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POLICY BRIEF

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ADOPTION OF INTEGRATED NATURAL RESOURCES MANAGEMENT PRACTICES AMONG SMALLHOLDER FARMERS IN WESTERN KENYA

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SOIL DEGRADATION-POVERTY NEXUS

The degradation of soils in the major agroecozones of Kenya, manifest in negative nutrient balances, is now widely documented. Agronomic and soil science research in recent years shows that soil nutrient mining (in which more soil nutrients are removed than are replaced) is widespread in places such as western Kenya. This undermines the ability of many agrarian households to produce enough food for household subsistence, much less surpluses for sale. The outcome is low and declining yields, leading to chronic food insecurity and widespread, persistent poverty.

The degradation of soils cultivated by smallholders is partly a consequence of their failure to make soil fertility replenishment and conservation investments. It is critical to understand why households routinely fail to make the requisite investments into their soils — or why they discontinue past soil conservation and fertility management practices — as these acts are a crucial determinant of their productivity and well being.

There is now firm recognition in the scientific and development community in Kenya that integrated natural resource management (INRM) and integrated soil fertility management (ISFM) offer broad, useful paradigms for guiding scientific, economic and policy research. In view of the high costs of imported fertilizers in Kenya and the need to increase food production and especially crop yields for a growing population, it is hard to exaggerate the importance of conserving the productive capacity of soils in agricultural areas. The extant literature shows that while the principles of ISFM and INRM are important, there remain major challenges to their implementation in farmers' fields. Among the most cited reasons, insufficient household endowments of labor and land often pose major impediments to the adoption of labor and land-intensive ISFM/INRM practices.

Despite recognition of these constraints, many development scholars and practitioners still harbor implicit assumptions that ISFM/INRM techniques are easily adopted by smallholder farmers. Poorer farmers especially are typically assumed to have a low opportunity cost of labor and to be well-positioned to adopt these methods.

Yet, there is there is little firm, micro-level evidence to establish whether ISFM/INRM techniques are indeed more accessible to poor smallholder households on the basis of their resource and technical requirements. This brief reports on empirical research on this question, identifying some key household-level factors important to the adoption of INRM/ISFM practices. Our results show that factors associated with higher wealth and human capital favorably influence the likelihood of adoption of ISFM/INRM methods. The implication is that improved natural resource management to enhance agricultural productivity and promote household welfare in rural areas depends, in large measure, on favorable pre-existing household conditions. This reinforces initial patterns of rural poverty as those with the least productive resource base are the ones least able and likely to take actions necessary to improve soil fertility. The result is an apparent poverty trap among such poor smallholder farmers.

DATA AND SAMPLE DESCRIPTION

The data we use were collected collaboratively by the BASIS CRSP research project between Cornell University, the Kenya Agricultural Research Institute, the World Agroforestry Centre and the

University of Nairobi. The data were collected from 123 smallholder farm family interviews carried out in 2002 in Madzuu location, Vihiga District in western Kenya. Eighty-nine of those households had been interviewed originally in 1989.

The 1989 data had been collected for a study that focused on rural factor markets, agricultural investments and productivity in western Kenya during March-April and August-October of 1989. A series of surveys over the entire agricultural calendar using structured questionnaires collected data on household characteristics and on farm activities such as plot level input use and other investments, including investments in ISFM/INRM practices such as application of inorganic (chemical) fertilizers or manure, planting of fruit trees, alley cropping and the incorporation of plant stover into cultivated soils. Similar data were collected during the same months in 2002 using structured questionnaires that duplicated all the relevant questions of the 1989 survey.

STUDY RESULTS

Plot-level adoption patterns

Summary descriptive statistics (Table 1) show that specific ISFM/INRM practices were adopted on between 32-57% of plots in 1989, signaling highly in-complete adoption of particular methods. Yet there was nearly universal adoption of at least one ISFM/INRM method indicating broad awareness of the need to manage a farm's natural resource base as well as willingness to do so.

Yet these techniques were subsequently dropped by 28 – 80% of the households using them in 1989, signaling that there is no guarantee of the persistence in use of a given practice once adopted. Rates of ISFM/INRM practices adoption were much lower in 2002, ranging from 30 – 43% for each practice. While it remained true that nearly all households used at least one practice, the range of ISFM/INRM practices in use at household level fell significantly between 1989 and 2002. This suggests the emergence of unfavorable conditions that weakened incentives for farmers to apply such practices. The high abandonment (disadoption) rates and movement between NRM practices suggest that if techniques with durable impacts but minimal maintenance costs can be developed or identified, these may stand a better chance of sustained utilization over a period of years.

Fertilizer use is of special, long-standing interest. Fertilizer adoption rates remain low. Only 30% of households used inorganic fertilizer in 2002. With nitrogen application rates commonly only 20 percent or so of recommended levels, it seems that fertilizer use will still have to increase substantially, even with adoption of ISFM practices. This is illustrated by the apparent complementarity of fertilizer and manure use. In 1989, none of the surveyed farmers used inorganic fertilizer unless they also applied manure to fields. In 2002, farmers were eleven times more likely to use chemical fertilizers if they also used manure than if they did not. Similarly, the probability of manure use is consistently about four times greater when households applied fertilizer than when they did not use chemical fertilizers (Table 2). Rather than being substitutes, these statistics indicate complementarities between manure and chemical fertilizer inputs.

Multivariate probit regression analysis (Table 3) revealed several key household-level factors that explain adoption patterns of the various NRM practices under study. Secondary and/or primary school completion positively and significantly affect adoption of each of the five practices under study, confirming the importance of human capital in farmers' propensity to improve their agricultural practices. A key feature of successful adoption is

Table 1 Plot and household level adoption of practices

NRM Practice	Plot level frequencies		Household level Frequencies		
	1989 (n=202)	2002 (n=179)	Adopters in 1989: % (count) of 89 households	Disadopters between 1989-2002: % (count) of 1989 adopters	2002 adopters %(count) of 123 households
Stover recycling	21.6	39.1	57.3 (51)	39.3 (20)	43.0(53)
Alley cropping	42.8	4.9	44.9 (40)	80.0 (32)	10.6 (13)
Fruit tree planting	28.4	24.0	33.7 (30)	33.3 (10)	23.6(29)
Manure use	34.7	39.1	48.3 (43)	30.3 (13)	51.0(63)
Fertilizer use	11.7	15.6	32.5 (29)	28.1 (8)	30.0(38)
None	2.2	5.6	5.6 (5)	NA	5.7(7)

farmer adaptation of technologies to meet their own needs and circumstances. Formal schooling may enhance or at least signify latent managerial ability and cognitive capacity. The result is greater facility in acquiring and processing new information and in adapting these to a farmer's own production circumstances.

Table 2 Conditional probabilities of manure and fertilizer use

Manure	Fertilizer		Fertilizer use given manure use
1989			
	YES	NO	
YES	7.2	24.3	0.23
NO	0.0	68.5	0.00
Manure use given fertilizer use	1.00	0.26	
2002			
	YES	NO	
YES	9.48	19.55	0.33
NO	2.23	68.74	0.03
Manure use given fertilizer use	0.8	0.22	

The implication for public and private extension systems in Kenya and SSA, where low levels of formal educational attainment are rampant, is that extension systems should seek not only to proffer technological options but also to make up for low levels of human capital among the vast populations of rural SSA, perhaps through emphasis on management training and skill building approaches in agricultural extension.

Male-headed households were statistically significantly more likely to adopt these ISFM/INRM practices than were female-headed households.

Previous research in Africa has documented that women generally have fewer resources available to them with which to mobilize labor. Furthermore, women often have less secure rights in land, dampening their incentives to invest in ISFM/INRM practices even if they have adequate resources. Perhaps surprisingly, whether a farmer had previous experience with the technique was not an important predictor of adoption of any of these practices. This reinforces the frequency with which households disadopt ISFM/INRM practices after they have experimented with them.

Household wealth is the single biggest predictor of the likelihood of adoption of ISFM/INRM practices on a plot. The size of the household's farm, the value of its livestock and family labor supply all had statistically significant positive effects on the likelihood of adoption for each method studied. The fact that these correlates of wealth positively affect not only adoption of fertilizers but also on-farm recycling of stover, alley cropping and fruit tree establishment is significant. Even ISFM/INRM investments that do not require cash outlays – as are necessary for inorganic fertilizer application – are more accessible to wealthier households. This positive wealth-adoption relationship is reinforced by the complementary finding that household non-farm income is positively and significantly related to adoption of several of these practices.

VARIABLE	STOVER RECYCLING	FRUIT TREE PLANTING	ALLEY CROPPING	MANURE USE	FERTILIZER USE
Secondary school education	+		++	++	++
Primary school education	++	++	+++	+	
Farm size	++	+++	++	++	+
Age of household head	−			−−	
Number of adults	+++	+	+++	+++	++
Male household head	++	+++	+++	++	+
Non-farm income		+++	+++		+
Previous adoption					
Value of livestock	+++	+++	+++	+	++

Table 3 Household factors that affect adoption of INRM among sample farmers in western Kenya.

Notes: The signs, +, ++ and +++ (−,−− and −−−) indicate that the variable coefficient was positive (negative) and was statistically significant at 10%, 5% and 1% level respectively.

POLICY IMPLICATIONS

It is imperative for research and development policy to focus on how to make ISFM/INRM techniques available and attractive so that farmers will adopt to a degree necessary to maintain or improve soil fertility. Under present conditions, those households that are better educated, have higher levels of household labor, can generate cash from non-farm sources, have larger farms and own more livestock are considerably more likely to implement ISFM/INRM methods such as use of crop residues, manure, fruit trees, alley cropping and fertilizer in crop production. Put differently, the poorer smallholder farmers most in need of natural asset protection and productivity enhancements are least likely to adopt improved ISFM/INRM practices. However, for the vast majority of poor smallholders, their future well-being depends on improving their soils. Agricultural development professionals and policymakers need to address these patterns.

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FURTHER READINGS

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