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Full Length Research Paper

Indigenous soil knowledge relevant to crop production of smallholder farmers at Rambuda irrigation scheme, Vhembe District South Africa

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Rambuda Irrigation Scheme is found in the Mutale Local Municipality in Vhembe District of the Limpopo Province. There is no information on soils or basis for crop choices. Farmers have been growing crops on a trial and error basis and consequently no increase in yields. Situation analysis was conducted followed by field surveys that included person-to-person interview and participatory soil mapping. Verification of participatory soil map was achieved through soil profile description and classification. In general, famers knew the different types of soil found in the irrigation scheme according to local soil classification system. Farmers identified and described four soil types namely, *Tshilogo, Dzwabo, Sengetavha* and *Tshitavha* using local nomenclature. They identified soil compaction, water logging, crusting and quick drying as limiting factors to crop production. Indigenous soil classification system is based on surface soil physical properties related to the use of the soils. Indigenous soil classification system classifies soil according to their properties and is consistent with other systems used elsewhere around the world. The results showed that indigenous soil knowledge and participatory mapping provide reliable information and can be used together with modern soil classification system to develop intermediate soil classification system for South Africa.

Key words: Indigenous knowledge, soil classification, physical properties

INTRODUCTION

Rambuda Irrigation Scheme was established in 1952. Soil studies, planning and construction work of the whole irrigation scheme were done by consultants, but there is no information on soils or basis for crop choices. Therefore, farmers have been growing crops on a trial and error basis using indigenous local knowledge of soils and crop performance on different soil types.

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There is increasing consensus on the invaluable contribution of local knowledge systems of traditional farmers in soil surveys or commonly known as local taxonomies and land suitability evaluations around the world (Ettema, 1994; Barrera-Bassols and Zinck, 2000; 2003, Krasilnikov and Tabor, 2003; Ryder, 2003; Mikkelsen and Langohr, 2004). This reduces time and money spent on surveying areas with poor agricultural potential (Ryder, 2003). This is well-documented for South America (Barrera-Bassol and Zinck, 2000), Central America (Sandor and Furbee, 1996), Africa (Osunade, 1988; 1992(a); 1992(b), Crane, 2001), Birmingham, 2003), Asia (Siltoe, 1995; 1998) in the Carrabean (Ryder, 2003). These studies have demonstrated vast and invaluable knowledge of ethnopedology which can offer important guidelines for development planers (Ryder, 2003).

The aim of this study was to investigate indigenous soil knowledge of smallholder farmers using local ethnopedology classification and participatory techniques in relation to modern taxonomic soil system of South Africa at Rambuda Irrigation Scheme.

RESEARCH PROCEDURES

Site description

Rambuda Irrigation Scheme is situated north of Thohoyandou between 23°01'00"S lines of latitude and 30°26'37"E lines of longitude in the Mutale Local Municipality in Vhembe District of Limpopo Province, South Africa. Surface irrigation method is used on this irrigation scheme. The total area of the scheme is 120 ha demarcated into 104 plots of 1.28 ha (1.5 morgen) each. The plots are subdivided into subplots with sizes ranging between 300 and 900 m^2. There are 104 farmers who are farming at Rambuda Irrigation Scheme. The chief is the custodian of the land and allocates plots to families. Each plot holder pays an annual rental fee of R1.50 ($0.20) for a 0.107 ha subplot or R18.00 ($2.40) for a 1.28 ha plot which is deposited into the Provincial Treasury Account.

The main source of water is the Tshala River. Water is supplied from a weir into the main concrete canal that supplies water by gravity into the four balancing dams on the irrigation scheme. Water is distributed to specific plots by secondary canals. Short earth furrows are used to irrigate the crops planted on ridges. An irrigation programme is used to allocate irrigation times to each plot holder.

Situation analysis

The study involved preliminary situation analysis of the irrigation scheme. Information collected during situation analysis was used to develop a theoretical framework that consists of the full set of soil factors. The framework was used to compile a logically arranged checklist of issues explored during interviews with participants according to the principles described in the triple-A framework (Van Averbeke and Khosa, 2004).

Participatory soil classification and mapping

Participatory soil mapping was conducted with plot holders to identify and describe soils and their properties based on their knowledge and experience. Farmers were asked to choose three group leaders and members of the group were randomly allocated to each group. A 1:3000 orthophoto map of the area was given to each group. Each group was requested to draw a soil boundaries and list of characteristics of each soil type based on their observations, understanding and experience. Farmers were also requested to indicate areas with soil problems such as slow infiltration rates, compaction; difficult to plough, poor yield and frost prone areas. Groups were then combined to integrate, resolve anomalies and validate participatory maps and soil characteristics. The corrections were used to draw the final participatory soil map and description tables. Fifteen soil profiles were dug and classified according to the procedures in the Soil Classification: A Taxonomic System for South Africa (Soil Classification Working Group, 1991) and the procedures for describing soil profiles (Turner, 1991).

Thomson soil auger was used to drill observation points. The information obtained from soil profiles and auger observations was used to collate and enhance trustworthiness of participatory soil map and tables. Final participatory maps were redrawn using ArcMap View 9.0 and all care was taken not to change boundaries as originally drawn by farmers.

RESULTS AND DISCUSSION

Soils of Rambuda irrigation scheme according to the farmers

In general, the response of the farmers showed that the majority of farmers know the types of soils found in their plots. Farmers were able to draw the soil map of different types of soil that they could identify across the irrigation scheme (Figure 1). The soils were classified by the farmers using local soil classification principles and nomenclature as Tshilogo (Neocutanic, chromic, luvic), Tshitavha (Neocutanic, chromic, haplic) and Dzwabo (Rhodic, mesotrophic, luvic) and Sengetavha (Neocutanic, chromic, rhodic, haplic) (Table 1).

Farmers at Rambuda Irrigation Scheme classified and described soils in terms of observable topsoil characteristics and did not consider the subsoil characteristics. Unlike pedologists who use the whole profile properties to classify soils (pedogenesis), farmers only assume that topsoil characteristics explain subsoil nature of the soil. Colour and texture were major soil properties used to differentiate and describe the soil by farmers at Rambuda Irrigation Scheme. Other soil properties such as tendency to waterlogging and organic matter content were considered as minor properties used to distinguish soils. Surface colour and soil texture are also the major criteria used to recognize and describe soils in many rural areas around the world (Mikkelsen and Langohr, 2004; Briggs, 2005; Barrera-Bassols et al., 2009). Several studies echoed the use of similar of criteria elsewhere around the world (Osunade, 1988; Barrera-Bassols and Zinck, 2000; 2003; Krasilnikov and Tabor, 2003; Oudewater and Martin, 2003; Ryder, 2003; Mikkelsen and Langohr, 2004). In more recent studies Barrera-Bassols et al. (2009) found that texture, consistency and stoniness were primary attributes used to classify soils among the Mesoamerican indigenous community; Breuning-Madsen et al. (2010) found that farmers in Bellona Island use surface to distinguish and classify soils and Baustita and Zinck (2010) also found that gave more weight to topsoil than subsoil properties. Farmers reported several soil problems that are limiting to crop production at Ramuda Irrigation Scheme. These are presented in Table 2 and Figure 2. *Sengetavha* and *Tshitavha* were listed by farmers as having good infiltration rate and are usually free from water logging. Dark brown sandy loam A-horizon underlain by clayey B-horizon is found in the eastern side of the scheme and listed as having lower water infiltration rate compared to *Dzwabo*.

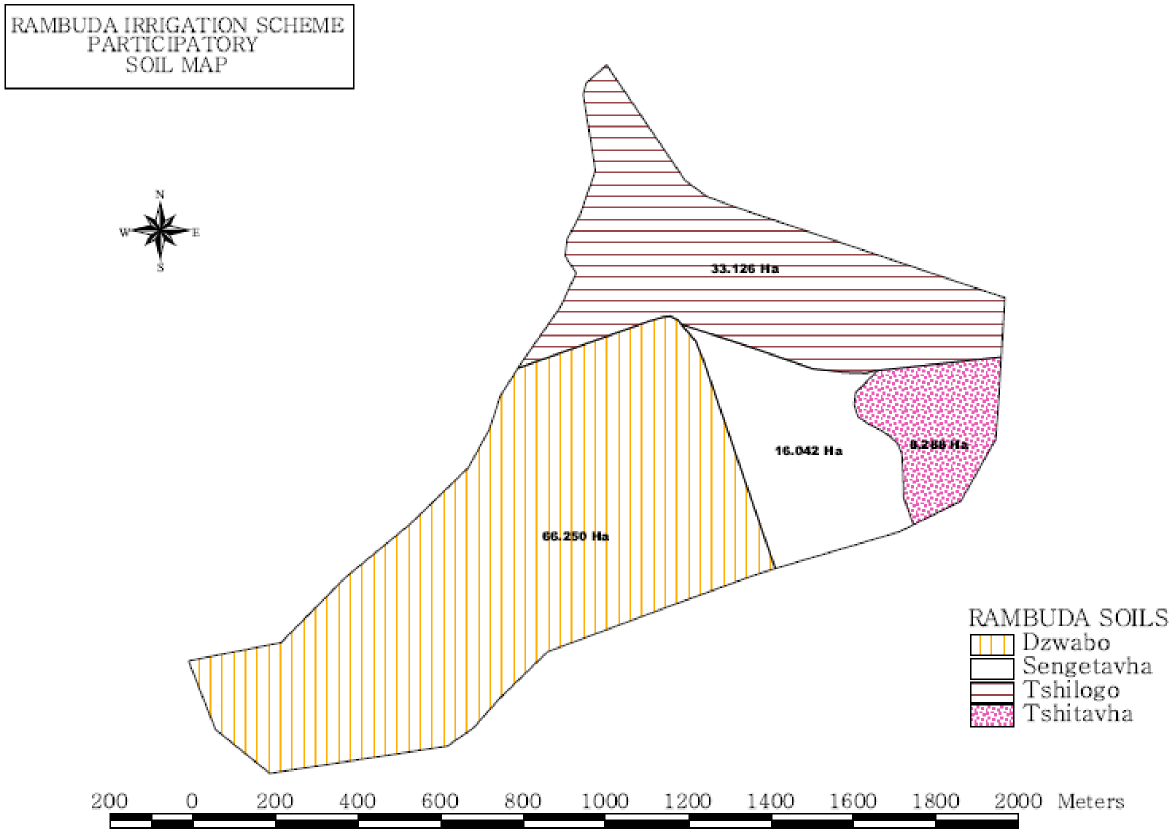

Figure 1. Participatory soil map of Rambuda Irrigation Scheme, Vhembe District.

Table 1. Indigenous soil classification and description.

Soil name	Description
Tshilogo (Dark brown/grey/black clay soil)	Soil may be dark brown, grey, black in colour with high clay content, high plasticity and very sticky when moist, prone to water logging, rich in organic matter and is considered to be fertile.
Dzwabo (Red clay soil)	Reddish clay soil, slightly sticky to sticky and plastic when moist, good drainage and considered fertile.
Sengetavha (Light sandy loam soil)	Reddish, grayish or brownish sandy loam soil, non-sticky and plastic when moist, may show signs of wetness and moderately fertile.
Tshitavha (Fine sandy soil)	Light sandy soil, non-stick and non-plastic, well drained, infertile soil.

Soils near the access roads were pointed out as having low infiltration rate, being compacted and low yields. This can be attributed to the movement of people, vehicles and tractor turning circles during ploughing. Knowledge of the behavior of soils under stress caused by the latter practices in important for decision-making on choices of cultivation methods and ripping programme to alleviate compaction in the irrigation scheme.

Clayey, *Tshilogo* and *Dzwabo* soils were reported by groups as difficult to plough and formed large clods during ploughing compared to other soil types. They also had lower infiltration rates than *Sengetavha* and Tshitavha. Tshitavha and Sengetavha soils were reported to be more suitable for sweet potato production. Sweet potato planted in these soils yielded good roots and was easy to harvest than those grown in *Dzwabo* and Tshilogo clayey soils. This can be attributed to high clay content which makes soil more compacted and thus restrictive to sweet potato root expansion and root growth (Niederwieser, 2004). Cabbages, Chinese spinach and (*Solanum scabrum; villosum*) (African shade) muxe performed better on *Tshilogo* and *Dzwabo* soils. Thus,

Table 2. Soil problems listed by famers at Rambuda Irrigation Scheme.

Soil type	Problems
Tshilogo (Brownish clayey)	Soil takes too long to dry; crusting; soil dries too quickly; compaction and large clods after plowing; water ponding and water logging.
Dzwabo (Reddish clay to sandy clay loam)	Crusting; compaction and large clods after plowing
Sengetavha (Loamy)	Dries quickly
Tshitavha (Sand)	Dries quickly, low yield

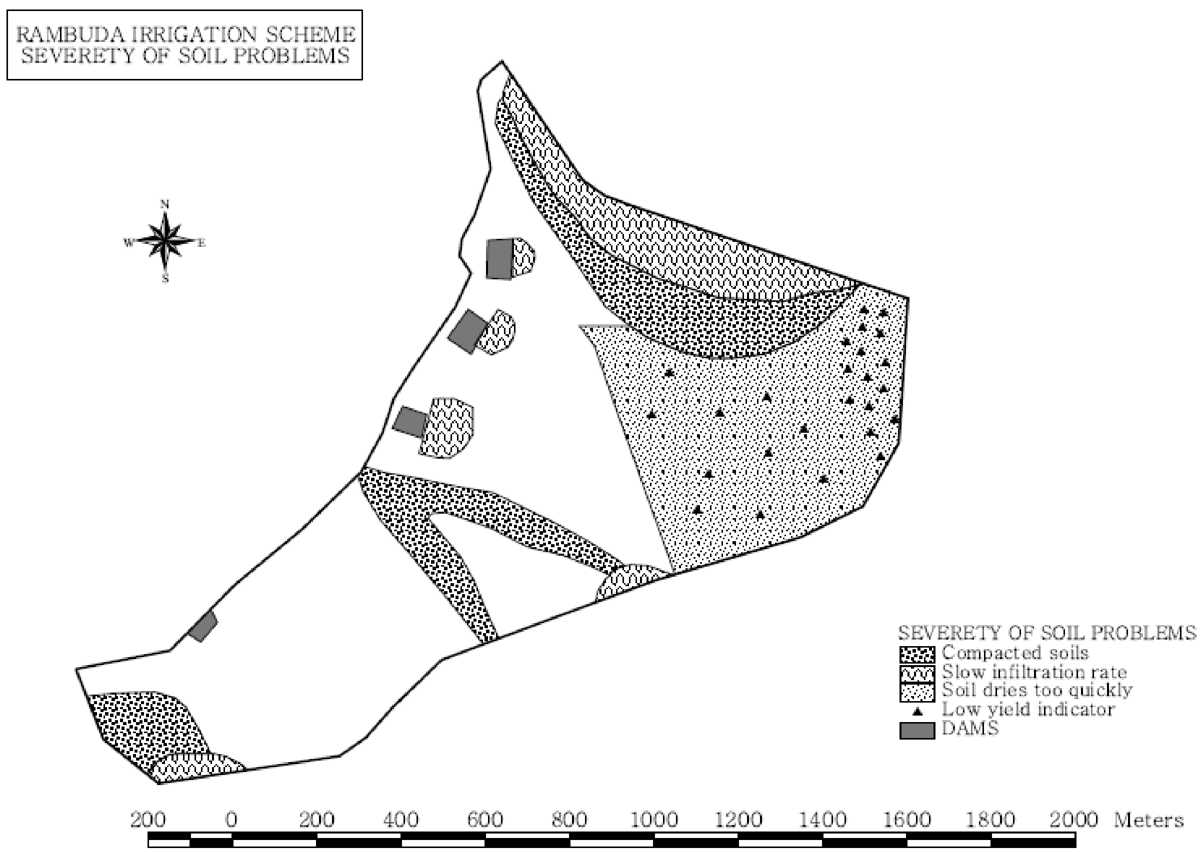

Figure 2. Spatial distribution of soil related problems at Rambuda Irrigation Scheme.

farmers also classify soils based on their suitability for growing specific crops. Breuning-Madsen et al. (2010) reported similar finding among farmers in Bellona Island.

Relationship between farmers' knowledge of soil and pedological classification

Observations of transect walks and soil profiles showed two soil forms namely, Hutton and Oakleaf according to the soil classification – A taxonomic Systems for South Africa (Soil Classification Working Group, 1991). However, farmers listed four soil types based on the traditional local taxonomic classification principles (Figure 1). Hutton soil form is a sandy clay dark red in colour and extends from the high-lying western section becoming light red sandy clay loam to sandy loam reddish yellow in the low lying central south-eastern section. Oakleaf soil form is dark brown sandy clay extends from the north-eastern section becoming light brown loamy sand towards the south where it borders the Hutton soil form. The transition of the two soil forms consists of sandy loam to sandy soil and is classified as *Sengetavha* using local indigenous soil classification principles. This change in texture and colour was the criteria used for identification and classification of soil into of four soil types by the farmers. Local farmers also view soil texture as an important property to decide on the suitability for different land uses and implements to use when ploughing the land. It is also important for determining suitable crops and irrigation cycles. Unlike in the local indigenous soil classification system, soil texture is not used as a differentiating criterion in the Soil Classification a Taxonomic System for South Africa (Soil Classification Working Group, 1991). Lambrechts and MacVicar (2004) argued that it should be used as a qualifier in conjunction with soil form and family such as for example Hutton fine sandy loam. This will be more explanatory for land users and will narrow subjective conclusions by different pedologists in different parts of the country. Both Hutton and Oakleaf soil forms may vary in soil texture and this determines their practical suitability for given land uses. Local system emphasizes the importance of soil texture in its classification and thus soils may be red, but differ in texture hence their suitability for given uses.

Unlike the nomenclature used in the soil classification : A Taxonomic System for South Africa soil forms and families, which use geographical names or feature near where the soil was identified for the first time, local nomenclature classification of soils is based on distinguishable soil properties by land users. This conveys more detailed information on which decision regarding land use can be made. Lambrechts and MacVicar (1974) indicated that much is lost because geographical name does not give indication about the horizons that are present or soil properties important for land suitability for given uses. Besides indicating horizons present in the soil profile, the nomenclature system does not tell the textural class of horizon. In the practical situation land users base the choices of land use on visible soil properties such as texture, depth, presence of hard layer, workability, moisture behaviour, vertic property of the soil, etc. Soil classification system also needs to recognize this fact for practical utility by land users.

Conclusions

The study showed that there is still wide gap between perceptions and terms used by soil scientists and farmers, particularly small-scale or subsistence farmers. The results have shown that farmers knew soils in the irrigation scheme. Little work if any has been done in the field of ethnopedology in South Africa to bridge the gap between soil scientists and farmers. Farmers' participation in soil surveys is indeed important for sustainable agricultural development planning and land suitability evaluation in developing countries where financial resources are scarce. This will bridge communication gap between the local soil knowledge and the soil classification - A Taxonomic Systems for South Africa. Looking at the results of this study one would be led to conclude that an intermediate land user friendly system of soil classification is necessary for the new integrated farming society of South Africa.

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