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REVIEW OF PROGRAM ON GATED-PIPE IRRIGATION ON SUGARCANE

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EXECUTIVE SUMMARY

1. The Sugarcane Working Group (SCWG) implemented a pilot program on about 500 feddans in Luxor and Qena Governorates in 1999 to introduce an improved on-farm irrigation system on sugarcane using perforated pipes. The purpose of the improved system is to reduce the water applied and consumed by sugarcane, and to improve yields and farmers incomes.

2. The program was successful. Farmers who participated in the pilot program see positive results with respect to yields, especially. They support expansion of the program.

3. The improved irrigation system consists of a deep ripping (sub-soiling) and laser leveling, a buried main, and above ground perforated laterals.

4. While the improved system has yielded positive results, it is most appropriate for large farms. In order to extend the system to a larger portion of farmers in Egypt, the SCWG should alter the system design to make it simpler and cheaper. The design should include above-ground aluminum pipes only, and gated, as opposed to, perforated pipes. This will provide farmers with more flexibility with respect to installation, and it will be much less expensive than the current design.

5. Future implementation should include 6 inch pipes instead of 4 inch pipes, which are currently used. This will improve water distribution and efficiency.

6. The SCWG should encourage the private sector to pursue licesing agreements with overseas manufactures to produce 6 inch gated pipe. It is too expensive to import pipe from abroad on a large scale.

INTRODUCTION

The Ministry of Agriculture and Land reclamation and the Ministry of Water Resources and Irrigation are implementing a program to reduce the amount of water applied to sugarcane, while maintaining high levels of productivity and improving farm incomes.

Sugarcane uses the most water of any crop in Upper Egypt. A minimum of 3.0 billion cubic meters of water is applied to about 250,000 feddans of sugarcane, or about 12,000 cubic meters/feddan. In some areas, water applied to sugarcane exceeds 16,000 cubic meters/feddan. To reduce the amount of water consumed by sugarcane, the Agricultural Policy Reform program (APRP) established the Sugarcane Working Group (SCWG). Composed of members from the two ministries, the Sugar Council, the Sugar Companies, and APRP's RDI unit and EPIQ, SCWG implemented a pilot program to install a piped on-farm irrigation system on about 500 feddans of privately owned and operated sugarcane farms in the Governorates of Luxor and Qena. This system was developed and tested during previous years by the Sugar Crops Research Institute (SCRI) and the Agricultural Engineering Research Institute (AEnRI), in collaboration with the Sugar Crops Council and Sugar Companies. The improved irrigation system is expected to reduce water application to between 8 and 9 thousand cubic meters/feddan, while maintaining current levels of production.

There are numerous benefits to the improved irrigation system. It has been shown to reduce water use in sugarcane by 20 to 25 percent. The new system results in: increased yields (from 10 to 25 percent); improved water quality and efficiency of water use; improved drainage; improved fertilizer efficiency; increased productive area of land by up to 10 percent; reduced incidence of belharizia; improved weed control; and costs savings associated with irrigation, such as reduced need for diesel fuel to operate irrigation pumps and lower hired labor costs.

The improved irrigation system requires farmers to substitute for the traditional system of flood irrigation used on all other crops in the Nile Valley, with a more structured and efficient system including:

1. Subsoil plowing;
2. LASER leveling of the ground prior to pipe installation;
3. Installation of a new high capacity water pump with a pump house to protect it;
4. Digging (1 m to 1.5 m) to install main pipes (PVC or polyethylene pipes);
5. Connecting main pipes to over-ground perforated pipes with valves to control water flow.

OBJECTIVES OF THIS STUDY

The objectives of this study are to:

- Review the implementation of the 1999 pilot program from an engineering and agricultural point of view;

- Evaluate the potential to improve upon the 1999 pilot program by installing a less costly and less complex irrigation system. The proposed system is completely over-ground, is made of aluminum pipes, and consists of pipes with gates, rather than perforations.

- Provide recommendations to the SCWG on expansion of the pilot program in 2000.

PERFORATED PIPE PILOT PROGRAM FOR IRRIGATED SUGARCANE IN EGYPT

Findings

1. The pilot program has shown conclusively that the combined package of laser leveling and perforated pipe water distribution is *effective* - leading to water savings of at least 20%, and *attractive*. It can result in increased yields of at least 20 percent combined with reductions in pumping costs of about 30 percent.

2. The pilot program has demonstrated that the package of laser leveling and perforated pipe is readily adopted by farmers. Those who have it want to extend it; those who have seen it and the results it brings, want it. In the pilot program implemented in 1999, farmers formed groups of up to 75 to make use of the system on a single block of land. Cooperation among these groups of farmers appears to be effective. They can plainly see the benefits of participating.

3. The total increase in production is the result of a combination of factors:

   i. deep ripping (sub-soiling) and laser leveling, which accounts for an increase of about five tons per feddan (5 T/fed);
   ii. reduction in unused area within the field through use of the gated pipe system, for an increase of 5 T/fed, and;
   iii. a combination of factors affecting increased health and vigor of the crop, for another 5 T/fed.

   These three together amount to 15 T/fed which on a base of 45 T/fed would be a 30% increase. Only occasionally are all three factors optimized simultaneously, thus the average increase in production on the demonstration plots is about 12 T/fed, or 25%. This is a significant figure considering that the base level is already high.

4. These results have been obtained from a *pilot* system which makes use of materials that are currently available in-country and not altogether suited to gated pipe irrigation. Further, the results were obtained by farmers who have never used this system before. With the elimination of some aspects that are expensive or result in sub-optimal results, and with the introduction of gated pipe specifically manufactured for this purpose, the system can be made more flexible and efficient. It will result in further water savings and productivity gains which will be even more attractive to sugarcane growers in the next phases of the project. It is important to note that analogous gated-pipe systems have been used successfully all over the world.

5. The buried pipe distribution system, while popular on large farms in the western U.S., has been shown to be uneconomic and unmaintainable in the context of the current pilot program. Contracting for the supply, installation, and maintenance of the buried pipes is not practical unless the farm is around 100 feddans, or more or unless the growers themselves manage the installation of the buried mains. This fact is obvious to the farmers; they would prefer an above-ground aluminum piped distribution system which they can install, move and maintain themselves. The engineers from AEnRI working on this project recognize this and agree with the farmers.

6. The laser leveling practices are well matched to the field sizes and soil types. The resulting field slopes are suitable and generally uniform. Some unevenness occurs at the tops and bottoms of the fields where the leveling equipment turns. This is unavoidable at first; such imperfections can be eliminated when the land is re-leveled before planting the next crop.

7. Agricultural practices of intercropping cane with beans, tomatoes, onions and garlic in the first season of the autumn planting results in the absence of defined furrows during the first part of the season. The whole field then behaves like a single 'border', or wide flow path, with small and irregular corrugations. Farmers construct furrows only after the third irrigation in order to avoid damaging the inter-cropped plants. This practice, which results in the fields being flooded rather than furrow irrigated (there being no furrows), is inefficient as it results in uneven water distribution. Over-irrigation occurs at the top of the field and under-irrigation at the bottom.

8. The SCRI is aware of this practice and its ill effects on field irrigation efficiency and on crop health and yields. It has performed tests showing that furrow spacings up to 120 cm are practical and that organized planting of the intercropped crop rather than broadcast planting as currently practiced gives better yields for both the cane and intercropped crops. Farmers, however, are reluctant to change habitual patterns and it will take considerable extension time and effort to get them to change these habits. It is worth doing, however, because straight, well-defined furrows and well-formed beds will add to the irrigation efficiency and crop yields. With broad beds it may be possible to intercrop at each rattoon.

9. The pilot system makes use of the aluminum pipe which is currently available from military factories in Egypt. These are of 4-inch diameter and have drilled, non-adjustable holes ranging from 22mm - 28mm diameter along their length. While making use of pipe that is available from government sources, the small diameter of the pipe and the non-adjustability of the holes, or 'perforations', result in a large variation of discharge along the length of the pipe. In a field test of the perforated pipe at the Abdul Monseif farm near Essna the discharge varied from one liter per second (1 LPs) at the inlet end, to 55% of that half way along, to approximately half of that at the end. The flow at the end was too weak to collect in the 5-liter container that was used to make this test. Also, water issues from the perforations in the upper half of the pipe's length at an excessive velocity and at an angle of about 45 degrees. This is due to the high flow velocities which occur in 4-inch diameter pipes. When water issues from the pipe at an angle it is difficult to direct the flow into the furrow. The use of *6-inch gated pipe* would avoid all of these difficulties. Indeed, 6-inch is the smallest size of gated pipe manufactured in the U.S.; this is because smaller pipe is hydraulically inefficient and is too easily bent when handled in the field.

Technically speaking, the gated pipe sections need to operate as a *manifold* - a device that distributes its contents, be it air or water, *evenly* over its length. The only way to do this with a pipe that also transports water is to make it sufficiently large in diameter that the flow velocity is low and to make the outlets adjustable, i.e. a gated pipe.

10. The buried distribution mains designed by AEnRI engineers and installed by government contractors are properly sized to function correctly hydraulically. They also save space in the field, because the perforated distribution pipes are the only part above ground. Yet, the farmers' experience with this system has been less than satisfactory. Due to poor installation practices, leaks have developed. They are next to impossible to locate, and even if found, there is no way to fix them because the contractors do not have service centers in Upper Egypt. In one case, a neighbor's back-hoe accidentally struck a buried main and broke it. The whole system there remains non-operable.

    There is, therefore, a critical missing element - the ready availability of local repair parts and services. Farmers are aware of this weakness and are reluctant to commit to the buried main system when they know there is no after-sales service. All demonstration farm operators stated this as a critical need. 1

11. "Fertigation", or the addition of measured amounts of chemical fertilizer to the irrigation water, is of great interest to farmers using the piped distribution systems. Fertigation is done through the use of liquid fertilizer solutions and off-the-shelf metering devices long used in piped irrigation systems in the U.S. The whole system of a 'nurse' tank, piping and injector costs about two hundred dollars.

12. The use of flow meters, which have been supplied by the Ministry of Water Resources and Irrigation and installed as part of each of the pilot systems, is an excellent water management tool. It allows both the farmer and Irrigation Ministry to see how much water is being used at each irrigation - and thus measure and improve efficiencies and better plan water deliveries. Unfortunately, most of the meters are either not working or are not being read. The meters need to be read and the data organized by the Ministry of Irrigation for its own use.

    <u>A word of caution about using these data for canal operations</u>:

    On large, complex irrigation systems, such as along the Nile, aggregating the savings on individual farms, no matter how large, does not lead to useful projections as to how the canals will behave. The only way to determine the changes in the canal dicharges is to *measure them in the canal*.

13. The Allweiler-Farid pumps used on the pilot plots are quite suitable for this application. They appear to provide an ample supply of water at a suitably low pressure or "head".

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1 See RDI Unit Report Number 86, "Status Assessment of the Upper Egypt On-farm Water Management Improvement Program" by Dr. Lamia El-Fattal. The report is available from the APRP/RDI Unit.

RECOMMENDATIONS

In order to extend the benefits of both reduced water use and increased yields on sugarcane land in Upper Egypt, the pilot system already demonstrated should be made available to farmers in a direct and simple way. Recommendations to accomplish this follow:

1. A surface system using aluminum pipe should be promoted as a first priority.

2. Continue to use the mainline sizing parameters currently used for the buried mains but *use 6-inch diameter gated pipes for the distributors.* The reasons for this are given in Finding 9 above.

3. Training of trainers and teaching of farmers in the application and use of these methods, as it is being done now, should be continued and expanded.

4. Plain and gated aluminum pipe, and all appurtenant fittings, in 6-inch and 8-inch sizes should be manufactured in Egypt. It is too expensive to import pipe from abroad on a large scale.

5. This goal could be actively pursued by the private sector through licensing agreements from overseas manufacturers with existing private sector aluminum pipe fabricators in Egypt.

6. As part of the agreement for licensing and manufacture of the growing supply of pipe and fittings that will be needed in the following phases of this project, distributorships with trained personnel and sufficient stocks of spares must be set up *starting in a town that is central to the project.*

   A way of setting up these relationships is shown on Figure 1.

7. It is not necessary to start this in a 'big way'. It will be sufficient only to set up the specialized forming and fabricating machinery, obtain supplies of the correct types and thicknesses of aluminum sheet and foundry stock, and turn out and stock the beginning requirements. Larger amounts of pipe in a wider array of sizes can be manufactured as demand grows.

8. Sales engineers in the distribution centers will need to be trained in the proper design and installation of the systems to meet individual farmer's needs. The existing training program run by the AEnRI is well suited for running specialized courses for these sales engineers. The professionals on the AEnRI staff have the knowledge and skills to teach such courses and can monitor their work in the field to assure that the systems are being properly designed and installed.

9. Flow meters should continue to be part of the installed package, but the meters should be of the electro-magnetic type. These meters have a smooth interior which does not collect debris and should be read for/by the Ministry of Irrigation at whatever intervals it wishes.

SOME AREAS FOR FURTHER TESTING AND DEMONSTRATION

1. Testing high-volume, low-head pumps driven by a prime mover on the order of currently-used small diesel pump sets to meet the needs of small and medium sized plantations. Allweiler-Farid manufactures a wide range of pumps and has excellent facilities for the development and testing of prototypes. A joint effort with this company would likely yield quick results.

2. Testing of existing 6-HP 'baladi' pumps to determine their suitability and limitations for use with gated pipe. If a means is found to match these pumps with a gated-pipe distribution system there would be rapid growth of demand, and concomitant water savings, as gated pipe is well suited for many other crops as well as sugarcane.

4. 3. Demonstration of off-the-shelf fertilizer injection equipment.

ANNEX ONE
DEMONSTRATION FARMS VISITED

Near Luxor: Samir Shounouda's farm, 26 fed.
Samir's neighbor who wants the system and is twinning his 7.5 hp pump.

Near Toudh: 'Adam-Bey's farm, 33 fed.
Ali El Edeisi's farm, 10 fed.

Near Qena: Makhadma farm, 37 fed.
Shekefi sugar factory farm, 40 fed.
Seka Hadid farm, 70 fed with 75 farmers cooperating.

Near Esna: Abdul Monseif Huzein's farm, 15 fed, all surface piping.

Near Nag Hammadi: El Shagab farm, 35 fed with 48 cooperating farmers.

Near Kom Ombo: Ag Research Station and two farms on new lands.

ANNEX TWO
PERSONS INTERVIEWED

In Cairo

- Dr. Abd-Elwahab I. Allam, Director, Sugar Crops Research Institute.
- Dr. Ibrahim El-Geddawy, Sugar Crops Research Institute.
- Dr. Azmy M. El-Berry, Director, Agriculture Engineering Research Institute.
- Dr. Ahmad M. El-Beheiry, Agriculture Engineering Research Institute.
- Mr. Galal el-Kady, Sugar Crops Council.
- Eng. Hussein Elwan, Head, Undersecretary, Directorate for Water Distribution, MPWWR.
- Eng. Mahmoud Nour, Program Coordinator, PMU.
- Dr. Jane Gleason, APRP/RDI.
- Dr. Sayed Hussein, APRP/RDI.
- Dr. Lamia El-Fattal

In Nag Hamadi

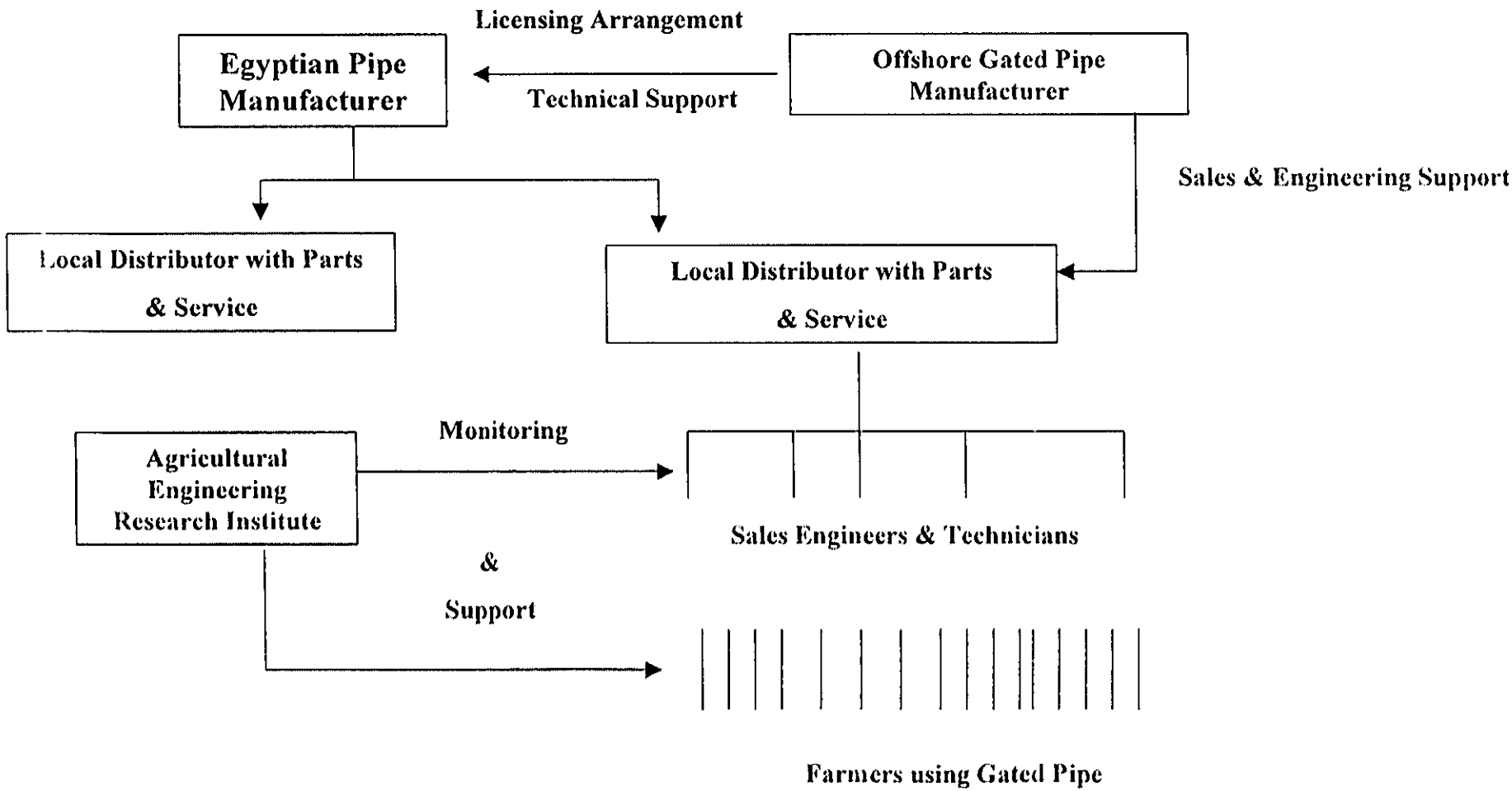
- Eng. Jaber Othman, Director, Sugar Factory, Nag Hamadi.
- Eng. Abu Zayd Zaydan al-Rashidy, General Director of Sugar Factory, Nag Hamadi.
- Eng. Abdul Fattah Abdul Rahman al-Sherif, Head of Agricultural Directorate, Nag Hamadi.
- Eng. Abdul Moutez Mahammad Rashwan, Deputy Head of sugarcane in the Agricultural Directorate, Nag Hamadi.
- Eng. Mashoot Mustafa al-Sheikh, Deputy General Director of Sugarcane in the Sugar Factory, Nag Hamadi.
- Mr. Abdul Sattar Abdul Hameed Abdul Sattar, sugarcane farmer, Nag Hamadi.
- Eng. Kamal Mahmoud Hifni, Head of Cooperative, in Nag Hamadi.
- Eng. Nassar Muhammad Mahmoud, Sugarcane Engineer, local cooperative, Nag Hamadi.
- Eng. Samir Abdulaah, landbasin supervisor, Nag Hamadi.

In Luxor

- Dr. Mohammad El Shazdi, Dy Director-General of Luxor Governorate
- Eng. Abdul HaniAbdullah, Dy Director of Sugarcane Dept.Min of Agriculture.
- Eng. Said Ahmed Ali, Director of Agriculture, City of Luxor.
- Eng. Adil Abbas, Sugar dept, Min of Agriculture.
- Eng. El Shafi, Director of Agriculture, Esna Dept.
- Eng. Ahmed Immam, Director of Technical Office, Min of Agriculture
- Dr. Abdel Moaiz Mohammad Rushwan, Dy. Dircetor, Qena Sugarcane Dept.
- Mr. Ayaad Thabet, RDI Coordinator.
- Dr. Salah El Khatib,
- Mr. Onsi.

In Aswan

- Dr. Ahmed Abu Douh, Dy. Director, SCRI, and Director, Kom Ombo Research Station.
- Eng. Samir Marghani, Director-General, Aswan Ag Dept.
- Eng. Nabil Kamel, Irrigation Equipment Supplier.
- Mr. Said, Representative of the Sugar Association.

Figure 1

Relationships from Manufacturer to Farmer for Gated Irrigation Pipe Supply