End of Tour Report
Water Management Technology Project
Jordan Valley Authority
Amman - Jordan

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Contents of Report

Respectfully submitted

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A. Introduction

This end of tour report covers the orientation, program development, and program accomplishments of one member of a team whose goal was to assist the vegetable growers in the Jordan Valley increase their production efficiency through improved technology. How well this team performed and succeeded may become more evident with time. We would like to feel that we made a contribution.

It has been a rare opportunity to work with vegetable growers as eager to try new practices, to take risks on behalf of improvement, and to be so appreciative of efforts to help them.

These two years have provided a great deal of challenge, some successes, some frustration, some saddness, and a great deal of warmth from Arab hospitality. We were deeply saddened by the untimely death of the Project Director, Dr. Karim Husseini. This kind man held the welfare of the Jordan Valley farmers with great concern, and was held in high regard by them.

The very capable administrative support from His Excellency, JVA President Omar Abdullah Dokhgan and Vice President Munther Haddadin, and Frederiksen, Kamine and Associates stateside back-up were of great help in program implementation.

The encouragement and concern expressed by AID Director Ed Harrell and Technical Project Directors Dr. Frank Denton and currently Dr. James Turman was always positive and optimistic. Of special and sustained help, both direct and indirect, WMT would like to express our appreciation to AID Agricultural Officer Charles Jenkins and Program Specialist Fu'ad Qushair. Mr. Jenkins and Mr. Qushair made frequent visits to WMT operations in the Valley, and were knowledgeable and supportive of the program. Of the seven foreign countries in which I have worked, Mr. Charles Jenkins is the most competent and helpful AID Agricultural Officer I have encountered. All of us in the field were greatly encouraged by their interest.

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I am glad I had the opportunity to work with the fine young staff of JVA/WMT engineers. To those with whom I worked most closely I am grateful for their assistance and indulgence. Their names are listed with projects results in the appendix of this report. Mr. Duane Lindgren RK-JVA/WMT was of great value on all of our water distribution planning and implementation. Miss Arkaid Abdel Nour Admin Assistant and Mrs Yana Mbaidin provided excellent office support for the program.

If I leave with one regret it is that I wish we could have done even more for the very deserving farmers in the Jordan Valley.

B. Assessment of Problems

The first five weeks in-country were spent in assessing the production patterns, methods, and problems of vegetable crops in the Jordan Valley. Visits were made to 42 farms in the southern, middle and northern areas of the Ghor. During the visits standardized, pre-determined questions were asked about each crop grown; problems the farmer felt were limiting his production and profit potential; and observations on practices which our interview team felt were likely to become problems, or practices which were currently inadequate.

On return from the Valley interviews, available written information generated by other sources was reviewed, conferences were held with JVA Ministry of Agriculture, University of Jordan College of Agriculture faculty, and about 10 commercial companies who supply seed, fertilizer, or pesticides to the farmers in the Valley.

It became obvious, less than half way through the assessment period, that the major problems of the Valley farmers were crop management rather than water management problems.

The farmers expressed problems related to water, but these were policy problems, such as uncertain delivery times, and uncertain quantity. These expressed needs were transmitted to the JVA. The farmers did not feel that sprinkler irrigation

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would be valuable to them for certain vegetable crops but felt that it would be good for citrus, bananas, cabbage, and lettuce.

The team noted that the zig-zag surface irrigation method, placement of fertilizer on top of the soil, high incidence of foliar and fruit rotting diseases, and improper use of mulch on drip irrigated rows could be replaced by better practices.

The farmers registered strong complaints about the cost of pesticides, fertilizers, and selling their produce. These problems were transmitted to the farm management section of the Jordan Valley Farmer's Association, as these were problems in their area of responsibility.

Serious soil borne diseases, high weed populations, guesswork in fertilizer rate determination, poor quality seedlings of tomato, pepper, and eggplant (when not direct-seeded), were also problems in crop management which the team felt deserved research attention.

In general, farmers were satisfied with the varieties of cucumber, eggplant, and pepper being used in the field, but felt that better greenhouse cucumbers and field tomatoes varieties should be made available which were more disease resistant, higher yielding, and with firm fruit suitable for shipping.

The disease problems of greenhouse and row covered cucumbers were strongly expressed. Poor coverage of spray, poor ventilation, the free-water method of irrigation were actually bigger problems than change of variety as felt by the farmers.

Another problem that surfaced was the lack of technical assistance for the farmers in routine problem solving. When asked what they were presently doing about getting information they said from other farmers, the commission men, and commercial sales people. It was obvious that the Ministry Extension Service was not reaching very many Valley farmers, at least

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not the 42 we interviewed.

Labor problems were pointed out by 64 % of the farmers interviewed. Weeding is a high labor, high cost input in the Valley, but not one of the farmer's had or intended to use, herbicides. Spraying labor costs are also high because most of the operations are semi-manual. The manual methods used require approximately three times more labor and five times more hours than is required by tractor drawn or selfpropelled sprayers. Because of small size of farm, high efficiency sprayers may not be justified but cooperative ownership or contract application could be helpful.

The farmers felt that grading and sizing were not justified, as higher prices were not given for graded tomatoes, peppers, or eggplant. The new marketing center at Arda will help growers to get better prices for sorted, sized, and graded products.

A final, and very important problem expressed was the tomato virus disease. The farmers said that this is one of their biggest problems with tomatoes. The virus diseases of cucumber, squash, and melons will be equally devastating unless strong measures are taken to curb their spread. Both diseases are spread by insect vectors, both have a wide range of weed hosts, and both seriously reduce yield and quality.

Another research area requested, from the JVA administration was the need for determination of water requirement for the various vegetable crops grown in the Jordan Valley. This information is to be used in water allocation in the future. His Excellency, Omar Abdullah Dokhgan also requested the development of a best practices package for each method of irrigation used in the Valley.

C. <u>Program Development</u>

After the survey results were digested and reduced, a research and demonstration program based on vegetable industry needs and JVA requests was outlined. It was suggested that some of the minimum stress technology from the USA be considered. During the following 4 weeks, seminars were presented to the JVA, USAID, Ministry of

Agriculture, and University. We were most fortunate to have someone from the AID show such interest in the new technology as Agricultural Officer Charles Jenkins. Mr. Jenkins visualized an on-farm demonstration program using these new technics. In a very short time, AID provided very strong moral and financial assistance to a Tomato Better Practices Program. Without Mr. Jenkins encouragement and help I doubt if we could have developed a program of such magnitude in that first year.

The demonstration program fitted in very well with the research program outlined. As tomatoes represent 40 % of the agricultural income from the Jordan Valley we made this crop our priority test crop in 1979. Decisions were made:

1. To study seedling production methods which would provide virus-free transplants for field research and demonstration plots.

2. To compare furrow, sprinkler,and drip irrigation methods for water-use efficiency, effectiveness with various practices, and influence on yield and quality of the five major vegetable crops.

3. To study the value of the full bed mulch system with drip and traditional furrow irrigation.

4. To test varieties of tomatoes for resistance to the major diseases in the Jordan Valley, for earliness and large fruit size, and yield.

5. To study fertilizer rate and placement methods with current and improved practices.

6. To compare and demonstrate various aspects of the new technology with practices used in the Valley and their influence on labor use, fruit yield and quality, and plant health.

7. To assess the value of systemic insecticides, anti-feedant oil films, and contact insecticides on the virus disease incidence of tomatoes and cucumbers.

8. To compare various row-cover management systems (tunnels) on the growth, yield, and disease incidence of cucumbers.

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(Systems compared: Kentucky, French, and San Diego).

9. To initiate studies which could help validate known water consumptive use figures for the major vegetable crops grown in the Jordan Valley.

10. To initiate an irrigation better practices body of information upon which could be used in future educational programs.

D. Program Accomplishments

1. Three greenhouses were constructed for containerized plant production. These structures were built by the JVA/WMT group with materials to exclude insect vectors of the Tomato Yellow Leaf Curl Virus (TYLCV) and Cucurbit Mosaic, (CMV). Integrity of the greenhouses was maintained with cloth or screening having openings of 0.2 mm or less the size of the first infective-stage of the TYLCV vector, Bemesia tobaci, the sweet potato whitefly.

Seedlings were grown in the patented trays of Speedling, Incorporated USA using a vermiculite-peat soil-less media. The technology of controlled seedling production was demonstrated and has been successfuly transferred to three competent Jordanian agricultural engineers.

The methods of sanitation to reduce insect and disease entrance to the seedling production area have been demonstrated and transferred. Studies were conducted on soil-less media which could be made from local materials; a formula of peat (purchased) sand (local), micro-nutrients (purchased) lime (local) and wetting agent has been developed, tested, and transferred.

Greenhouse construction, ventilation, and evaporative cooling methods were designed, constructed and transferred.

The superiority of containerized, disease-free vigorous seedlings has met with marked interest among growers and business persons in Jordan.

The Todd Planter Flat has been modified slightly, is

now being manufactured, and is being sold in large quantities to growers in the Jordan Valley. It is hoped that growers will incorporate the entire disease-free system (media, sanitation, air-pruning, demand watering and fertilizer, roguing, etc.) as the tray is but one segment of the system.

The importance of cotyledon retention, maintenance of seedling vigor, transfer technics, soil moisture control, seedling fertilization, and pesticide application were demonstrated and transferred.

A two-stage program to insure the production of virus-free seedlings has been initiated. An high-integrity (0.2 mm) greenhouse for growing the seedlings, and another for growing to fruiting stage was designed and constructed at Pump 16, Karameh. The proposal is to have a 4 to 5 % sample of each lot released from the Seedling house to be grown in the Validation house. If the plants grown to fruiting in the Validation house remain free of the TYLCV, one could assume that the seedlings left the Production house of the virus. This program could be used for the cucurbit virus program, too.

2. In order to start a field research program it was necessary to add a field station in Wadi Yabis to serve farmers in the northern Ghor, establish activity on JVA land in Deir Alla for farmers in the Middle Ghor, and Karameh for farmers in the Southern Ghor (down to Ghor Safi). The demonstration area at Kafrein was already available, and for this reason plant production house number one was constructed on that site.

At Kafrein, tomato variety trials, irrigation methods studies, and cultural practices comparisons were made in the fall of 1979 and spring of 1980. The Wadi Yabis station was ready for limited testing in the fall of 1979, and by spring 1980, 16 plots were established. Plots at Wadi Yabis included irrigation methods, water use efficiency studies, best practices studies, 3 different tomato variety trials, fertilizer rate and placement studies, and several variety trials on melons, cucumbers, and beans.

The irrigation methods studies showed that drip and furrow (not zig-zag) yielded approximately the same (Drip 3.6, Furrow .2 MTD) whereas, sprinkler yielded 4.1 MTD. The farmer yield of 1.4 MTD was used in comparison. In early season yields, furrow was better than drip, as follows: furrow 2.6 drip 2.5 and sprinkler 0.7 MTD. Sprinkler plots developed later yields but fruit quality was also less than the surface methods. This same pattern held for tomatoes, cucumbers, muskmelons, okra, sweet corn and watermelon as shown in the Appendix of this report.

3. In addition to the preparation of the field stations, equipment procurement was initiated. In order to demonstrate and evaluate the full bed mulch system equipment to form and firm an elevated bed was needed. Ordering from the US was unfortunately delayed, thus it was decided to manufacture a bed press in-country. From slides and drawings WMT provided, the Royal Scientific Society fabricated two bed presses which were used extensively for research and demonstrations. Lacking other needed equipment it was necessary to improvise or do many of the operations manually.

The raised beds were 90 cm across 15 cm high. Before the plastic film (mulch) covered the bed, a band of fertilizer was placed on the outer edge of each side of the bed refered to as shoulder placement. A center band of superphosphate was applied. The drip tube was placed off-center about 5 to 8 cms. Fumigation was a manual operation, thus a 450 gram can of methyl bromide was placed in an open top oil can over a nail block for puncturing. The fumigation can was removed from beneath the plastic after 48 hours.

The film was placed firmly over the bed and soil was used to lock the film to the base of the bed. These operations are all machine operations. An equipment order was placed in the spring of 1980 but has not arrived as yet, due to the Gulf crisis and restrictions on shipments from the Port of Aqaba.

The full bed mulch system (FBM System) was demonstrated in the Better Practices Demonstration Program (BPD Program) on

20 different farms and at all field stations in 1979-1980. Farmer interest in this practice was very high. At this date the former Prime Minister, Said Al Rifai has set up a 80 dunum model farm in Karameh in which the entire FBM system is being used. The farmers immediately grasped that better growth, less loss of fruit due to ground rot, ease of spraying, harvesting, and great reduction in weed growth was associated with the system. Many of the plots included staking and tying, a further improvement on the FBM System.

The BPD Program was very successful and most of the credit goes to Mr. Jenkins and Mr. Fu'ad Qushair af AID Jordan who helped to obtain funds and supplied such interest and moral support for the Program, and to the American coordinator Mr. Robert T. Montgomery an Extension Agent, Univ. Florida who coordinated the program so effectively with the help of various Jordanian engineers.

The best tomato yields from the BPD program in the Southern Ghor were 4.6 metric tons/dunum (MT/D), the farmer average was 1.4 and the average for all BPD farms was 2.4 MTD. In the 10 farms in the North the farm average is 2.6 MTD, and the BPD farms 4.2 MTD.

The research studies on the FBM system compared to farmer's average yields showed that fumigation doubted yield (2.6 to 6.4 for fumigation; raised beds 6.3 versus farmer's flat mulch method 2.6 MTD; and mulched versus non-mulched 6.3 versus 2.4 MTD. There is little doubt that this technology has been successfully transferred. The current limitation is availability of equipment.

The FBM system uses approximately the same amount of plastic per dunum, the same fertilizer amounts, and the same amount of drip tubing. The increase in efficiency of these inputs is obvious. The advantage of staking was felt in crop earliness, reduction in cracking, larger size fruit, easier spraying and easier harvesting. An increase in marketable yield (from farmer average 1.4 to staked plots 5.4 MTD) was achieved.

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The FBM system was transferred in detail to 9 Jordanian engineers working for JVA/WMT.

4. Tomato varieties were tested at Wadi Yabis, Kafrein, and at Karameh. Fifty varieties were assembled for replicated and observational trials. The cultivars were obtained from USA, Europe, Japan, USSR, and local sources. Twelve varieties were screened for adaptability to sprinkler irrigation. A summary of these trials is presented in the Appendix.

The methods of evaluation of varieties in the field and for consumer acceptance (taste panel, and a 5-point organoleptic procedure) was demonstrated and transferred. Another value of our variety studies was to increase an awareness of yield potential and yield assessment. Farmer samples showed that the average tomato grower in the Southern Ghor produces about 17 to 20 fruits per plant. In our variety trials many varieties exceeded 30 without mulch, and more than 50 with mulch. In Florida, an average of 87 (very carefully graded) <u>marketable</u> fruit per plant is achieved. In studies Mr. Montgomery and I conducted in Florida the average total fruit per plant is 124, marketable 87. Jordan can be expected to increase yields significantly as cultural practices improve and the virus is better controlled.

5. Fertilizer application for most vegetables in the Valley is a manual, high labor and high materials, high cost practice. Most farmers pay a great deal for chicken manure and medium analysis fertilizer. The Univ. of Jordan admits that most rates of application are guesswork.

WMT studied the influence of complete fertilizer in bands under mulch with drip irrigation, and another trial on the value of supplemental nitrogen. It was faund that there was no significant yield increase above the 150 Kg/Dunum rate of complete fertilizer with the high use-efficiency of the FBM system. There was no significant increase in marketable yield beyond 100 Kg/Dunum of supplementary nitrogen with the FBM system. The farmer average of 2.6 MT/D was almost tripled (7.0 MT/D) in these fertilizer tests, most of which was attributed to better placement and the

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increased efficiency due to the full bed mulch system.

6. Some of the pessimists feel that tomato production in the Jordan Valley may be economically unfeasible in 10 years unless The TYLC virus is checked. Optimists feel that 15 years is realistic. It was hoped that JVA could bring together the resources and talents of the Min. of Agri. Faculty of Agric., and the JVA into an intensive team effort, but such has not materialized. WMT accomplishments include creating an awareness of the possibility of growing virus-free transplants; providing these seedlings with a systemic insecticide before leaving the safety of the greenhouse; covering the field set plants with an anti-feedant oil; and following with effectively applied contact insecticides. WMT put out 2 trials with these variables, and we have shared our thinking and stylet-oil with U.J. Fac, of Agric. who have new initiated research along these lines. We have promissing leads, hope and enthusiasm but the answer is still in the distance.

7. Three methods of applying clear plastic over rows of cucumbers were developed and demonstrated (tunnels or row covers). Four Agric. Engineers for the JVA have seen and worked with these technics. It was hoped that on-farm demonstrations could have been established but WMT has not given this effort much priority. The French method (in use in Jordan involves a half circle wire hoop covered on both bottom edges with soil. The low labor, easy ventilation method used in San Diego (USA) involves a post and wire holding 2 strips of film over the plants, like an inverted V. Edges of the two strips of plastic are buried at the ground level and held at the top of the wire by clothes pins. To ventilate, one or both sides can be unpinned and the film drops to the ground. The labor saving, disease reduction, and greater yield should be a very quickly adopted practice in the Valley.

8. Facilities for the validation or determination of the evapotranspiration figure for the various crops were not available; but WMT has been provided with complete project information, plot design, data input and output suggestions for three approaches to this problem. One approach covers crop efficiency per unit

of water supplied, another measures delivery system efficiency by crop response, and the third is the development of low-cost volumetric lysimeters for hillside construction. The hillside construction would save costs of excavation by one-half, and the gravity flow collection facility would eliminate the need for out-flow pumps and measuring pits.

9. The development of an irrigation better practices package is now in its second phase. WMT should feel confident that the FBM system is highly applicable to drip irrigation at bed widths up to 90 cm, and for furrow irrigation one side watered up to 60 cm wide. For furrow irrigation side holes need to be made in the bed wall on which the furrow water is being applied.

With the FBM system fertilizer, water, and labor efficiency can be increased between 50 and 60 % according to our preliminary results. This work should be continued, so that a reliable, highly visualized, educational publication in simple language and line drawings could be available for distribution to farmers, allied industry personnel (fertilizer, pesticide salesman), and commission merchants.

10. His Excellency, President Omar Abdullah Dokhgan, requested a five year plan for research based on the priorities I felt should be addressed for the Jordan Valley.

A 5 year Plan for Research, and a 5 year Plan for Demonstration needs was prepared and presented. Each element of the Research Program Proposal was organized in the following manner:

1. Title
2. Objectives
3. Duration of Investigation
4. Suggested methods of Investigation
    a. Variables
    b. Constants
    c. Treatment
    d. Experimental Design
    e. Data to be Taken
    b. Information to be Expected

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5. Field Layout, Equipment Needs, etc.

Each element of the Demonstration Program Proposal was organized in the following manner:

1. Title
2. Objectives
3. Duration of Demonstration
4. Size and Location of Demonstration
5. Methods of Approach
6. JVA Inputs
7. Farmer Inputs
8. Care of the Demonstration
9. Expected Value of the Demonstration

The Research Program Proposal included the following:

A. Plant Protection: Incidence and Control

1. Influence of Date of Planting on Virus Incidence and cost benefit ration of Tomato Production
2. Influence of Virus-free Seedlings, Systemic and contact insecticides and anti-feedant oils on the Virus Incidence of Tomatoes.

B. Water Management

1. Influence of Method of Irrigation on the Growth Development, and Economics of Production on the 5 Major Vegetable Crops in the Jordan Valley.
2. Determination of Water Requirement of the 5 Major Vegetable Crops in the Jordan Valley.
3. Determination of an Irrigation Best Practices program for each method of Irrigation for the 5 Major Vegetable Crops in the Jordan Valley.
4. Evaluation of the Minimum Stress High Efficiency Semi-Closed System of Irrigation.

C. Cultural Practices

1. Evaluation of Varieties of the 5 Major Vegetable Crops

under the Full Bed Mulch and Open Systems of Culture.

2. Evaluation of Fertilizer Rate, Kind, and Method of Placement under Strip, Full Bed Mulch, and Open System of Culture.

3. Evaluation of Major Components of the Minimum Stress Full Bed Mulch System on the 5 Major Vegetable Crops.

D. Seedling Plant Production

1. Assess Plant Production Technics as to Improvement of Plant Quality, Labor Efficiency, and Field Performance.

2. Evaluation of Virus-Free Status of Seedlings Produced in the 2-Stage System.

3. Assess Factors Influencing Summer Dormany Problems of Tomatoes.

The Demonstration Program Proposal included the following:

A. Field Demonstrations

1. Best Practices Program 5 Crops

a. Fumigation
b. Raised Beds
c. Disease-Free Seedlings
d. Full Bed Mulch
e. Full Coverage Pest Control
d. Band Placement Fertilizer
f. Irrigation Method Used in Area

2. Farmer Adoption Program

a. Farmer supplies inputs
b. JVA provides technical assistance

B. Greenhouse Demonstrations

1. Best Practices Program (Cuke, Beans, Tomato)

a. Screening
b. Fumigation
c. Ventilation
d. Drip irrigation
e. Mulching
f. Variety trials
g. Controlled pollination
h. Growth regulations: Fruit set

C. Modified Hydroponics System: High Tolerance Crops

1. Sandwich Technic: High Salt Areas
2. Nutrient Film Technics
3. Semi-Closed System

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D. Plastic Row Cover Systems (Cuc.,Tom.,Pep.,Egg.)

1. Systems
   a. Kentucky Hoop and Hook System
   b. French System
   c. San Diego System

2. Practices
   a. Mulching
   b. Ventilation
   c. Disease Control
   d. Staged Fertilization
   e. Pollination
   f. Labor Efficiency
   g. Cost Effectiveness

Both Program Proposals were submitted with equipment needs, personnel needs and capital outlay for each of the five years. Copies of this entire package were given to His Excellency the President; the new Agricultural Director of JVA,WMT Mr. Labadi the assistant to the Director, Mr. Anwar Haddad, and one for the WMT file.

E. Associated Contributions

1. Assisted in the selection and evaluation of preliminary, intermediate, and final design proposals of the JVA-JVFA Plant Propagation Facility. Three units of 20 Seedling Nursery Greenhouses for the Jordan Valley.

2. Assisted Government of Jordan in development of grade standards for pepper and tomatoes.

3. Assisted in the selection and procurement of US machinery, equipment, and supplies to implement the research and demonstration programs.

4. Presented fifteen seminars on various topics related to the new technology for vegetable crops in Jordan. These presentations were for three different audiences: academic, extension-research, and private industry.

5. Instructed JVA/WMT engineers in functional field plot design, data collection, data analysis and reduction, and data interpretation.

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6. Assisted in the organization of a training tour of vegetable production systems in Florida for 4 JVA/WMT engineers.

7. Provided technical assistance to the demonstration programs, and to the water management training advisor.

8. Provided technical assistance to the allied industry and commercial firms on selection, procurement, and operation of equipment, supplies and methods related to seedling plant production, fertilizer, fumigation, and cultural practices related to the new technology.

9. Assisted in the orientation and technical assistance to more than 20 visiting individuals or groups (such as World Bank, FAO, etc.).