INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

MARKET GARDEN IN THE SAHEL:

FRUIT-TREES AND VEGETABLES FOR LAND REGENERATION AND MANAGEMENT

AFRICAN MARKET GARDEN

FINAL TECHNICAL REPORT

Submitted to International Development Research Centre (IDRC)

JUNE 2005
The Project

Project Name: Market Garden in the Sahel: Fruit-Trees and Vegetables for Land Regeneration and Management

IDRC Grant Number: 101307-001

Research Institution: International Crops Research Institute for the Semi-Arid Tropics

Countries of Research: Burkina Faso, Ghana, Mali, Niger, and Senegal

Date of Presentation: June 2005

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ACKNOWLEDGMENTS

We would like to gratefully acknowledge the contribution of several individuals and institutions who made the African Market Garden (AMG) project possible. First, a special thanks to the International Development Research Centre (IDRC) of Canada for providing financial support to the AMG program and for facilitating our work and to the following institutions for their help: the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Program for Arid Lands (IPALAC), the Desert Margin Program (DMP), the Food and Agriculture Organization (FAO), and the World Bank.

Second, we thank Agrhymet, NARS, local NGOs and other institutions for their cooperation and for lending their expertise and providing guidance to this project. We are deeply indebted to our country coordinators in Mali, Niger, Burkina Faso, and Ghana and agents from the Jean Paul II Foundation for contributing their time and expertise to this project.

Third, much gratitude goes to the many individuals from ICRISAT, including the management group, the socio-economic experts, and the field technicians for their patience and hard work.

Last but not least, we wish to acknowledge the contribution of farmers who have been instrumental in the realization of demonstrations, infrastructures, training and diffusion of information related to the AMG project.

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# Table of Contents

List of Abbreviations and Acronyms.............................................................................v  
List of Tables..................................................................................................................v  
List of Figures..................................................................................................................v  

EXECUTIVE SUMMARY..............................................................................................vi  

I. INTRODUCTION........................................................................................................1  
1.1. Research Problem..................................................................................................1  
1.2. The African Market Garden (AMG) Concept......................................................1  
1.3. Objectives of the AMG Program...........................................................................2  

II. METHODOLOGY: Project Design and Implementation..........................................3  
2.1. Program Initiation.................................................................................................3  
2.2. Program Consolidation..........................................................................................3  
2.3. Program Implementation.......................................................................................5  

III. RESULTS: Project Research Findings and Outputs..............................................6  
3.1. Objective i.............................................................................................................6  
   3.1.1. Gender Analysis...............................................................................................6  
   3.1.2. Study on Land Tenure and Resource Access...............................................6  
   3.1.3. Feasibility Study.............................................................................................6  
3.2. Objective ii..........................................................................................................7  
   3.2.1. Identification of Suitable Vegetable Varieties...............................................7  
   3.2.2. Multiplication of Vegetable Seeds....................................................................9  
   3.2.3. Selection of Quality Fruit Tree Varieties and Species....................................9  
   3.2.4. Development of Techniques for Pest and Disease Control..........................10  
   3.2.5. Testing Large Scale Date Palm-Based Production Units..............................10  
   3.2.6. Dissemination Programs.................................................................................11  
3.3. Objective iii.........................................................................................................14  
3.4. Objective iv.........................................................................................................14  

IV. CAPACITY BUILDING............................................................................................16  

V. FULFILLMENT OF OBJECTIVES............................................................................17  

VI. PROJECT MANAGEMENT.....................................................................................19  

VII. CONCLUSIONS AND FUTURE PERSPECTIVES...............................................20  

ANNEXES. Photos and Key Flyers Produced under the Project.................................21
LIST OF TABLES

Table 1. Fulfillment of Project Objectives.................................................................18

LIST OF FIGURES

Figure 1. AMG Project Conceptual Framework.........................................................4
Figure 2. Profitability of AMG System........................................................................7
Figure 3. Hot Peppers Variety Trials Results..............................................................8

LIST OF ACRONYMS AND ABBREVIATIONS

ICRISAT International Crops Research Institute for the Semi-Arid Tropics
IDRC International Development Research Centre
IPALAC International Program for Arid Land Crops
MASHAV Israel's Center for International Cooperation
NARS National Agriculture Research Service
NGO Non-Governmental Organizations
UNESCO United Nations Educational, Scientific, and Cultural Organization
EXECUTIVE SUMMARY

The African Market Garden (AMG) is a small-scale cost effective horticultural production system that comprises a gravity-fed low-pressure drip irrigation system and a mix of vegetables, tubers, and fruit trees (in particular, the date palm), which can all be grown simultaneously in the same unit area.

The AMG project was established by ICRISAT and IPALAC and funded by IDRC of Canada to alleviate poverty through income generation, to improve the health of the population by expanding vegetable and fruit consumption, and to establish environmentally sustainable irrigated production systems in Sahelian countries.

This report highlights the main results and key achievements of the project since its inception, in 2002. Some of the more significant achievements of the project include:

- Production of two AMG manuals;
- Evaluation of the AMG technology through gender analysis, a study on land tenure and resource access, and a feasibility study;
- Identification of vegetable varieties (tomato, lettuce, onions, hot peppers, and sweet corn) that are suitable for the rainy season and for the export market;
- Multiplication of seeds for vegetables (tomatoes, lettuce, onions, eggplants, sweet corn, okra, and cowpeas);
- Establishment of a mother tree plantation in Sadore (Niger) and planting of quality fruit tree (pomegranates, grapes, figs, orange, clemantine, pomelo, sapodilla, papaya, moringa, guava, apples, and mangoes);
- Building of a demonstration and training facility, a vegetable seed multiplication facility, and date palm acclimatization and hardening nurseries.
- Introduction of the AMG in Burkina Faso, Cape Verde, Guinea Bissau, Cote d’Ivoire, Senegal, Mali, Burkina Faso, Niger, Chad and Cameroon; and
- Training of more than 1200 pilot farmers, fields agents, and NGOs personnel on the AMG, tree propagation and nursery management, vegetable seed production and storage, and methods of tissue culture propagation of date palms.
I. INTRODUCTION

1.1. Research Problem

Agricultural production in the Sahel, often based almost entirely on rain-fed cereals and pulses, is characterized by low crop productivity due to increased land degradation. Although water and soil fertility are key factors that limit agricultural production in the Sahel, farmers face several other productivity constraints, ranging from lack of appropriate technologies to socio-economic aspects (i.e., land tenure).

The challenge is to develop and disseminate a technology that is appropriate to the Sahelian context, in the sense that the technology takes into account the complex production system prevailing in the Sahel and addresses many of the constraints listed above.

Market gardens, which occupy small (a few square meters) to relatively large (2000 m² or more) land area, are common forms of irrigated agriculture seen in many Sahelian countries. Productivity and product quality of such market gardens are currently low due to the poor management of the whole system, particularly of irrigation. In most places, irrigation is done through the use of watering cans, a very labor-intensive operation. In other cases, flood irrigation, which consumes large quantities of expensive fuel is the preferred system.

Drip irrigation, a relatively new system can solve the productivity problem with a two-fold increase in crop yield in many cases. Until recently, however, existing drip systems required a fair amount of energy to operate properly, as well as some maintenance, and were too expensive for the small-scale African farmer. Newer and more robust low-pressure drip irrigation systems with no such constraints have recently been developed. These newer systems require only one meter of pressure to operate successfully, and the costs are within the reach of most small-scale farmers. IPALAC/ICRISAT have adapted this new system and developed an integrated irrigation production system, which is called The African Market Garden (AMG). The African Market Garden (AMG), the fruit of over 4 years of reflection and exploratory experimentation, addresses a number of the constraints enumerated above and blends with current farming systems in the target areas.

1.2. The African Market Garden (AMG) Concept

The African Market Garden is a small-scale horticultural production package based on low-pressure drip irrigation, a mix of annual and tree crops, and an "operating system" which leads the farmer to irrigate according to scientific principles. The AMG is composed of a mixture of fruit trees and vegetables and could be exploited on land area ranging from 80–500m². It incorporates all the advantages of a conventional drip system at a fraction of its cost, including energy costs.

In addition, the AMG is an integrated production system that is sustainable and does regenerate soils. Due to the presence of vegetables and date palm trees in the system all year round, little or no soil erosion will take place. Furthermore, the high biomass
produced by the crops after harvest will be composted to be used as fertilizers in the system. In fact one of the added advantage of the system if successfully promoted in the Sahel will be to help mitigate land degradation.

In the end, the AMG is designed to provide the farmer with a stream of steady income from vegetable production, while the date palm grows and matures. It is designed to avoid excessive requirement for labor, and blends well with normal labor use pattern of the farmer. The system has in a limited way, demonstrated its potential to contribute to food security, improved land use and increased household income.

1.3. Objectives of the AMG Program

The general objective of the program is to introduce to the Sahelian zone a “Date Palm-Based Agriculture” capable of improving the micro-environment to enhance normal agricultural activities, and thus contributing to food security, while at the same time alleviating poverty through the resulting income generating activities. More specifically, the program seeks to:

i. Evaluate the AMG within the context of the multiple farming systems dimensions, with special emphasis on the social, economic and gender dynamics at the community and household levels;

ii. Test and promote the AMG, an integrated date, fruit trees, and vegetable production system in four countries;

iii. Establish commercial nurseries for tissue culture propagated plants; and

iv. Implement a training program, which targets various stakeholders (i.e., farmers and research institutions), in order to promote system sustainability.

The aim of this report is to highlight the main results and key achievements of the AMG program since its inception. The report is structured as follows. Section 2 describes the project design and implementation strategy. Section 3 summarizes the project research findings and outputs. Section 4 outlines the main capacity building activities undertaken by the program. Section 5 assesses the performance of the AMG program in terms of fulfilling its stated objectives. Section 6 provides information as to the management of the program and Section 7 concludes and outlines the future perspectives of the program.
II. METHODOLOGY: Project Design and Implementation

The project was implemented using a well-planned and phased approach with clear milestones that layed the framework for a successful large-scale adoption of a Date Palm-Based Agriculture in the Sahel. Figure 1, below, shows the conceptual framework adopted for the implementation of the AMG project. The three phases of the project, with each phase laying down essential infrastructure for the following one, were as follows:

2.1. Phase I. Program Initiation

The “Dates for the Sahel” program was initiated in a workshop that took place at the ICRISAT Sahelian Center at Sadore, Niger, in July 1997. The event brought together, experts in date palm cultivation and some policy makers from 7 countries including Senegal, Mauritania, Burkina Faso, Mali, Niger and Cameroon. The objective of the workshop was to examine the technical, social and economic aspects of revitalizing date palm production in the Sahel, and make appropriate recommendations. Some of the conclusions and recommendations of the workshop were:

- Date palm production should be incorporated into existing market gardens, so that it is well blended into on-going farming activities, in order to ensure system sustainability. In this way, short-term income from vegetables and fruit farming will be provided, while waiting for the longer-term revenue from the date palms that reach maturity only after six years;

- Every effort should be made to use only tissue-culture propagated varieties to minimize disease and pest problems, and ensure good quality products;

- Only good quality varieties capable of competing on the international market, once local market is catered for, should be the preferred planting material

The lead institutions concentrated on building human capital (i.e., training of NGOs, extension agents and farmers) and physical capacity (i.e., built a demonstration and training facility for the AMG) within the framework of the recommendations. A master project document that spelt out the three-phased approach was developed with inputs from participating countries. Finally, this period also saw the preparation and submission of requests for Date Palm Technical Cooperation Programme (TCP) to FAO, two of which (Niger and Burkina) have been awarded. These TCPs have allowed each of the two countries to purchase tissue cultured date palm seedlings for wide testing in selected locations with some backstopping from the Date for the Sahel Program.

2.2. Phase II. Program Consolidation

The consolidation phase started in 2002 and lasted approximately three years. This phase started with a project-launching meeting, which took place on the 26-28 of November 2002 at the ICRISAT Sadore center. Fourteen scientists attended the meeting from the
Figure 1- AMG Project Conceptual Framework

PHASE I: PROGRAM INITIATION

Program Initiation Workshop

Recommendations

Human and Physical Capacity Building

PHASE II: PROGRAM CONSOLIDATION

Objective 1: to evaluate the AMG within the context of the multiple farming systems dimensions
- Gender Analysis
- Study on Land Tenure and Resource Access
- Feasibility Study

Objective 2: to test and promote the AMG, an integrated date, fruit trees and vegetable production system
- Identification of Suitable Varieties
- Multiplication of Vegetable Seeds
- Selection of Quality Fruit Tree Varieties and Species
- Development of Techniques for Pest and Disease Control
- Testing Large-Scale Date Palm-Based Production Units
- Promote the AMG in Four Sahelian Countries

Objective 3: to establish commercial date palm nurseries for tissue culture propagated plants

Objective 4: to implement a training programme, which targets various Stakeholders from farmers to research institutions in order to promote system sustainability
- Training on Seed Production
- Training on Fruit Tree Propagation
- Training of Farmers Adopting the AMGs
- Training on Methods of Tissue Culture Propagation of Date Palms

PHASE III: PROGRAM IMPLEMENTATION

Facilitate the establishment of 1000 hectares of date palm-based agriculture in Burkina Faso, Mali, Niger, Senegal and Ghana
four participating countries. This included the Director General of the National Agriculture Research Services of the four countries or their representatives, the Desert Margin Program (DMP) coordinators and the program coordinators of the four countries, as well as staff from ICRISAT.

The specific objectives of the consolidation phase were fourfold. First, the program aimed at evaluating the AMG within the context of the multiple farming systems dimensions, with special emphasis on the social, economic and gender dynamics at the community and household levels. The project socio-economic team conducted three types of studies (a gender analysis, a study on land tenure and resource access and a feasibility study) towards the attainment of this objective.

Second, the project sought to test and promote the African Market Garden, an integrated date, fruit trees and vegetable production system in four Sahelian countries (Niger, Burkina Faso, Mali, and Ghana). This objective embedded several components ranging from the identification of suitable vegetable varieties, the multiplication of vegetable seeds, the selection of quality fruit tree varieties and species, the development of techniques for pests and disease control, and the testing of large-scale date palm-based production units.

Third, the program targeted the establishment of commercial date palm nurseries for tissue culture propagated plants to assure availability of date seedlings at the implementation phase.

Finally, the project planned to implement a training programme (e.g., on the AMG technology, seed production, fruit tree propagation, and methods of tissue culture propagation of date palms), which targets various stakeholders from farmers to research institutions, in order to promote system sustainability. In 2002, two manuals were produced within the framework of the African Market Garden program in order to facilitate the conduct of the different training courses.

2.3. Phase III. Program Implementation.

This phase started towards the end of the second phase and took about 5 years to implement. The aim was to facilitate the establishment, in each of the four participating Sahelian countries, of an area of 1000 hectares of date palm-based agriculture totaling 4,000 hectares; thus to establish by the end of phase three 4,000 hectares of dates.

Most of the date palm plantations established in the AMG system were of small and medium size. About 75% of the date plantations incorporate fruit trees, vegetable and/or forage crops planted among the date palms, to constitute the “Date Palm-Based Agriculture” (DPBA).
III. RESULTS: Project Research Findings and Outputs

In this section, the project research findings and outputs are presented by main project objectives. This section begins with an enumeration of the key research findings from the socio-economic studies, continues with a summary of major project outputs, and ends with a description of important training activities undertaken under the program.

3.1. Objective i: to evaluate the AMG within the context of the multiple farming systems dimensions, with special emphasis on the social, economic and gender dynamics at the community and household levels.

The project research team in collaboration with the local NGOs, development partners and farmers associations conducted a series of socio-economic surveys (gender analysis, land tenure and resource access, and a feasibility study) to assess the different components necessary for a successful introduction of the African Market Garden (AMG). The main findings of these studies are summarized below.

3.1.1. Gender Analysis
The results of this study revealed that potential beneficiaries of the AMG technologies included women who are traditional market gardener and who could manage the small units promoted by the program. However, the study showed that the introduction of the AMG to small scale farmers (particularly women) requires a very intensive follow up activity due to the lack of production know-how of the very small scale farmers.

3.1.2. Study on Land Tenure and Resource Access
This study found that land tenure for small plots (800 m2) was not a major constraint to women, provided they could have access to micro credits. In addition, this study also uncovered that targeted farmers only adopted the AMG technology when the NGOs installed the reservoirs for them and that higher adoption rates were intrinsically linked to the farmers' level of professionalism.

3.1.3. Feasibility Study
The feasibility study demonstrated that the AMG is well accepted by the farming communities in Niger because (i) it saves labor and hardship; (ii) it significantly increases yield and improved produce quality; and (iii) it allows the extension of the production season from the current five months to 10 months of the year.

In addition, the study revealed that the AMG system is a profitable investment whether the system includes date palm trees or not (see Figure 2 below). However, the results clearly reveal that an AMG system with date palm trees is a far more profitable investment than one without. For instance, the results indicate that profits under the AMG system with dates are 229 % higher than those under the AMG production system without dates ($2.3/m2 vs. $0.7/m2) and 2,200 % higher than the AMG conventional system ($2.3/m2 vs. $0.1/m2).
Finally, the results of the feasibility study revealed that the main limiting factor for the large-scale dissemination of date palms within the AMG was the high cost of tissue culture propagated material. A one-year-old date plant that originated in an overseas tissue culture laboratory costs in the Sahel US$40.00. An economic analysis was carried out and it was found out that it would be possible to produce (with a profit) at Sadore date palm plants at a cost of US$15.00 per plant.

3.2. Objective ii: to test and promote the African Market Garden, an integrated date, fruit trees and vegetable production system.

3.2.1. Identification of Suitable Vegetable Varieties
Several research and development activities were carried out to identify vegetables varieties with the participation of the farmers that are suitable for production in each of the three distinct climatic seasons (rainy, cool and dry, and hot) that prevail in the Sahel. Likewise the project searched for open pollinated varieties with tolerance to diseases and viruses, high yield potential and good quality. Farmers preferred traits and market demands also formed an integral part of the selection process. The key research findings are:

- The Tyjoco tomato variety has the best performance in terms of shelf live (28 days versus 11 days for Florodade) but the Tanya and Daniela varieties have the highest total soluble sugar levels, 5.6 and 5.5 percent, respectively, implying that these varieties taste better than the other ones.
The Xina tomato variety has the best performance during the rainy season in terms of average total yield. For instance, average total yield ranged from 2359 g/m² (23590 kg/ha) for FM1048 to 4061 g/m² (40610 kg/ha) for Xina. The trials also revealed that the Xina variety could produce fruit in the climate of the rainy season in Niger while the other varieties abort their flowers.

The Iceberg type Aviram lettuce cultivar is showing great promise during the rainy season. Three varieties (Queensland, a leafy variety; Aviram, an iceberg type variety; and Noga, a romaine type variety) had the least bolting (i.e., flowering, the main criterion for selection) of all the tested varieties.

The Onion variety was the only open pollinated variety that matured before (2-3 weeks earlier) Violet de Galmi.

Safi and Hot Habanero hot peppers varieties were identified as suitable for exports among 18 varieties sown in the nursery on December 20th, 2003 and transplanted to the field on February 25th, 2004.
• The Hawaii super sweet corn cultivar was introduced in 2004 for the first time and it was highly appreciated by the local farmers and consumers. The advantages of this cultivar are that it is bred for tropical conditions and, more importantly, it is an open pollinated cultivar.

3.2.2. Multiplication of Vegetable Seeds

The multiplication of vegetables seed of selected cultivars started in a 0.5 hectares drip-irrigated field in November 2002. A second round of vegetable seeds multiplication was conducted in July 2003. The project’s seed multiplication program produced two types of seeds: (i) foundation seeds that are sold to local seed producers and (ii) certified seeds that are sold directly to farmers. The species from which seed were multiplied are: tomatoes (Negev and Perry Morse 1048), lettuce (Aviram and Noga), melons (Honey Dew), Onions (one cultivar), eggplants (one cultivar), sweet corn (Hawaiian super sweet), Okra (one cultivar), vegetable cowpeas (two cultivars), Leaf Amaranthus (one cultivar) and others.

3.2.3. Selection of Quality Fruit Tree Varieties and Species

A 0.5-hectare mother plantation was established at Sadore to provide propagation material (seeds, cuttings, scions etc) to an attached nursery to use for initial screening of suitable species and varieties and demonstration. The following quality fruit trees have been planted: pomegranates (35 varieties), grapes (7 seedless varieties and 3 with seeds),
Figs (22), Orange (2), Clemantine (1), Pomelo (1), Sapodilla (4), Papaya (5), Moringa (3 species and 3 varieties of *M. oleifera*), Guava (1), Apples (1), Mango (7), and Lannea acida (1).

3.2.4. Development of Techniques for Pest and Disease Control
Findings of research activities indicate that the oil of *Jatropha curcas* seeds is an effective insecticide against trips that attack cowpeas flower buds, against bugs that attack the green pods in the field and against storage insects. *Jatropha* oil in concentration around 5% was effective against all insects tested.

3.2.5. Testing large-scale date palm-based production units
A two-hectare demonstration commercial date palms plot was planted at Sadore. The field is irrigated with pressurized drip irrigation. The date plantation is divided into three plots. One plot is a pure date stand, in the second plot dates are inter-planted with vegetables (using a separate drip irrigation system) and in the third plot dates are inter-planted with fruit trees: a row of tangerines between two rows of dates and pomegranates inside the date rows. In the first plot the spacing between palms are 8x10m. In the other two plots spacing is 10x10m. The date plantation is used mainly for demonstration to private sector and decision makers. Moreover, date palms (*var.*
Medjool and Barchi) were planted in pilot farmers AMG plots in four Sahelian countries: 3 plots were planted in Senegal, 3 in Mali, 2 in Burkina Faso and 4 in Niger. Date palms were planted only in plots that were well maintained by the farmers.

3.2.6. Dissemination Programs

Three dissemination programs were carried out in parallel. The first and the largest was the program for the Promotion of African Market Garden in Niger financed by the Development Marketplace program of the World Bank. The second was the testing of five AMG units in four Sahelian countries and the third was the cooperative activity with Jean Paul II foundation market garden in nine Sahelian countries.

- Promotion of African Market Garden in Niger
  - The Experience of Women AMG at Sadoré
    Recently, a major new ICRISAT initiative to promote economic development for the women of ICRISAT laborers and of those living in the nearby village of Peta-Djounga was completed and formally inaugurated in September 2004. The Association of Sadoré Women for Community Development was created under the initiative of ICRISAT to promote income-generating activities, education, and health care. Mme Dar, representatives of the government of Niger’s, the chief of the village, and all the women of Sadoré, attended the inauguration ceremony. The project involved the construction of a 500 m2 AMG and the launching of a warrantage credit system. The women of Sadoré have expressed their satisfaction with the AMG system, as they have already made a huge profit selling recently harvested lettuce.
Program of African Market Garden in Niger (PAMGN)

Through a different grant secured from Word Bank, the PAMGN program is aiming at the introduction of 900 African Market Garden units all over Niger. The program started with the selection of a number of 30 pilot farmers from each of the participating country locations. These farmers will become the focal points for the dissemination of the African Market Garden. The Pilot Farmers, together with technical agents from their corresponding regions have been trained at the Demonstration and Training facility in Aghymet on all aspects of installation and operation of the AMG. Following training, the Pilot Farmers AMG units were installed in their fields. At present, 838 units out of 900 have been installed through the country and 548 (61%) are operational.

Green Peppers Field  Tomato Field

Introduction of the AMG in Burkina Faso

The AMG sub-regional program for Burkina Faso started in March 2004. The project scientist and coordinator met with NGOs agents and program representatives to establish partnerships with the purpose of promoting the AMG technology and facilitating its adoption in the country. They also traveled to various locations in Burkina Faso, where small-scale irrigation schemes were already installed, to identify trial sites and pilot farmers. Three demonstration sites were built in the vicinities of Ouagadougou, Ouahigouya, and Bobo Dioulasso. The project scientist and coordinator also met with vegetable and fruit processors, exporters, and various private sector actors to discuss future cooperation. Furthermore, 26 pilot farmers and field agents were trained during five days at ICRISAT-Niamey in April 2004 on the installation, operation, and management of the AMG. Two horticultural engineers were hired in June 2004 as extension workers and trained for a month on the principles and operation of the AMG in ICRISAT-Niamey. Finally, several
equipments, including laptops, drip systems, and motorcycles were purchased by ICRISAT-Niamey and forwarded to the Burkina Faso AMG program.

- **The Jean Paul II Foundation Regional Program**
  The Jean Paul II Foundation is a regional NGO supported by the Vatican. The Foundation started in 2002 a program for the introduction of African Market Gardens in nine Sahelian and Sudano Sahelian countries: Cape Verde, Guinea Bissau, Ivory Coast, Senegal, Mali, Burkina Faso, Niger, Chad and Cameroon. ICRISAT is responsible for all the training aspects from nursery construction to providing backstopping to the program. The Jean Paul II Foundation Regional Program has contributed to spread the AMG technology to these countries and has helped to install 8 AMGs in each of the nine countries mentioned above. In 2002, ICRISAT has conducted a special course for training Jean Paul II agents and pilot farmers on the African Market Garden and on nursery methods (the latter within the framework of the regional course). In 2003, six builders from six participating countries were trained in Niamey on the construction of cement reservoirs for the AMG. Several trips were made to these countries between June 22\textsuperscript{nd} and October 1\textsuperscript{st}, 2004 for follow-up activities and extension work. More specifically, the following activities were conducted in each country:
  
  - Building metal casts and establishing 4 m\textsuperscript{3} capacity reservoirs
  - Training 8 selected farmers per country
  - Installing 500 m\textsuperscript{2} AMG with low-pressure drip irrigation system
  - Distributing eight 500 m\textsuperscript{2} AMGs
  - Following-up of AMGs and nurseries set up in 2003

![Cucumber Production on AMG System in Cape Verde](image)

**3.3. Objective iii: to establish commercial date palm nurseries for tissue culture propagated plants.**

Two fruit trees nurseries were constructed: one of 500m\textsuperscript{2} using locally available materials and another of 800m\textsuperscript{2} area using imported materials from Israel. The latter nursery is 4 meters tall and is covered with an aluminum coated net to reduce heat. A mist propagation facility was constructed inside an existing adiabatic cooled ICRISAT glasshouse. This is an automated facility with the capacity of handling
some 20,000 cuttings at a time. Plants so far have come from 2 tissue culture laboratories:
1. Palm date in Namibia and
2. Marionet in the United Arab Emirates

Moreover, the program has established a modern date palm tissue culture hardening tunnel with a capacity of 3000 plants at Sadoré. So far, 3500 plants have been acclimatized in this facility. Presently, 1500 seedlings are under production and 1000 seedlings have been planted at Sadoré and in selected sites in Niger for a total of 10 hectares.

3.4. Objective iv: to implement a training program, which targets various stakeholders (i.e., farmers and research institutions), in order to promote system sustainability.

- Training within the Framework of the Development Marketplace Program
The Development marketplace program trained in 2002/2003 some 1,000 farmers, NGO agents and reservoir builders in a series of courses.

- Training of Jean Paul II Pilot Farmers and Agents
A training course on the African Market Garden and on vegetable seeds multiplication was given in 2002/03 to the Jean Paul II pilot farmers and field agents. The course took place in Niamey, Niger from December 3-13. Twenty-three participants from 9 countries (Burkina Faso, Cape Verde, Chad, Gambia, Bissau Guinea, Mali, Mauritania, Niger and Senegal) attended the course. Eighteen units of drip irrigation, two per country, were distributed.

- Training on Tree Propagation and Nursery Management
A regional course was carried out (With the support of MASHAV and Finland) during the period of October 21 to November 1, 2003 on nursery methods. There were 32 trainees from 9 countries. Another regional training course on tree propagation techniques and nursery management was held at the ICRISAT/ Sadoré
between February 24th and March 1st of 2004. Thirty-four participants from Senegal, Mali, Burkina Faso, and Niger attended.

- **Training on Vegetable Seeds Production and Multiplication**
  In 2003, a regional course on vegetable seeds production was given to 33 small-scale seeds producers and farmers from 4 Sahelian countries. In 2004, twenty-eight participants from Senegal, Mali, Burkina Faso and Niger attended a regional training course on vegetable seed production and storage held in ICRISAT/Sadoré from March 23rd to 29th.

- **Training on Methods of Tissue Culture Propagation of Date Palms**
  Selected laboratory staff were trained on the methods of tissue culture propagation of date palms. In 2002 and 2003, three technicians participated in training courses on date palm production in Israel, 1 technician was trained on the techniques of acclimatization of tissue culture date seedlings in Namibia.

- **Other Training Activities**
  In 2002, a regional extension worker was trained in Israel on the operation of the AMG; a training and demonstration workshop for 60 NGO leaders from four Sahelian countries, was held for the Dates for the Sahel program; and country coordinators participated in an international date symposium carried out in Namibia.
IV. CAPACITY BUILDING

• Demonstration and Training facility
A demonstration and training facility was built for the AMG on the grounds of Agrhymet at Niamey. Since its installation, the facility has attracted more than 1500 visitors, composed mainly of farmers groups, NGOs, extension personnel as well as bilateral donor agencies and development projects.

Vegetable Trial Plots at Agrhymet

• Vegetable Seed Multiplication Facility
A vegetable seed multiplication facility, a mother-tree plantation and a tree nursery were constructed at Sadore. The seed multiplication facility has an area of 7 hectares. These facilities were built to support the program training capacity.

• Regional Laboratory
A regional laboratory for the acclimatization and hardening of tissue culture propagated date palm seedlings is functional, as well as 10 AMGs training and demonstration sites in each of the participating countries.

• Requests for Date Palm Technical Cooperation Programme (TCP)
Requests for Date Palm Technical Cooperation Programme were prepared and submitted to the FAO. Three of the requests (Niger, Cameroon and Burkina) have been awarded to allow each of the three countries to purchase tissue cultured date palm seedlings for wide testing in selected locations with some backstopping from the Date for the Sahel Program. Similar grants are expected for Mali, Senegal and Mauritania.

• Other Capacity Building Outputs
  ▶ A total of at least 1,000 AMGs planted with date palms in Niger alone, 500 in each other countries (Burkina Faso, Mali and Senegal).
Ten nurseries with capabilities of acclimatizing in vitro propagated date palm seedlings are in place.

Ten certified vegetable seed producers and 15 fruit tree nurseries producing a range of quality fruit tree varieties.

Each country has at least one representative of a drip irrigation company that can service both small scale and large-scale date palm groves.

Coordinating unit for date palm programme management established in each of the four participating countries.

IV. FULFILLMENT OF OBJECTIVES

The AMG project has fulfilled all the objectives set in the program’s proposal. Table 1, below, lists our objectives, the corresponding activities undertaken, and the completion status.
Table 1: Fulfillment of Objectives

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Activities</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. To evaluate the AMG within the context of the multiple farming systems dimensions, with special emphasis on the social, economic and gender dynamics at the community and household levels.</strong></td>
<td>• Gender analysis</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Study on land tenure and resource access</td>
<td>✔</td>
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<td></td>
<td>• Feasibility study</td>
<td>✔</td>
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<tr>
<td><strong>2. To test and promote the African Market Garden, an integrated date, fruit trees and vegetable production system:</strong></td>
<td>• Seek OPVs with tolerance to diseases and viruses, high yield potential and good quality.</td>
<td>✔</td>
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<tr>
<td>(i) Identification of suitable vegetable</td>
<td>• Test selected varieties in Randomized Complete Block Designs</td>
<td>✔</td>
</tr>
<tr>
<td>(ii) Multiplication of vegetable seeds</td>
<td>• Incorporate the selected varieties into the seed multiplication program.</td>
<td>✔</td>
</tr>
<tr>
<td>(iii) Selection of quality fruit tree varieties and species</td>
<td>• Undertake a vegetable seed multiplication program.</td>
<td>✔</td>
</tr>
<tr>
<td>(iv) Development of techniques for pest and disease control</td>
<td>• Train small commercial producers.</td>
<td>✔</td>
</tr>
<tr>
<td>(v) Testing large-scale date palm-based production units</td>
<td>• Seek partners from public and private organizations</td>
<td>✔</td>
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<tr>
<td></td>
<td>• Introduce high quality varieties from main existing fruit trees</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Establish a mother plantation of these fruit trees at Sadore</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Test varieties before releasing them to the farmers.</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Establish research and demonstration production units Aghymet in Niamey and Sadore.</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Set up on-farm tests on farmer’s field</td>
<td>✔</td>
</tr>
<tr>
<td><strong>3. To establish commercial date palm nurseries for tissue culture propagated plants</strong></td>
<td>• Identify professional nurserymen</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Train nurserymen on tissue culture propagated plants.</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Construct a date palm nursery in each country</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Purchase seedlings from certified tissue culture laboratories.</td>
<td>✔</td>
</tr>
<tr>
<td><strong>4. To implement a training programme, which targets various stakeholders from farmers to research institutions, in order to promote system sustainability.</strong></td>
<td>• Training on seed production</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Training on fruit tree propagation</td>
<td>✔</td>
</tr>
<tr>
<td></td>
<td>• Training of farmers adopting the AMGs</td>
<td>✔</td>
</tr>
</tbody>
</table>
IX. CONCLUSIONS AND FUTURE PERSPECTIVES

This report has provided a description of the AMG concept, the project design and implementation strategy, and has highlighted the key achievements of the project since its inception in 2002. The program has successfully reached all of its stated objectives of (i) evaluating the AMG within the context of the multiple farming systems dimensions; (ii) testing and promoting the AMG in four Sahelian countries; (iii) establishing commercial nurseries for tissue culture propagated plants; and (iv) implementing a training program, which targets various stakeholders (i.e., farmers and research institutions), in order to promote system sustainability.

The optimistic results of this project can partly be attributed to the fact that the results of the socio-economic studies were applied to fine tune the AMG technology and make it appropriate to the Sahelian context. As such, the AMG addresses many of the productivity constraints faced by Sahelian farmers. The results indicate that the AMG project has resulted in increased availability of food of high quality throughout the year even during drought years in participating households. Farmers in Niger, especially women, have already witnessed a substantial increase in their income levels.

This program is now the highlights of ICRISAT work in West and Central Africa. It has drawn hundred of visitors (scientists, donors, policy makers and especially farmers and NGOs) to the pilot sites of the program. Based on this successful undertaken, a more ambitious program to implement the program in the Sahel is underway to be supported by a number of donors including the Islamic Development Bank (IDB), The United Arab Emirates, Italy, The Global Environment Facility (GEF), FAO and USAID to the tune of 20 to 30 millions dollars US. These are all testimony of the success of this program in contributing to the alleviation of poverty, food security and the conservation of the environment.