farmer went on to say "in comparison with the time when I was young and today, the difference is that today there are big changes, people have been educated about gardens". Other farmers made similar comments. It appears on the initial analysis, that the younger generation has an understanding of the need for more education and additional knowledge in order to improve cultivation and achieve higher yields.

Access of seeds - Some the farmers bought seeds from local stores while others depended mostly on exchange with other farmers and harvesting their own seed. Farmers were very interested in acquiring seed of new and better varieties. Several farmers had a basic understanding of the concept of genetic selection and one said "I would like to get the original nightshade which hasn't been contaminated, the current on is mixed with other plants and rubbish".

Home consumption - Most farmers understood the nutritional importance of the leafy vegetables. Many spoke about the preference for bitter tasting varieties. There were a number of methods used to cook these vegetables including roasting and cooking with bananas. Several people noted that they used these plants for medicinal purposes including using nightshade "to add up the blood and it helps to prevent other diseases for stomach problems".

Problems in cultivation - Farmers spoke about various problems that they had when cultivating these crops including lack of water (which they often called drought), insects and diseases as well as a lack of a market to sell the crops.

Agromanagement of crops - Farmers used various methods for growing the crops including various types of fertilizers and irrigation techniques and spacing.

Preservation of traditional vegetables - Some farmers felt that it was their responsibility to preserve the seeds while others thought it was the government's or others responsibility. In general they were interested in gaining access to better quality seeds that would give higher yields and better crops, both for home consumption as well as to sell in the market.

In the second year we will be conducting some 25-30 additional interviews and several focus groups. Once all interviews have been recorded and transcribed, we will analyze them in depth.

C. SCIENTIFIC IMPACT OF COLLABORATION

The cooperating scientists have participated in the project in several ways have improved each as a scientist. First, all decisions in planning and experimental design were discussed by both P.I.s and other participating scientists. Collections and indigenous knowledge were joint endeavors. For details, please see Section II D.

D. DESCRIPTION OF PROJECT IMPACT

It is too early in the project to describe its impact on Tanzanian farmers. Nevertheless, anywhere we traveled in Tanzania the local people hoped that by the end of the project we would be able to give them improved seed and knowledge.

E. STRENGTHENING OF DEVELOPING COUNTRY INSTITUTIONS

The project has allowed AVRDC to purchase needed laboratory and field items for their field station. Several Tanzanian junior scientists have obtained training in collection and agronomic trait evaluation and an Israeli scientist in indigenous knowledge (see section D below for details).

F. FUTURE WORK

In year 2 we plan on completing our collection of accession lines and indigenous knowledge interviews, start the molecular genetic analysis in Israel, continue field trials in both countries and start the nutritional evaluation in Tanzania. The project is on schedule. The work plan has been revised by adding a fourth species, *Amaranthus*, to the project. We found many farmers growing this crop instead of spider flowers.

SECTION II

A). MANAGERIAL ISSUES: To date we have had no managerial issues.

B). BUDGET: We have not altered any budgets by 10% or more.

C). COLLABORATION, TRAVEL, TRAINING AND PUBLICATIONS:

A. Collaboration - Besides the basic collaboration in designing and conducting an integrated research program, Israeli and Tanzanian scientists collaborated on the collecting trip between September 6- September 21. Dr. Mendlinger (the Israeli P.I.) and Ms. Sheryl Mendlinger (an Israeli Ph.D. student who is specializing in qualitative analysis of interviews) went to Tanzania for the collecting trip for genetic resources and indigenous knowledge. Mr. Hassan Mndiga of AVRDC was the Tanzanian collaborator on the collecting trip. The three of them together with Dr. Chadha planned the trip and the areas to be collected. During the trip Dr. Mendlinger and Mr. Mndiga chose the farms where seed was to be collected. Mr. Mndiga and Ms. Mendlinger chose the farmers to be interviewed and together conducted all interviews. The interviews were based upon a questionnaire that Dr. Mendlinger, Ms. Mendlinger, Ms. Shayo and Mr. Mndiga developed. Mr. Mndiga, who has extensive experience collecting, received training from Ms. Mendlinger in how to conduct interviews.

B. Training. - 1). Ms. Rose Shayo - Ms. Shayo, a junior scientist from AVRDC, spend 6 months, from May to October 2002, in Dr. Mendlinger's laboratory in Israel learning how to conduct field trials in a greenhouse and statistical analysis. Upon her return to Tanzania she became part of the research team for this project at AVRDC.

(Her stay in Israel was paid for by a grant from the Israeli Foreign Ministry to Dr. Mendlinger for training junior scientists from developing countries);

2). Ms. Sheryl Mendlinger - Ms. Mendlinger, a Ph.D. student at Ben Gurion University of the Negev, specializes in analyzing qualitative data from open ended interviews. In this program she is receiving training in indigenous knowledge in agriculture. She is not receiving any salary from this project and is paying all of her expenses including airfare.

C. Travel - 1). Ms. Rose Shayo of AVRDC went to Israel for six months (May-October) for training;

2). Dr. Sam Mendlinger went to Tanzania from September 6 to September 21 for coordinating the project and for the first year's collecting trip;

3). Ms. Sheryl Mendlinger went to Tanzania from September 8 to September 21 to join the collecting trip in order to conduct the interviews for indigenous knowledge.

E. REQUESTS FOR AMERICAN EMBASSY OR A.I.D. ACTIONS:
None.