Cover Legumes Increase Productivity of Upland Rice under Intensified Land Use

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Improved fallow technologies can contribute to the stabilization of upland rice-based systems and to sedentary production, thereby avoiding further clearing of new land for agricultural production. Thus, legume technology provides opportunities to contribute to the conservation of the natural-resource base while maintaining inter-annual yield and generating increased output.

Screening of cover-crop legumes at WARDA

Declining Yields under Intensified Cropping

Most upland rice in West Africa (about 2.3 million hectares) is produced by subsistence-oriented small-holder farm families in bush-fallow systems with slash-and-burn practices, primarily in the humid forest zone. Population pressure has forced upland rice farmers to drastically reduce fallow periods or expand cultivation onto marginal soils. Between 1984 and 1994, the average number of consecutive cropping years in the savanna zone increased from 5 to 8. In the same period, the average length of fallow in the forest zone decreased from 14 to 5 years. These processes have increased erosion, mined soil fertility, provoked the build-up of weeds and other pests, denuded large areas of natural vegetation, and reduced production potential.

Four years of diagnostic trials in over 500 farmers' fields in representative upland rice-growing environments across Côte d'Ivoire indicated that this reduction in fallow length was associated with a 20–30% yield reduction. Weeds are the dominant factor responsible for land use intensification-related yield loss in the forest, while the reduction in soil organic matter content and nitrogen-supplying capacity were the main culprits in the savanna (Table 1). In the short term, resource-poor farm households are unable to purchase the inputs necessary to reverse yield declines related to land use intensification (e.g. herbicides and N fertilizers).

Potential of Legumes

The use of weed-suppressing cover legumes as short-duration fallows offers the potential to sustain rice yields under intensified cropping. Some 43 legume species (over 130 accessions) from the WARDA cover-crop germplasm collection were evaluated for weed suppression, N accumulation, biological N-fixation (BNF) and yield effects on rice, and adaptation to the major upland rice-growing environments and production systems. Biomass of the fallow was in most instances significantly greater with legumes than

Table 1. Productivity Implications of Rice Cropping Intensification

	Savanna			Forest		
	Ext		Int	Ext		Int
Organic Carbon (%)	2.1	*	1.4	1.7	ns	1.5
Soil N-supply (mg N/kg)	21	*	16	20	*	14
Weed Biomass (g/m²)	32	ns	41	16	*	26
Rice Yield (tonnes/ha)	1.3	*	1.1	1.3	*	0.9

Ext = extensive, Int = intensive cropping.

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with natural vegetation, and several legume species suppressed weed growth. Nitrogen accumulation by legumes varied between 1 and 270 kg/ha, with 30–90% of that derived from BNF. Grain yields of rice that had been preceded by a legume fallow were on average 0.2 tonnes/ha (about 30%) greater than that preceded by a natural 'weedy' fallow. Some of the legumes also had an effect on the weed growth in the subsequent rice crop. The reduced weed pressure required less labor for weeding (Table 2).

Table 2. Technology Performance Evaluation

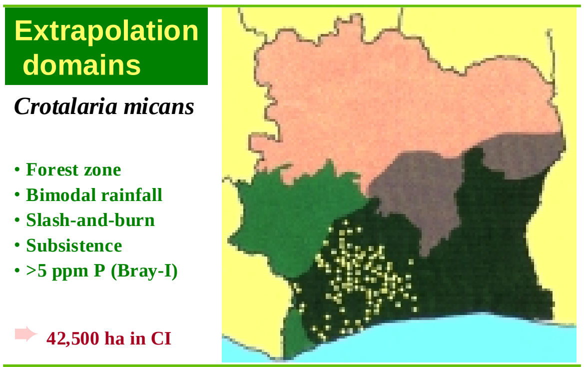
	Natural Fallow (3 years)		Off-season Legume
Fallow Nitrogen (kg/ha)	29	*	88
Clearing Labor (h/ha)	211	ns	195
Weed Biomass (t/ha)	0.61	*	0.33
Weeding Labor (h/ha)	355	*	268

Farmers Choose

Over 60% of 129 farmers involved in various participatory technology evaluations expressed interest in using fallow legumes in their own upland rice-based systems. Frequently selected fallow legumes included *Tephrosia villosa*, *Crotalaria juncea* and *Indigofera hirsuta* in the savanna, and *Crotalaria micans* and *Cajanus cajan* in the forest. In the forest zone, use of farmer-selected *Crotalaria micans* in the off-season increased system performance, while decreasing the labor requirement in comparison with a three-year natural fallow (Table 2). Farmers selected fallow legumes largely on the basis of labor considerations such as ease of land clearing (male) and weed suppression (female), but also on the basis of yield effects (male and female). Farmer-selected legumes are currently grown by farmers at WARDA key sites.

Spreading the Technology through Targeting

For each of the promising legumes, agroecological niches have been determined and extrapolation domains visualized (Map) as a basis for systems development research and technology transfer strategy.



More Potential

Improved legume establishment and residue management practices, as well as rock-phosphate application strategies to enhance nutrient cycling, have been shown to increase the productivity of such systems even further. Preliminary results show that for every well-managed hectare of improved fallow, several hectares of land can be taken out of the slash-and-burn production, with obvious benefits for natural vegetation and biodiversity, and the environment.

For more information:

Becker, M. and D.E. Johnson, 1998. Legumes as dry season fallow in upland rice-based systems of West Africa. *Biology and Fertility of Soils* 27: 358–367.