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*Figure 1. Farmyard manure with perennial and annual crop residues*



*Figure 2. N-Fixing legume cover crops and biomass transfer from multipurpose trees*

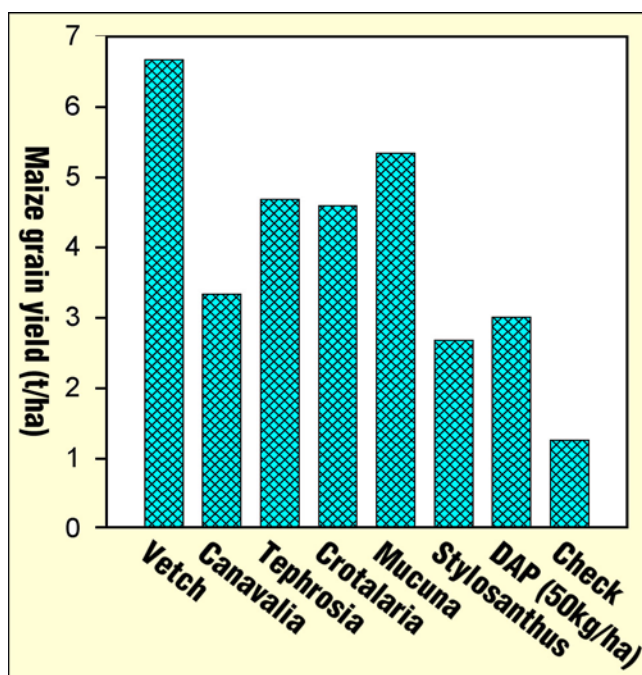
**Farm-generated organic nutrient resources can boost agricultural production in resource-poor households. Decision guides can assist in targeting different technical options according to soil parameters, land size and market access.**

## Soil Fertility Decision Guide Formulation: Assisting Farmers with Varying Objectives to Integrate Legume Cover Crops

Soil fertility decline is the major constraint to agricultural production and food security in Ethiopian highland farming systems. Farmers have very limited capacity to invest in fertilizers or soil conservation measures. As a result, yields are low and many farmers are forced to put fallow and marginal lands into production to meet their food needs. A potential solution for soil fertility maintenance is to use farm-generated resources such as crop residues, farmyard manure and legumes that are intercropped as green manure or used for biomass transfer. However, there are limitations to the amount of biomass these systems can produce. There are also competing demands for these resources because they are used as livestock feed, cooking fuel and to generate income. Given these short-term needs, it is challenging for farmers to weigh these options with the longer term objective of improving soil fertility. This results in slow adoption of soil improving measures including legumes by most subsistence farmers. The critical question is therefore, “Are there ways of using these organic resources more efficiently so as to meet both short- and long-term objectives?” This question was the starting point for an investigation to find out what the various diversified needs are and what options might assist farmers with different goals and resource endowments.

### Improved Management of Various Sources of Organic Fertilizers

The first phase of research was to ascertain how to improve the management of available organic resources, including farmyard manure, crop residues, multipurpose trees



*Figure 3. Effect of various legume cover crops on maize yield following biomass incorporation*

and nitrogen-fixing legumes (Figures 1 and 2). This was done through the evaluation of maize yield response to diverse inputs. Figure 3 shows that crop yield can be significantly increased by timely incorporation of high value green manures. The effect of various green manures on crop yield depends on the decomposition rate of the legume, the amount of biomass produced, its nutrient content, and time and method of application. Maize yield was highest under vetch because of its low lignin (fast decomposition) and high nutrient content (mainly nitrogen).

### Formulation of Decision Guide

The second phase of research was to identify spatial and temporal niches for growing legume cover crops. Here it was critical to learn more about farmers' decision criteria for selecting soil fertility options based on

their enterprises, needs and resources (labor, land, livestock holdings). The guide aims to assist farmers and extension workers to identify potential legume options that are compatible with farming systems and feasible for farmers to use.

The decision tree shown in Figure 4 was developed based on observations made in farmers' fields and results from on-farm and on-station experiments.

System Goal	Fallow Type	Recommendation
Maintaining soil fertility of cropland with relatively high fertility	Medium-term fallow (>5 mos.)	Plant Tephrosia or Macuna
	Short-term fallow (<3 mos.)	Plant Vetch
Improving soil fertility of cropland with low fertility	Medium-term fallow (>5 mos.)	Plant Crotalaria
	Short-term fallow (<3 mos.)	Plant Crotalaria

Figure 4. Decision guide on various spatial niches for legume cover crops in short- and medium-term fallow under subsistence farming

Using focus group and stratified individual interviews, it was found that farmers' most important criterion in selecting soil fertility options was livestock holdings. Second in importance was whether the farm manager was owner or tenant, followed by degree of market access, size of the landholding, and land quality.

These factors are linked, and upon further observation and analysis, land productivity (as governed mainly by soil fertility status) was found to be the first determinant of legume acceptance by farmers. Subsequently, farmers with livestock always choose to integrate food and feed crops. This choice is then modified by the degree of market access for selling livestock products. Then final determinant was the size and quality of land allocated for growing feed legumes.

More fertile fields near the homestead were never allocated for feed legumes. Here, farmers give priority to food legumes and to high-value and staple crops. The best niche for growing feed legume cover crops was therefore in outfields. Outfield cover crops were of interest to farmers who have lower resource endowments, exhausted land and limited markets, and who are sharecroppers (tenants). This tenant and poverty status has

exacerbated soil nutrient mining and poor management practices in general.

The diagram in figure 5 depicts the driving factors for choosing cover crop legumes. The guide is flexible and can accommodate more legumes and soil fertility management practices as they become validated under farmers' conditions.

## Research Implications

Research findings illustrate a number of important principles regarding cover crop use and management:

- ✓ Selection of cover crops is multi-faceted. Some legumes do well in all environments and others must be targeted to more specific conditions (i.e., nutrient and water levels).
- ✓ Farmers were found to make cover crop selections (among 7 available species) and manage them differently based on their resource endowments.

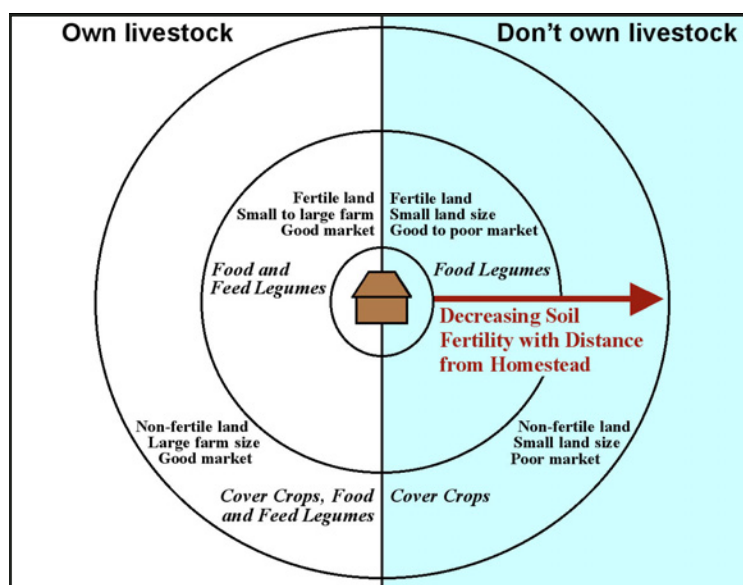


Figure 5. Integration of food and feed legumes and legume cover crops into small-scale farms as a function of resource endowments and market conditions

- ✓ Most farmers want cover crops to improve the areas which are "addicted" to mineral fertilizers. This commonly refers to less fertile parts of the outfields.
- ✓ There are few legume cover crops that can be used to improve degraded cropland, with the exception of Crotalaria. Most need better conditions to become established.
- ✓ Vetch was found to be the best fitting legume for short-term fallows, particularly for maintaining the fertility status of already fertile areas.

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