A review on the potential of improved fallows and green manure in Rwanda

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Abstract. Agricultural production in the densely populated highlands of Rwanda is subject to serious soil fertility constraints. As the use of imported mineral fertilizers is beyond the economic means of resource-poor farmers, research and extension efforts of several projects, institutes and organizations concentrated during the last 15 years on the development and promotion of improved fallows with woody and herbaceous legumes, like Tephrosia sp., Cajanus sp., Crotalaria sp., Sesbania sp., Mucuna sp. and Mimosa sp., planted over one or more seasons as pure green manure, in hedgerows (alley cropping), or on fields as seasonal inter- or relay-crop.

Green manuring proved to be a risky enterprise, due to highly variable biomass production and residual effects. Yield increments on-farm of up to 74% in the first season and 46% in the second season did not compensate loss of yields and labour investments during green manuring. Even where biomass production was sufficient, residual effects were in most cases unsatisfactory, due to rapid nutrient leaching (N, K) or inappropriate foliage incorporation on-farm. In researcher-managed trials, residual effects were in general somewhat higher, but more than a mere compensation of lost yields was not possible and farmers' adoption of these labour-intensive technologies was rather low. Due to acute land shortage, farmers were reluctant in allocating land to fallows or hedgerows also, with the exception of fields already out of production. Consequently, the concept of improving soil fertility and crop yields with the help of planted fallows or green manure in rotation failed. Woody legumes might have a future on abandoned fields and in wide spaced contour hedges, mainly for the production of firewood and bean stakes. For soil fertility management, the production and availability of farmyard manure and country-own mineral fertilizers, such as travertin and volcanic ashes should be supported. The question is raised as to whether sustainable agricultural development is possible without a credit system for small farmers, reallocating land and creating off-farm employment.

1. Introduction

The most densely populated agricultural areas in Africa are found in the East African Highlands. In Rwanda an average of 380 persons/km² usable land was estimated, but regional densities of more than 700 persons/km² are no exception [Nduwayezu, 1990; Cambrezy, 1984]. A population growth rate of 3.7% (the doubling rate is less than 20 years) and a continuous sharing of patrimony in the absence of non-agricultural employment, have led to an
overexploitation of natural resources, especially agricultural soils [Steinfeld, 1994; Ford, 1990].

Migration to adjacent 'unused' areas has been periodically proposed and in the sixties and seventies employed as a solution to Rwanda's overpopulation. Nevertheless, a 50% increase in farm land led to an overall production increase of only 24%. As the productivity of the newly reclaimed marginal land was rapidly decreasing the strategy therefore aimed at introducing more productive but sustainable production systems [Harth and Molt, 1995; Nduwayezu, 1990]. Research focused first of all on mineral fertilizer, erosion control, and improved crop varieties, but in an increasing number of projects also on organic farming and the use of agroforestry systems as more appropriate means of site-adapted and sustainable land use. A pioneer in the development of such 'ecological farming systems' in Rwanda was Egger [1982, 1995].

As transporting fertilizers from the nearest sea port involves considerable expense, the use of mineral fertilizers is extremely low (0.4 kg/arable ha) in Rwanda [McIntire, 1986]. On the other hand, organic recycling practices such as mulching, manuring and composting, are well known in the country [Yamoah and Grosz, 1988; Kotschi et al., 1991; Egger, 1995]. Organic residues are mostly used as mulch to cash crops, such as coffee and beer bananas, or as fodder. In this way 1.5–3 t/ha of farmyard manure could be annually produced under optimistic conditions (up to 2,000 m hedgerows and 2–3 stall-kept goats or one cow) [Korus, 1993; Ndayizigiye, 1993]. However, the potential of farmyard manure is being limited by the decreasing number of livestock, as cropping and livestock compete for the same land resources. Today, about 30% of farmers in South Rwanda are unable to keep any livestock, and only 20–30% can afford one or more cows [Ford, 1990; Steinfeld, 1994]. Buying farmyard manure and renting pastures are common practices, but the spending power of most farmers is very low [Engel, 1994; Hartmann, 1993; Steinfeld, 1994].

To compensate for reduced fallow periods and insufficient quantities of manure, research was focused on the introduction of fast-growing nitrogen-fixing legumes for improved fallows, such as rotational fallows of variable duration, inter- or relay-cropping of green manures, and alley cropping. This paper summarizes the state of knowledge on these systems in Rwanda.

After a brief introduction to the area, this paper consists of two main parts. The first presents a summary of experimental results, obtained over 15 years all over the country (selection of the most adapted and productive species, ways of integrating green manures into existing production systems, management of green manure in order to reduce competition and to synchronize nutrient release and nutrient uptake of crops, development of soil fertility and residual effects). The second is an account of linked work on farmer acceptance of these methods.