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TECHNICAL BRIEF

Rainwater Harvesting

Rapid soil surveys for IRWH towards enhanced food security in rural areas

An Improved Soil Survey Technique for In-field Rainwater Harvesting (IRWH)

Enhancing household food security

The well-being of poor subsistence farmers in semi-arid rural areas is jeopardised by low incomes and inadequate food security. In-field rainwater harvesting (IRWH) technology has been developed to reduce the risk of crop failures and enhance crop production by enabling the most productive use of available rainfall in such areas.

IRWH has proved to be highly effective under experimental conditions in the central Free State and among subsistence farmers and households in the Thaba Nchu region. Because of its importance in uplifting subsistence farmers, wider application of IRWH is eminently desirable, but only on soils that have suitable characteristics. This condition implies that intensive soil surveys need to be carried out **rapidly, efficiently and cost-effectively**, over large areas of South Africa.

A soil survey technique for delineating soils suitable for IRWH

Traditionally, intensive soil surveys (scales around 1:10 000 and larger) have been conducted using a relatively time-consuming and expensive grid-pattern approach. To overcome time and cost constraints in identifying land suitable for IRWH, it has been necessary to investigate the possibility of developing and using an improved, purpose-driven survey technique that employs modern technology and innovative approaches involving predictive soil mapping based on comprehensive pedological knowledge and experience.

As a result of this investigation, the initial development of such an improved soil survey technique has been successfully accomplished and fully documented; further refinement through future practical application is, however, foreseen.

Stepwise development of the improved soil survey technique

A valuable framework within which to conduct any intensive soil survey is the national Land Type Survey (scale 1:250 000), which provides basic information for the whole of South Africa. This, therefore, serves as the essential point of departure in the process of developing and applying a cost-effective, intensive soil survey technique for delineating land suitable or IRWH applications.

The first step forward from this point of departure is the subdivision of land types occurring in the region of interest into soilscapes on 1:50 000 maps. Examples of such subdivisions have been documented for three land types in the central Free State, namely Dc17, Db37 and Ca22.

A soilscape is a mapping unit that facilitates the identification of arable land and consists of a hillslope (or combination of hillslopes) having a characteristic pedosequence, of which the hillcrest forms the upper boundary and the drainage line the bottom boundary. In Landtype Dc17, for example, 66 soilscapes were delineated.

Further steps in the reconnaissance phase leading up to the soil survey include dividing soilscapes into groups, each with similar terrain form, and selecting a representative hillslope for each group. The toposequence (downslope variation in soil distribution pattern) of each representative hillslope is then intensively studied employing the potential of predictive soil mapping facilitated by the on-site use of GPS technology and the computer program 3dMapper.

Predictive mapping, done under the guidance of an experienced pedologist, is the process of creating soil maps based on known relationships among soil properties and environmental variables such as climate, soil parent material, topography and organisms. Results are used to support the formulation of a hypothesis regarding soil distribution pattern for the group of hillslopes represented by the intensively-studied hillsllope. The hypothesis is then tested on similar, unstudied hillslopes, followed by improvement, retesting and further refinement as necessary.

Information and experience gained in the course of this series of steps greatly facilitate subsequent 1:10 000 soil mapping at the level of the soilscape and land type, by greatly reducing the amount of fieldwork normally involved in such a soil survey.

The development of the improved soil survey technique for delineating land suitable for IRWH was based on trial and error, while carrying out soil surveys for IRWH on two of the 66 soilscapes of Land Type Dc17. These two soilscapes were found to cover areas of land respectively totalling 2 721 ha and 1 599 ha, of which 1 177 ha and 183 ha were rated as being good for IRWH.

This trial-and-error approach has culminated in a documented procedure being proposed for an improved soil survey technique. Each step has been described in great detail to facilitate future application.

Initial steps in the procedure result in predicted soil patterns for a hillslope that is representative of all hillslopes in a particular soilscape. Subsequent steps extend predictive mapping to the soilscape as a whole, with results thereafter being compared with field data.

In locating toposequence testpit sites for the acquisition of this field data, all the knowledge gained by pedologists during preceding steps needs to be mobilised and benefits offered by the 3dMapper program need to be fully employed to minimise the number of testpits required. The depth to which testpits should be dug is important.

Whereas detailed soil classification dictates that test pits be dug to a depth of at least 1,5 m, a profile depth of 900 mm has proved to be adequate for revealing characteristics needed to classify soils with regard to their IRWH suitability.

Digging of testpits is followed by the description of soil profiles. A specific, time-saving form has been developed to facilitate recording of necessary soil profile data. These data, in conjunction with toposequence information pertaining to the representative hillslope, reveal a characteristic soil pattern on each hillslope of the soilscape when plotted on 3dMapper and 1:10 000 soil maps.

The relatively low-density testpit configuration used up to this point is finally augmented by soil penetrometer sites (for rapid and low-cost acquisition of soil-depth data) and a sufficient number of additional testpit sites needed to produce the good quality soil maps that meet the objective of revealing soils suitable for IRWH.

Conclusion

Cost-effective soil surveys for delineating land suitable for rainwater harvesting are facilitated through adopting certain innovative techniques and approaches in support of predictive soil mapping. These include intensive application of GPS and the computer program 3dMapper, in conjunction with advanced pedological expertise. In addition, soil profile descriptions are speeded up by using a simplified soil profile description form and a simple, low-cost penetrometer to make rapid determinations of soil depth.

Despite the beneficial use of predictive mapping, this approach still requires optimisation through introducing more detailed understanding of pedogenesis at levels of the land type, soilscape and hillslope, and through maximising the contribution of 3dMapper.

Whereas a map scale of 1:10 000 was used in developing the improved soil survey technique, a 1:5:000 scale with 1 m contours is recommended for future applications.

Experience has shown that soil surveys provide scope for employment of villagers as labourers and at the same time make them aware of the soil resources in their areas. There is also some potential for soil-survey capacity development among better educated members of the community.

Further reading:

Procedure for an Improved Soil Survey Technique for Delineating Land Suitable for Rainwater Harvesting (**Report No: TT311/07**).
To order this report contact Publications at
Tel: (012) 330-0340; Fax: (012) 331-2565 or
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