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RAIN WATER HARVESTING SYSTEM FOR LIVESTOCK IN SANDY SEMI-ARID REGIONS

CDR Research Project: PDE-5544-G-SS-6019 Third Progress Report

July 11, 1987 - July 10, 1988

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This report briefly summarizes the various activities carried out in Israel and Kenya in the framework of the research project.

I. Work in Israel

1. Technical and experimental work

The plan for modification of the experimental set-up used for measurement of the soil hydraulic properties was executed by "Control-Bit" Company. Operation of the Gamma attenuation system by the new computer is now under test.

Soil water retention and saturated hydraulic conductivity of different sand samples were measured. A previously tested site by the Mediterranean coast about 20 km south of Tel-Aviv is chosen for the experiment. Construction will start this summer with the objective to observe its efficiency during the winter.

2. Theoretical work

Significant progress has been achieved towards developing an engineering model suitable for an optimal design of the rain water harvesting system. Simple mathematical functions can be fitted to the measured hydraulic properties of the sand and subsequently used to solve the imbibition and the redistribution processes under given rainfall. The solution considers the propagation of the wetting front in the unsaturated zone, the accumulation of water above the impermeable layer, the saturated flow over the plastic sheet and the outflow from the collecting unit. Some numerical problems related to

the varying boundary conditions in the central channel and at the soil surface including evaporation are still to be solved. However, the results show that our simplified solution reduces the computer time by orders of magnitude in comparison to the time required by exact solution (of the Richards equation).

Further progress has been achieved in estimating the surface sealing effect on infiltration and runoff. Two papers relating to this study are now under review of referred scientific journals. The results may have significant implications to the Kenyan cultivation practices which are beyond the scope of our project. The practical conclusions in respect to the rain water harvesting system to be built in Kenya are reflected in the following section.

3. Personnel

Upon my return from a sabbatical year in Spain, I found that Mr. M. Cohen, who was supposed to work on the theoretical aspects of the project, had not made any progress. He was then assigned to work on programing my simplified solution. In May 1988, his financial support was cut as he could not meet my requirements and he ceased working on the project.

Mr. Zvi-Biniam, a new graduate student, is assigned to experimentally test my simplified theoretical solution for the soil water regime and the yield of the rain water harvesting system as part of his M.Sc. study program.

II. Work in Kenya

Due to some bureaucratic problems, the transfer of research fund was delayed and actually reached our colleagues in Kenya only in May, 1988. Unfortunately, they also had a problem in building an active

research team on this project (see also section on personnel). No significant reseach work was accomplished there yet. However, the research fund for Kenya is fully reserved and will be used upon meeting the project needs. The following seciton is a report on my visit to Kenya and the practical guidelinnes set to Mr. R.K. Muni for execution.

1. Visit to Kenya (May 26 - June 12, 1988)

While in Kenya my attention focused on three objectives: (a) Study of local conditions; (b) Search for graduate students to join our research team; (c) Coordinate the laboratory and field study with work conducted in Israel. In order to pursue these objectives, I met members of the University of Nairobi and officials of the Ministry of Agriculture, presented the project at a staff meeting in the Dept. of Agricultural Engineering, carried site investigation visits to explore the prospect of building field rain water harvesting systems, and had a series of working sessions with Mr. R.K. Muni and Prof. D.B. Thomas to plan future research work.

Prof. Musuva, Dean of the Faculty of Engineering, expressed the University's interest in our project as the shortage of water for domestic use and livestock is a serious problem in the arid and semi-arid areas of Kenya. He was also pleased with our objective to train graduate students in Israel and in Kenya in the various aspects of the proposed rain water harvesting system. Prof. Osongo, Chairman of the Dept. of Civil Engineering, Prof. Keter, Chairman of the Dept. of Soil Science and Prof. Ogana, Chairman of the Dept. of Mathematics also expressed their appreciation of the project and their will to cooperate in finding qualified graduate students from their departments to work and be trained in the various aspects of the

research study. Mr. Muchiri, Head of the Engineering Department at the Ministry of Agriculture offered his assistance for cooperation with the Ministry of Agriculture on investigation of rain water harvesting systems.

2. Site Investigation Visits

Three site investigation visits were undertaken in order to study the applicability of our method of rain water harvesting in various regions in Kenya (Fig. 1):

- Katumani area (70 km south-east of Nairobi, approximately 750 mm rainfall/year) was visited on May 30, 1988
- Longonot area (50 km north-west of Nairobi, 500-750 mm rainfall/year) was visited on June 1, 1988
- Olepolos-Oltepesi area (40 km south-west of Nairobi, 250-500 mm rainfall/year) was visited on June 3, 1988.

Generally, the soils in these areas include a fraction of fine material, silt and clay, that make them susceptible to crusting which might not be severe for agricultural use but would be a deficiency for our rain water harvesting method. However, there is sand in these areas, mainly in the river beds and in some of the flood water channels. In Longonot, a gravel layer is found below the sand in the river bed. The sand is often mined for construction purposes. In the Olepolos-Oltepesi area, black volcanic sand is found in the main river beds. While the brown sand is popularly used there for construction purposes, the black sand (according to local information) has poor cement bonding characteristics developing cracks when used for construction. Both types of sand and the gravel sized stones are usually freely available to the public and are considered to be suitable material for the rainfall collecting units.

Based on our study of the local conditions, and considering the limited funds and qualified manpower on the one hand, and the future benefit of the Nairobi University and the farmers in the semi-arid regions of Kenya, on the other, we set the following goals for the next year of work in Kenya:

3. Description of the Rain Water Harvesting Tests

In the framework of this study, four sand types, gravel stones, and three local soils, shall be tested to observe their functions in the rain collecting units. Two main types of soil composition will be tested:

(a) The rainfall harvesting unit, where the rain infiltrate and drain through a conductor pipe into a water reservoir, will be filled completely with pure sand, or locally available gravel stones.

(b) The draining conductor pipe will be surrounded with sand as in the first type but the rest of the harvesting unit will be filled with local sandy soil and mulched with either sand or gravel stones. The thickness of the most appropriate mulching layer will have to be determined.

4. Laboratory Tests

Measurement of the water retention curves and the hydraulic conductivity of the various sand, gravel and soils, will be carried out at the Kabete Campus on samples taken from selected fields. The results will be used for prediction of the soil water regime and for the design of rain water harvesting units.

5. Controlled Field Tests

In order to allow continuous scientific observation and protected experimental set-up, the field rain water harvesting units will be built at the Kabete Campus of the University of Nairobi. The sand, gravel and soils will be taken from the investigated areas and carried by lorries to the experimental site in Kabete. Twelve controlled field test units will be constructed. These units will be small in order to limit the cost, but large enough to enable the various observations to be carried out. For this purpose, only a section of one wing of the rain collecting unit will be built for each test, taking advantage of the complete symmetry of the proposed original configuration of the rain water harvesting unit. This will save on the materials, size, work and time.

6. Farm Test

The chosen site is at the foot of the Longonot crater. The land there is successfully cultivated taking advantage of the runoff from the hills. Yet there is acute shortage of water for domestic and livestock use. Water is ferried in drums or jerricans for a distance of more than six kilometers from the public water supply tank located at the Hillstop trading centre under the farm company management.

A local farmer who showed to have self-multivated rain water practices was approached in order to build a single unit rain water harvesting unit on his premises. The ojective here would be to demonstrate the idea for the local farmers and interested authorities. Our interest is that the farmer will have an input in this project in terms of construction work and observation of local data such as recording rainfall and volume of water collected from the unit. Some of the materials will be supplied by the study project funds on

condition that everything will be done according to our instructions.

The collected water will be available for use by the farmer who will be required to keep proper records of volume of water abstracted from the unit. After completion of the project, the unit will be handed-over to the farmer.

The dimensions of the collecting unit will be planned to harvest approximately one month's water requirement for the farmer (1000 chickens, 16 cattle and a family of six members).

7. Personnel

After Mr. G. Muchiri left his position at the University of Nairobi to be Head of the Department of Engineering at the Ministry of Agriculture, Prof. D.B. Thomas stepped in as the cooperative Kenyan scientist in his roll as the new Head of the Department of Agricultural Engineering of the University of Nairobi. Upon my request, Prof. Thomas agreed to continue his overall supervision of the research team in Kenya though the actual research work will be carried out by Mr. B.K. Muni, with graduate students and technical aids.

As of now, no qualified Kenyan graduate student has been sent to study in Israel and be trained in the various aspects of the project. During my visit, I was approached by a faculty member (with M.Sc.) who expressed his interest in coming to Israel to study for a Ph.D. degree. Unfortunately, he does not enjoy the support of the Dean, Prof. Musuva, because of his age (approximately 50 years old). Recently, another student applied for information on this position. We shall continue trying to find a qualified student. In case this effort will not be successful up till September, 1988, I hereby request permission to fill this position with a foreign student from

another African state or a South American country.

It was concluded that Prof. Thomas and Mr. Muni will try to have graduate students studying for their M.Sc. program to work on this project and be trained in rain water harvesting at the University of Nairobi. However the problem of finding a local academic supervisor has yet to be solved.

Y. Mualem

July 17, 1988