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Farmers' soil knowledge for effective participatory integrated watershed management in Rwanda: Toward soil-specific fertility management and farmers' judgmental fertilizer use

N.P. Rushemuka[a,d,*], R.A. Bizoza[b,1], J.G. Mowo[c,2], L. Bock[d,3]

[a] Rwanda Agriculture Board (RAB), Box 617 Butare, Rwanda
[b] National University of Rwanda (NUR), Box 56, Butare, Rwanda
[c] World Agroforestry Centre, Box 30677 Nairobi, Kenya
[d] Liège University (ULg), Avenue Maréchal Juin, 27-Bat. 52, B-5030 Gembloux, Belgium

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ABSTRACT

In the complex soilscape of Rwanda, failure to tailor soil fertility management technologies to specific soil types is the major constraint to their adoption. A study was undertaken to understand how scientists can introduce new soil-related technologies as part of the already functioning farmers' soil knowledge (FSK) system and achieve soil-specific fertility management interventions. Farmer participatory research and biophysical diagnostic methods were used in Akavuguto watershed, southern Rwanda. Results from this study show that the FSK system is not only rational but also practical and consistent with the technical soil knowledge and has the potential of being user-friendly for local fertility experts, agronomists and extensionists compared to the international soil classification systems. The farmers' rationality is demonstrated by a clear agreement between farmers' cognitive soil knowledge and farmers' soil-related practices. The farmers' practices follow a clear coping strategy in a poor and complex biophysical environment. In the Akavuguto watershed case study, the mountains, with their Urubuye (Entisols), are limited by the slope gradient and stoniness; they are planted with trees. The upper hills, with their Urusenyi (Entisols) and Inombe (Ultisols), do not have major edaphic limitations; they are used for growing beans and sorghum, crops that are demanding but key in farmers' food security strategy. The back slopes, with their Umuyugu/Mugugu (Oxisols), are limited by poor fertility status; they are used for growing cassava and sweet potato which are acid tolerant and less demanding. The valley bottoms, with their Nyiramugengeri (Histosols) and Ibumba (Ultisols), are limited by very strong acidity; they are used for growing sweet potatoes. It was concluded that understanding the biophysical environment in terms of land units and associated farmers' soil types constitutes an appropriate entry point to achieve soil-specific and replicable fertility management technologies

1. Introduction

Sub-Saharan Africa farming systems are known for their heterogeneity even within short distances (Giller et al., 2011). Heterogeneity occurs primarily as farmers' adaptation to variation in soils and their suitability (Steiner, 1998). It is also caused by differential resource management by farmers (Zingore et al., 2007). Under such circumstances, conventional research and extension find the systematic consideration of soil fertility variations a challenging issue (Rutunga, 1991; Steiner, 1998; Giller et al., 2011). In practice, the same rate of fertilizers is still formulated for entire 'Agro-Ecological Zones' (AEZs) with different soil types in relation to potential crop demand on a blanket basis (Giller et al., 2011). The response to such fertilizer application is erratic and inefficient leading to poor adoption of fertilizer use (Rutunga, 1991; Sanchez et al., 1998; Steiner, 1998; Sileshi et al., 2010; Giller et al., 2011).

The Participatory Integrated Watershed Management (PIWM) innovation model (Fig. 1) was developed to address the drawbacks of conventional research and extension (German et al., 2007). The approach takes its roots in the 'farmer first' philosophy (Chambers et al., 1989) and builds on previous approaches such as the Integrated Natural Resource Management. The goal was to stimulate interactions between farmers, scientists and the

* Corresponding author. Tel.: +250783471871/+250785651672; fax: +250530830.
E-mail addresses: Rushem2005@yahoo.fr, prushemuka@student.ulg.ac.be (N.P. Rushemuka), Abizoza@nur.ac.rw (R.A. Bizoza), j.mowo@cgiar.org (J.G. Mowo), laurent.bock@ulg.ac.be (L. Bock).
[1] Tel.: +250788415218.
[2] Tel.: +254207224298.
[3] Tel.: +32081622542/+32081622538.

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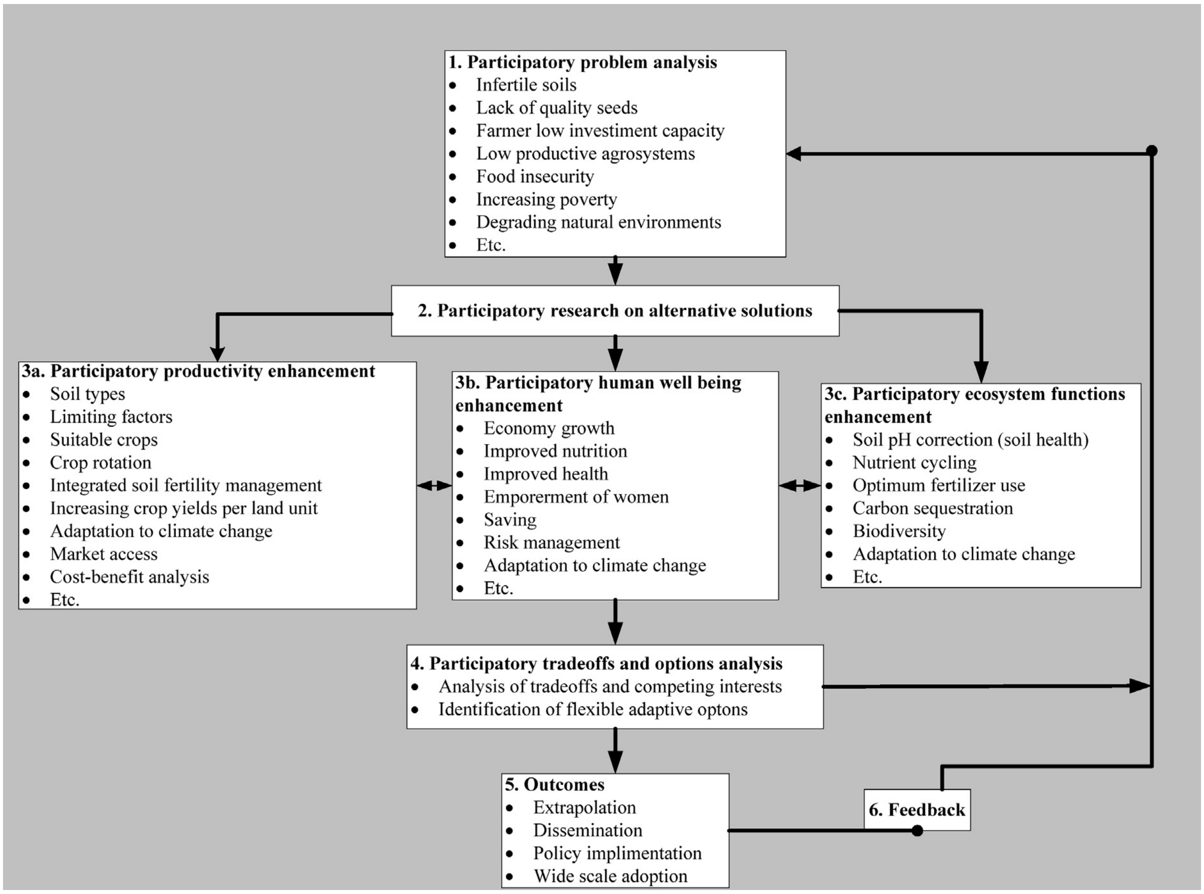

Fig. 1. Participatory Integrated watershed management model.
Modified by authors of this paper from CIFOR (2000).

biophysical environment to design and implement a project that is socially acceptable, ecologically sustainable and economically viable (Mugendi et al., 2011). It is from the arena of participatory and integrated research approach at watershed level on the one hand, and the inability of the international soil classification systems to work in participatory manner on the other hand, that scientists recognized the value of farmers' soil knowledge (FSK) (Habarurema and Steiner, 1997; Steiner, 1998; Barrera-Bassols and Zinck, 2003; Barrera-Bassols et al., 2006a; Krasilnikov and Tabor, 2003; WinklerPrins and Sandor, 2003). The FSK is also referred to as local, traditional, folk, native or indigenous soil knowledge. While Winkler Prins (1999) finds the term "local" the least problematic, Leeuwis and van den Ban (2004) p. 106 specify that, in essence, scientific knowledge too is "local" and speak simply of scientists' versus farmers' knowledge. Since scientists compare their own soil knowledge to that of farmers as two epistemic communities/cultures (Ingram et al., 2010) and because the concept is already in use in Rwanda (Steiner, 1998), in this paper we opt for the term FSK.

The awareness of FSK worldwide has led to a new field of science which is called Ethnopedology. The later is a hybrid discipline at the interface between natural and social sciences. It is distinct from anthropology, as it focuses on development issues to produce a locally informed development agenda and solutions of relevance to local people (Sillitoe, 1998 cited by Payton et al., 2003).

Ethnopedological studies have been carried out in all continents, with most publications from Africa, America and Asia (Barrera-Bassols and Zinck, 2003; WinklerPrins and Sandor, 2003). The wide range of research covered under the umbrella of Ethnopedology (Barrera-Bassols and Zinck, 2003) can be grouped into four main themes (1) the formalization of farmers' soil and land knowledge into classification systems, (2) the comparison of technical and farmers' soil classifications, (3) the analysis of local land evaluation systems, and (4) the assessment of agro-ecological management practices.

With this much conformism to technical soil science subdisciplines, ethnopedology scientists have been able to demonstrate that this branch is a valid scientific discipline – "the other pedology" – but not yet to create the required interaction between biophysical and social scientists for effective PIWM. Therefore, many researchers (Rhoades, 1999; Leeuwis and van den Ban, 2004; Quinlan and Scogings, 2004; German et al., 2007) have been wondering why an approach with a clear and relevant framework has failed to function. An examination of conference debates and field-level realities indicate that the fundamental cause of the impasse is the inaccessibility of the technical soil resource information to non-pedologists and the absence of communication bridges between soil science and FSK to enable effective communication about soils between scientists among themselves and scientists and farmers. In this context, the PIWM approach has resulted into frustrations and occasional acrimony among natural and social scientists (Papadakis, 1975; Quinlan and Scogings, 2004). As a consequence, biophysical scientists have perceived participatory research as social science only and consequently, for many, it was reduced to a political tool – a kind of diplomacy – and less used as a scientific methodology' (Quinlan and Scogings, 2004). The CGIARs[4] and their collaborator National Agriculture Research

[4] CGIAR: Consultative Groups of International Agricultural Research.