CREATIVE SELECTION AND INTEGRATION OF FARMING PRACTICES: MAKING ETHIOPIAN AGRICULTURE SUSTAINABLE

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Abstract

With the introduction of green revolution technologies in the 1960s a dual form of agriculture consisting of indigenous farming and external inputs-driven agriculture has emerged in Ethiopia. Indigenous farming depends on intensive use of labour and manure while external agriculture uses commercial inputs such as chemical fertilizers. Drawing data from six communities of north Shewa, this paper examines how farmers creatively select and combine 'best-bet' farming practices which are tuned to the socio-economic and agro-ecological conditions of the farming population. A key finding of this study is that indigenous farming with its diverse ways of fertilizing the soils offers farmers locally available farming options not supported by modern farming technologies.

1. Introduction

Ethiopia is a food deficit country, with 3.5 to 26 % of the population requiring food assistance in a given year. To deal with this persistent problem the government has identified agriculture development-led industrialization as the main strategy for achieving growth and rural development. Although the strategy recognizes farmers as key partners of rural development in practice it does give a lip-service to those who rely on indigenous farm inputs.

This paper describes the potential and limitations of the various indigenous farming methods in Ethiopia by focusing on the different farming innovations undertaken by farmers. One of the key features of farmers' innovations is the selective blending of external farm technologies and indigenous farming practices by matching types and

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amounts of chemical fertilizers with types and quality of organic inputs in the soil. Supporting farmers in their efforts to use 'best-bet' locally proven farming technologies should be given due attention in the provision of extension service.

There is a growing realisation among agricultural experts about the value of combining both indigenous and external inputs. This is important in efforts aimed at achieving sustainable livelihoods and sustainable agriculture to the millions of developing countries' farming families. The Noble prize winning agriculture scientist and green revolution architect, Norman Borlaug believes in combining the right amounts of both organic and inorganic fertilizers to restore soil fertility and increase food production. Sanchez (2004: 77) echoes this approach: …we need both mineral fertilizers and organic inputs – the mineral fertilizer-only approach is insufficient as the organic fertilizer-only approach. Farmers in the First World routinely apply both types of nutrient inputs. African farmers should be given the opportunity to do the same"

Farmers try to adopt external farming technologies by modifying or altering existing farming practices. As documented in Beyond Farmer First: Rural Peoples Knowledge, Agricultural Research and Extension Practice (Scoones and Thompson eds., 1994) subsistence farmers continually undertake experimentations of different farming methods often culminating in selection, incorporation and application of improved farming practices that fit to existing social and agro-ecological conditions. Nielsen (2001, quoted by Wu, 2003) identified 1614 innovative practices mentioned by a total of 505 East African farmer respondents, an average of 3 innovations per interviewee. These and many other examples indicate innovation as an aspect of subsistence farming.

2. Farming Systems in Ethiopia

Considering various types of farming technologies used, two main farming systems can be distinguished in Ethiopia (Endashaw, 1997; Workineh, 1997). These are the plough-cereal complex of the northern, north-western, north central, southern and eastern highlands, and the hoe-based root crops complex of the south central, western and southern lowlands. The plough-cereal complex, also known as seed-farming complex (Awegechew et al., 1999) has as its main elements of farming: wooden ploughshare, the yoke, the oxen, seeds and the farmer. The oxen-based farming system is specialized in the production of cereals (tef, wheat, sorghum, barley, millet) which accounts for more than three-quarters of the total agricultural output in the country.

The hoe-root crops complex is a form of cultivation where digging implements provide a major means of moving the soil and is practised by both sedentary and shifting cultivators; though the latter are the main bearers of the hoe farming culture. The hoe is also used among enset growers – enset (*Ensete ventricosum Welw. Cheesman*) is a perennial tree crop supporting over 20 % of the Ethiopian population living in the southern and south western of the country (Alemaz and Niehof, 2004, citing Brandt et al., 1997). The use of hoe is not restricted to root crops but also used by cereal growers especially those tilling hilly plots.

There are similarities and differences between the plough-cereal and hoe-root crop complexes. Regarding some common traits, it can be stated that both:

- Are undertaken in combination with livestock raising, although animals seem to play a more direct socio-economic role under the hoe-root crops farming;
- Depend largely or wholly on local cultivars transferred from generation to generation;
- Complement each other – the use of one does not necessarily exclude the other;
- Are facing scarcity of prime agricultural land due mainly to population pressure and clearing of trees and bushland; and
- Are heavily dependent on rainfall as main source for soil moisture.

There are some differences, which are important especially if seen from the point of view of extension intervention. Some of these include:

- The hoe is used on small plots and hence not suitable for growing most of the field grains that require larger plots;
- Women play a leading role in the cultivation of hoe-based crops compared to the plough-based farming system where men plough the land; and
- The hoe farming system is embedded in manure and tree leaf litter as source of organic fertilizer but these resources are disappearing from the plough farming scene. For this reason, extension seems to have more reception among the plough-cereal farmers.

Using a combination of nature of economic activities and farming technologies used, Almaz and Niehof (2004) provided a more detailed classification of farming systems in Ethiopia. These include the plough and cereal complex, the enset farming complex, pastoral production complex and shifting cultivation. Of all, the plough-cereal farming complex is the most important since:

- Plough-cereal farming complex covers an estimated 74% of the cultivated land in 1999/2000 (CSA, 2000);
- More than 80% of the population in the highlands depends on the plough-cereal farming system;
- Production from cereals provide an estimated 67% of the calories consumption in the country (CSA, 1998);
- Cereals grow almost in all agro-ecological zones, though some crops are more adapted to some ecological zones than others.

Despite the strategic importance of the plough-cereal farming system in achieving food security in Ethiopia, it has faced a number of challenges in recent years. Some of these include:

- Traditional technology unable to meet the demand for increased food supply due to rapid population growth;
- Declining landholding size, as tiny as 0.89 ha per rural household, due mainly to increased population pressure on the land;
- Gradual depletion of rural household assets resulting from frequent drought and famine;
- Fragmented and underdeveloped rural markets unable to respond to farmers' periodic market needs; and
- Lack of an effective extension services support systems.

Faced with the above and many other challenges, Ethiopian farmers are trying to adapt more innovative farming practices by combining indigenous farming knowledge and selective use of extension services.

This paper presents some of the innovative farming approaches cereal growers use in their efforts to improve crop yield and increase household income based on a fieldwork undertaken from north central Ethiopia, north Shewa. The data collection methods are discussed below.

3. Study Site and Data Collection Procedures

Study Sites

The data for this study came from a sub-region of north central Ethiopia, north Shewa. The region is located from $8^0$38-$10^0$42N and $38^0$40-$40^0$03E. It is a major cereal producing area supplying such crops as *tef* and wheat to the Debre-Berhan (zone capital) and also Addis Ababa markets.

Within north Shewa two districts, namely Tarmaber and Ensaro (see location map of the study area), were selected for a fieldwork undertaken in 2001. From each district, the fieldwork focused on three sub-districts, *kebeles*[1] (highland Sina, midland Armanya and lowland Asfachew from Tarmaber; highland Dembi, midland Salayish and lowland Dalota from Ensaro). The kebeles were selected with a view to representing the three major ecology zones: highland (2400-3000 m asl (above sea-level); midland (1800-2400 m asl and lowland (<1800 m asl. An agro-ecological approach to farming systems research was undertaken as farmers in different ecology zones are likely to practice various farming innovations congruent to each zone's soil, rainfall, vegetation, and households' resource conditions.

[1] Kebele refers to the lowest administrative unit

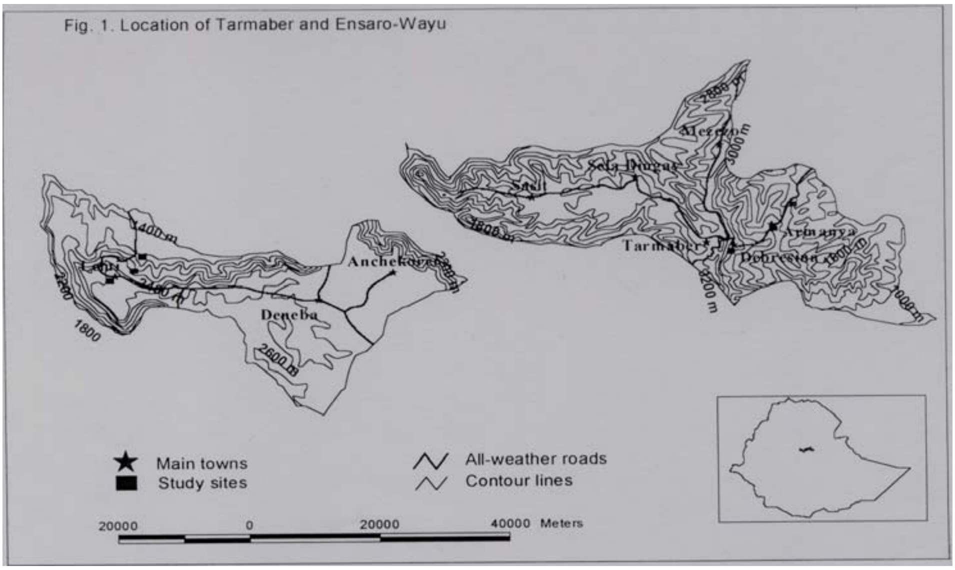

Figure 1: Location maps of Tarmaber (right) and Ensaro (left) weredas

Data Collection Procedures

The data used in this study was gathered through a household questionnaire administered to a randomly selected 305 household heads, 50 respondents from each of the six study kebeles. A land register consisting of a list of household heads who received plots in the 1997 land redistribution was used. As records were not up to date, a usable sampling frame had to be constructed in consultation with kebele officals and development agents of the respective kebeles.

The household questionnaire was developed as part of a PhD study (for details of the survey instrument see Abeje, 2004) and pilot-tested among farmers before it was administered to household heads. Most of the time respondent household heads were interviewed at selected accessible locations. Experienced research assistants and trained staff from the Department of Agriculture of the two districts assisted in completing the questionnaire.

To complement the survey questionnaire, key informant and focus group interviews were also conducted with farmers, farmer groups, kebele officials and development agents working with government extension projects. Most of the interviews were conducted on or near the farms so that the researcher was able to get first-hand information on the diverse ways farmers are using to maintain the fertility of their plots.

Diversity as the Essence of Farming in the Study Area

The most noticeable aspect of farming in the study area (and this is also true in the rest of Ethiopia as well) is the use of diverse farming strategies to increase crop yield. In the survey questionnaire 305 respondent farmers were asked if they use a combination of the following land cultivation methods: crop rotation; manure; and chemical fertilizers (See Table 3.1). The majority of respondents ticked more than one land intensification method, implying most farmers apply different farming skills and inputs to produce a crop or a mix of crops.

Table 3.1: Percentage distribution of respondents by methods of land intensification

Tarmaber wereda	Ensaro wereda						
Land intensification method	Sina (H)	Armanya (M)	Asfachew (L)	Dembi (H)	Salayish (M)	Dalota (L)	Total
Fertilizer only	...	…	2.0	22.0	…	…	3.9
Fertilizer + crop rotation	3.8	7.7	2.0	56.0	8.0	10.2	14.4
Manure + crop rotation + fertilizer	31.2	82.7	49.0	22.0	24.0	20.4	38.4
Manure + crop rotation	66.0	9.6	47.0	… 68.0	69.4	43.3	

Key: H = highland; M = midland; L = lowland

Extent of use of various land cultivation methods varies from locality to locality and across ecology zones. For example, manure + crop rotation appeared to be the principal methods of land intensification in the lowland kebeles followed by manure + crop rotation + fertilizer. Growing a legume crop followed by a cereal crop – crop rotation – is a ubiquitous practice; although, its use in combination with fertilizer appeared to be more intense among the highland Dembi respondents where opportunities for composting manure is almost non-existent because of increased demand for domestic fuel.

Closer examination of survey data (Table 3.1) and careful scrutiny of results of qualitative interviews and researcher's repeated observation of farming practices in the study area reveals that farmers employ at least four farming strategies: (1) indigenous inputs; (2) chemical fertilizers; (3) manipulating crop-mixes, and (4) labour intensive and skilful farming practices.

The 1st strategy focuses on intensification of farming methods using organic inputs such as manure and compost while the 2nd strategy relies on commercial fertilizers that are imported from abroad. The 3rd strategy emphasizes a combination of crop rotation and growing agro-ecology-specific crops to minimize crop failures due to the vagaries of nature while the last strategy pays attention to various labour intensive land husbandry and farm management practices farmers use to protect soil and water erosion thereby to increase crop yields.

Farmers' selective use of the above farming strategies as determined by each household's level of access to resources, farming history, agro-ecology and weather conditions is discussed below by taking specific examples from the study area. Whether the farmer relies heavily on manure/compost, or chemical fertilizers or crop rotation provides basis for treating the four strategies separately. However, the four farming methods should not be seen as mutually exclusive but complementary. It should be noted that individual farmers tend to use a combination of two or more of these approaches in order to grow a single crop on a certain land.

4. Agricultural Intensification using Indigenous Inputs

As has been stated, the smallholder subsistence agriculture in Ethiopia is heavily dependent on intensive use of organic inputs, mainly manure and compost. Livestock constitute the primary source of manure while compost is derived from household and compound litter, plant and crop residues and a mixture of ash, sheep/goat/poultry manure and soil materials. Every rural household with varying degrees has access to these materials either through own production or by acquiring through purchase or a combination of both. Traditionally, manure is used for field crops with compost being used for backyard crops. The following section describes the different indigenous faming methods as used in the study area.

Manure

In midland and lowland kebeles of Ensaro, farmers are engaged in an organized system of producing manure, called *chichet.* Cattle fenced off by mobile woody and stony fences spend two or three nights on farm site with the intent of fertilizing plots using manure and animal slurries (Table 4.1). Manure produced in this way is used for *tef* and sorghum crops which, because of relatively larger acreage, require herd size that is beyond the possession of each household. The practice is that households would enter into a joint undertaking by putting together herds during the night and rotating them on a turn basis. Households who receive the support of relatives and friends can have more access to cattle than those with narrow kinship networks.

Table 4.1: Examples of informants who reported applying on-farm manure, Dalota, Ensaro

Informant expected years	Plot (Ha)	Estimated animals	No. of nights animals spent	Labour cost in Birr (excl. food)	Of yield return
1	0.75	40	60	200	4
2	0.25	60	90	150	3
3	0.25	20	120	200	4
4	0.75	40	30	150	6
5	1.00	70	70	175	5
Average	0.60	46	135	180	4.5

Source: Based on focus-group interviews (2001)

According to the farmers, land fertilized with cattle manure, having in place soil and water conservation activities, can give yields for 3 to 4 successive years. Sheep/goats, equines and poultry can also provide an important source of manure and farmers know from experience that this kind of manure (if applied in reasonable quantity) enhances the fertility of the soil. But, producing enough quantities is always a problem. Some farmers acknowledged that they do not think it is worth the effort to collect fragmented pieces of poultry manure as it takes longer time to accumulate.

Focus group informants from Ensaro noted that *chichet* is an expensive activity. Construction materials have to be fetched from far off places; fences have to be erected and re-erected every other night; and labour has to be hired for tending animals in remote and mosquito-infected lowlands. Older and female households who often face shortage of male labour are at a disadvantage in their efforts to undertake and benefit from *chichet*.

The use of manure as a fertilizer is not restricted to a particular agro-ecology. In highland Tarmaber farmers use a mixture of cattle, horse, donkey and sheep manure and ash – called locally *godeda*. In Sina, Tarmaber, a single-mother who cannot afford fertilizer relies on cattle and sheep manure collected from one ox, a cow, a heifer, a calf and a few sheep. In Gedelege, a highland near Debre Sina, an 81 year-old farmer bought manure from his neighbour and used on his a quarter of a hectare of his *meher* crop – barley. For poorer and older households, small plot size is an advantage that is manageable for intensification of manure and compost.

Generally, most farm households in the study area are facing shortage of manure resulting from its competing use for firewood. Dried cowdung is a source of income for some households. In Dembi and Chancho localities, near Lemi and Deneba towns respectively, it is not uncommon for households to keep a pile of heaps of cowdung around residence to be sold to town residents. Some highland Dembi farmers reported that due to cold weather they do not use cattle manure for crops. Frost and icy conditions reduce the effectiveness of manure as it does not easily decompose and mix with the soil.

4.3. Ash as Source Of Compost

Although organized production of ash and household litter for field crops does not seem to be a common practice among farmers in the study area, most households collect ash and household refuse (consisting of remnants of human food and animal feed, household rubbish, crop residues) and apply them to nearby plots. Nowadays, with rising cost of fertilizer, farmers around Debre Berhan have started using ash for distant fields. Here, beans fields are the primary target since beans is a staple crop in the area.

A 73-year-old man in Chole kebele, Basona Warana *wereda*, had to transport 170 sacks of ash (50 kg each) to spread onto 0.25 ha of land prepared for beans. He employed 16 donkeys in 25 rounds to transport from Debre-Berhan, 20 minutes journey. Relatives and neighbours assisted with labour and donkeys. Friends residing in town supplied ashes. They in return would expect to receive dried cowdung. *If I give a donkey's load of cow dung to a relative in town I can expect to fetch more than 20 sacks of ash next year*, the man said. He was one of the first in the area to use fertilizer but its high cost is forcing him to return to indigenous inputs.

Some farmers have become innovative in their use of ash by mixing it with animal manure and slurries and storing it in pit under-ground for one rainy season before transporting it to the field. Mixing ashes with household and compound litter increases interaction between ashes and soil organisms and this, in turn, enhances soil fertility, according to the farmers. They say that the value of ash is enhanced when mixed with household litter and kept to 'age' before being used on the farm. They further note that fresh ash can cause burning of plant roots and stems. One farmer said ash, to be healthy for plants, should be stored at least for one season.
The above observation by farmers has support from the soil science literature. For example, Brodt (1999) studied a village in India and reported that the villagers were

against use of fresh organic manure such as cowdung and ash as it would cause burning in plants. Similarly, Ashman and Puri (2002) noted that fresh ash can cause shortage of nitrogen in the soil. Wild (1993) also notes that composted and decayed ash encourages the formation of microbial organisms like earthworms that have a profound effect in mixing ash and litter under wet conditions, and thus comes farmers' logic of storing ash longer.

Farmers do not recommend planting cereals (e.g. wheat) on ash-treated plots during the first year, especially if the ash has not been allowed to 'age' for a while. This should be preceded by the practice of *ikir* where legume crops are grown first before the land is used for cereals. The use of ash on waterlogged black soils also helps mitigate the problem of soil drainage. This however is a secondary function – the primary being providing compost.

4.2. Burning of soil

Soil burning – *gai* – is an indigenous agronomic practice of burning grasses and soils together intended to mobilize soil nutrients and make them available for use by crops. Grassy land is dug and collected at different locations and then burned under mounds of grass and soil. The fire helps loosen soils and improve workability through acceleration of biological, chemical, and physical interaction in the soils. The burning process (*gai*) might take days and any grass residues left from burning would be mixed with the soil by ploughing.

Gai is a practice observed in parts of Ensaro where vertisols predominate. These soils tend to form large cracks during the dry season, which makes digging relatively easier, though working manually on long-fallowed plots requires effort and energy. The land is dug using the wooden-ploughshare or *maresha*, or other hand-digging implements before ploughing, and axe and wood are used in breaking large soil fragmentations.

A 41-year-old man in Wele-Deneba, Ensaro, for example, used *gai* to grow barley in 2001 *meher*. As far as he remembers, the land has not been ploughed during his lifetime. Shortage of cultivable land forced him to use his only grazing land as farmland, the man said. The man planned to plant barley for the first year with wheat/*tef* for next year. Neither wheat nor *tef* is fit for planting during the first year, as both tend to grow long stems but yield too little, the man said.

Two interrelated factors are likely to impede the practise of *gai*. The first is relating to the overall phenomenon of shortage of cultivable land. This has had a direct impact on the size of fallow land available to households, mostly in the form of patchy hay and grazing land. Whatever has been there is also disappearing. In consequence, fewer households are likely to practice *gai*. The second reason is that land shortages are forcing households to convert whatever strip of fallow land they may have into farmland – an outcome of a desperate move to cope with land scarcity. These conditions are making *gai* less sustainable.

Besides, there are some considerations that work against the use of *gai*. From the point of view of modern agronomic practices *gai* may cause burning of soil organisms (eg fungi) which play an important role in decomposing organic matter and improving soil fertility. Some sources attribute loss of organic matter to *gai* (Murphy, 1968). For farmers, *gai* helps blend grass, wood, and soil under the pressure of fire – it is a way of mobilizing accumulated soil organic matter and making it ready for cultivation. Besides, it helps burn weeds.

4.3. Mulching – Covering Soils with Branches and Leaves

Use of decaying leaves, branches, and bushes in order to keep moisture in the soil/improve its workability – mulching – is a sound farming strategy widely used in the study area. The usual practice is that branches of certain trees and bushes are sliced off and left scattered on farms to shade their leaves off. Then, dry woody parts are removed before the fallen leaves are ploughed and mixed with the soils. Loosened soils that have been ploughed once or twice provide the ideal condition for mixing added plant residues and soils easily and quickly.

For mulching, certain local plant species are preferred. These include *bissana*, *ameraro*, *ambacho*, *abalo*, and acacia. In Armanya, Tarmaber, it is a common practice to keep scattered *bissana* (*Croton macrostachys*) trees on the farm as it is adapted to midland ecologies. Ege (1990) observed that soils treated with bissana are productive. The shady leaves, providing protection for the soils against the sun, are important source of organic fertilizer. Furthermore, *bissana* provides shading for animals during the dry season. Girma (1999) also noted that farmers in Yilma-Densa recognize mulching effects of *bissana* on their soils.

Lowland farmers use the drought-resistant acacia tree to treat sandy soils. It contains small leaves that provide an important addition of organic matter to the soils. Small shrubs of acacia that grow close to the soil also provide mulching, though unlike acacia stems which are often trimmed off the tree, shrubs have to be uprooted from the soil, exposing soils to erosion. Small ruminants and cattle prey upon acacia leaves thereby competing against their use as fertilizer. The use of acacia as a source of wood charcoal and material for construction has also resulted in the disappearance of the acacia tree from the lowlands.

Generally, the practice of composting tree leaves and shrubs is widespread in Tarmaber *wereda*. Use of a particular tree seems to dominate a given agro-ecology. For example, *ameraro* appears to be common in highland Gedelege, *bissana* in midland Armanya and acacia in lowland Asfachew. This does not mean that use of *bissana* excludes acacia or vice-versa – farmers use a combination of soil fertility enhancing leaves and bushy woods. Shortage of trees is becoming a constraining factor. This is the case mainly in the highlands of Ensaro *wereda* where vegetation is almost non-existent, save for eucalyptus.

4.4. Agricultural Intensification using Chemical Fertilizers

North Shewa has a long experience in using fertilizers starting the early days of the advent of green revolution technologies in Ethiopia. As the 73 year-old farmer, from Chole near Debre Berhan remembers (refer to section 4.7), he was a pioneer in the use of fertilizer when a quintal of DAP used to be sold for less than Birr 40. He recalls that most of his-generation-farmers were not at first enthusiastic about fertilizer when introduced into the area in the 1960s. Now, fertilizer has entered every peasant household and some even cannot think of living without it.

The degree of fertilizer intensification however varies from one area to another and from crop to crop. Of the two study weredas, Ensaro with over 32,000 farm households and having vertisols and flat highland topography is one of the highest fertilizer-using weredas in the zone. In 2001/2002 agricultural season more than 15,000 quintals of fertilizer was distributed in the wereda. During same season

Tarmaber, prone to frost and deficient rainfall, used less than half of Ensaro. Results of the household survey also show that the Ensaro respondents appeared to have used as much twice fertilizer as Tarmaber ones. Tef (with its ecology zone versatility and cash oriented production), wheat (a highland crop) and partly sorghum (midland-lowland crop) absorb more than two-third of the fertilizer used in the study area.

Although fertilizer intensification is the most preferred method by the government-run extension program, its continued use is being challenged by a number of factors. The most important ones as identified by the farmers include: (1) sky-rocking fertilizer prices; (2) unreliable moisture making fertilizer use risky; (3) poorly organized rural and regional markets unable to absorb production increases in times of good weather; and (4) lack of farm-specific fertilizer recommendations. Farmers are also increasingly becoming worried about their increased reliance on chemical fertilizers when the country is dependent on the international market for fertilizer imports.

Faced with a continuing hike in fertilizer prices and uncertainty in the continued supply of fertilizers most farmers are likely to return to local land intensification methods. Most are betting on crop rotation (see below). Many in Ensaro are committing their small plots to pulse and oilseeds crops (eg. vetch and *abish*) so that they can become receptive to cereals. Concern with feeding the family (cereals being main food source) is likely to cause a delay in shifting from fertilizer-dependent cereals to pulses and oilseeds that require no fertilizers, according Deneba farmers. Scarcity of land is partly impeding farmers' effort to undertake crop rotation without seriously undermining present food needs of family members.

4.5. Crop Rotation

In the study area, every farmer practices some form of crop rotation or *ikir*. Crop rotation involves growing different crops in succession to maintain soil fertility. As one farmer noted *ikir* requires planning farming activities for two or more successive years with the farmer keeping a schedule of planting decisions as to which crop should be rotated after another. *Ikir* is not just crop alternation but requires ploughing land when there is moisture in the soil and selective planting of one crop after another. Discussion with focus-group participants revealed that each rotation is preceded by a series of planning planting decisions with the objective to enhance soil fertility by curbing soil depletion due to continuous planting of one crop.

Table 4.2 shows how different crops are sequentially rotated, with legumes often preceding cereals. In the study area, *ikir* is more effective when a legume crop (e.g. vetch) is alternated with a cereal (e.g. wheat), according to the farmers. But sometimes a cereal (e.g. wheat) might be alternated by another cereal (e.g. tef). However, this is used as last resort when there is not enough land or land is not suitable to grow legumes. Belay (1998b) warns against such practices as 'dangerous trends' that are likely to lead to soil fertility depletion and consequently production loss.

In recent past the use of fertilizer has reduced the value of *ikir* as a soil fertility maintenance strategy. However, a trend is emerging among farmers who are taking up *ikir* in a bid to avoid debt accruing from fertilizer loans. Besides, pulses such as lentils are fetching good prices thereby encouraging farmers to practice *ikir*.

Table 4.2: Some examples of crop rotation in different agro-ecologies from the study area

Agro-ecology	Crop Rotation				Examples from study kebeles
	1st	2nd	3rd	4th	
Highland	Vetch	Wheat	*Tef*		Dembi kebele, Ensaro
	Abish	Barely	Wheat	*Tef*	Romee kebele, Ensaro
	Beans	Barely	Wheat	*Tef*	Sina kebele, Tarmaber
Midland	*Dengolo*	Sorghum	*Tef*		Armanya kebele Tarmaber
Lowland	Sesame	Sorghum	*Tef*		Asfachew kebele, Ensaro
		Sorghum	*Tef*		Dalota kebele, Ensaro

Source: Based on focus-group interviews (2001)

However, the government extension service in the area seems to be indifferent to farmers who are practicing *ikir* or other local soil maintenance methods. For example, no credit is extended for such farmers for buying seeds or acquiring manure, etc. They are rarely visited by the extension staff. To date, extension training programs offered at Wereta, Merto-Lemariam and other similar institutions hardly cover courses on indigenous farming. This situation has to improve if farmers are to benefit extension service. Extension support should be extended to all farmers who are cultivating their plots using various soil fertility enhancers.

4.6. Labour intensive and farm skill-oriented approaches

The study area is rich with many other examples of innovative indigenous farming practices. Some of these include: releasing soils underneath stones and wood stumps; addition of weed residues; capturing soils from upland erosion, and intercropping and agro-forestry. Each of these strategies can be considered as a sub-element of one or more of the farming strategies discussed above and are complementary to one another. A brief discussion of each is given below.

4.6. Unravelling soils beneath stones and wood stumps

This is a form of releasing soils by digging stones and wood stumps to unearth soils buried underneath. The practice occurs mainly in parts of Salayaish and Dalota localities where farms appear to be covered with large-sized stones that have to be removed from the soil using the oxen-plough, or any other digging tool such as a shovel. Stones tend to harbour fertile soils, which can be put to use by moving the stones around or by collecting the stones at selected sites on the farm. The stones could be also used to construct erosion diversion structures around farms.

The presence of stones in large numbers on farms can have its own merits and demerits. On the positive side, stones are valuable as building materials (as shown by the presence of stone-built houses in most parts of the study area) or for fencing or boundary demarcation. Gullies are plugged up and terraces are constructed using stones. Stones provide barriers against soil erosion. Through the process of weathering, stones also constitute a vital aspect of the formation of soils. On the down side, too many stones on the farm can make cultivation difficult. Farmers are aware of the economic and conservation value of stones.

In Armanya, a 67-year-old farmer who has built conservation structures from stones has converted the stone bunds into agro-forestry. Initially, the structures were erected as a blockage to soil erosion but later *ghesho* was planted between the stones. No land is kept idle, the man says. The farmer is critical of researchers who often tend to visit villages instead of farms. If you really want to study and know how we make a living, you better study our farms rather than the villages. You might not grasp fully if I told you about the way I keep and use this land without you actually visiting and experiencing the area. Now you have seen it yourself you can be a witness to my best use of the land. The two perennial crops have made the plot the best farm in the area in terms of raised soil level and greenness of the farm, which are visually observable.

4.8. Adding Crop and Weed Residues

Weeding is a temporary removal of grass and other alien plants from the crop with removed materials staying on the land at different sites to be returned to the soil through ploughing. Adding weed compost and crop residues to the soil can reduce the nutrient removal effects of crops. Farmers use weeds to minimize run off water and seal gullies that occur as a result of raindrops or flooding. This practice is common across all ecology zones in the study area.

Farmers have also observed from experience that collected weeds provide shelter for insects and earthworms that accelerate decomposition of compost and mixture with the soils. However, some weeds (eg *akenchira*) have to be permanently destroyed, if possible, because of their destructive effect on crops. Nowadays, weeds like crop stalks are being used for animal feed, and this is in competition with their use as fertilizer. Some farmers noted that returning weeds to the soil in the form of compost is likely to multiple weeds in the following year. Farmers resort to burning of weeds that tend to aggressively compete with crops.

4.9. Capturing Soils

Some farmers try to benefit from erosion activities occurring in upland plots. This may happen in two ways, according to an 81-year-old informant from Gedelege, Sina kebele. A farmer may engage in soil and water conservation activities aimed at capturing the soils coming from upland fields. This can be done by collecting and distributing rainwater and soils throughout the cropland. Temporary water and soil harvesting structures (eg *boi*) might be constructed to allow water to enter the fields. This is a case of positive intervention of a farmer undertaking proactive measures to retain the soils within the community.

The above informant also spoke about a case of his plot neighbour who deliberately acted as a catalyst to increase erosion on the man's plot with the intention of benefiting from upland erosion. According to the informant, his plot neighbour removed soil and water conservation structures (stones, weed residues, soil mounds, fences) from the plot above him to encourage erosion. This is a case of negative intervention where a farmer engages in soil conservation activities that cause harm to his/her neighbours. The informant blames his old age making him vulnerable to the unscrupulous acts of some farmers with little respect for old people.

4.10. Intercropping and Agro-forestry

As with crop rotation, intercropping – growing two or more crops simultaneously on the same plot – is a vital component of indigenous farming. The rationale is that crops with different nutrient requirements can benefit from each other by interacting on the same soils. The pattern is that a cereal crop is often intercropped with a legume or an oilseed crop with the latter providing nutrients for the former. A form of intercropping in the highlands is a system of growing legumes along the edge of wheat or *tef* to serve as a defence against grazing by animals on the main crop – cereal crop. In the lowlands cereals (eg *tef*) are intercropped with oilseeds (eg sesame).

Another form of intercropping is the practice of growing one or more annual crops interspersed with perennial trees – agro-forestry. Most perennial crops grow as horticultural crops but shortage of land around residences is a problem, according to Dalota and Salayish informants. The lowlands also suffer from scarcity of water or moisture. In the warmer areas of Armanya and Asfachew, *ghesho* and coffee may be grown usually on the edge of annual crops providing protection against erosion or as a buffer against boundary incursions. The practice of keeping *bissana* or acacia trees on the farm is also a form of intercropping having multiple benefits.

The highlands of Ensaro do not seem to be conducive for agro-forestry, as eucalyptus is the only tree grown in the area. As a rule, this tree, with its selfish roots consuming more water and soil nutrients than most perennial trees, seems to be hostile to crops.

5. Relationship between Indigenous Farming Methods and Fertilizer Use

Both indigenous and modern farming methods are focused on preparing soils that are receptive of seeds thereby to increase farm output per unit of area. Most activities of indigenous farming are oriented to improving organic content of the soils. Long-term grass fallow, for example, increases the organic matter content of the soils while shortage of naturally occurring inorganic matter (eg phosphorus) can be corrected by adding chemical fertilizers. In this way, the two complement each other.

Some indigenous farming and soil fertility treatment methods are more conducive to the application of chemical fertilizers than others. Others, if used properly, can produce sustainable yields without external inputs. Farmers know from experience that this indeed is the case. Based on discussion with farmers, it is possible to classify indigenous farming and soil fertility methods into two: those that can be used in combination with chemical fertilizers and those that may not require chemical fertilizers.

5.1. Indigenous Farming Methods that Complement Chemical Fertilizers

Whether a farmer plans to use chemical fertilizers or not, continued planting of the same crop on the same plot in succession does not seem to be healthy for plant growth. Most farmers are of the opinion that alternating crops is a judicious decision to make before considering using fertilizers. It seems that most farmers believe that for application of fertilizers to be effective, it should be augmented by some kind of rotation of legume crops. As noted by Brookfield (2001: 92), *farmers soon would have seen that all their crops grew better when planted after legumes or interplanted with them*.

The use of crop rotation complementary to fertilizers seems almost compulsory for the two fertilizer-dependent crops – *tef* and wheat. Informants from Wele-Deneba, Romè, and Abbaya kebeles of Ensaro indicated that neither *tef* nor wheat would respond favourably to fertilizers unless the previous crop was vetch or some other herbaceous plant. This is supported by survey data where 88% of the fertilizer-dependent Dembi respondents indicated they use crop rotation. But this method appears to be less common in the fertilizer-dependent midland kebele of Armanya where opportunities to apply tree litter or agro-forestry seem to be present.

There are a number of advantages of combining fertilizers with crop rotation, according to farmers. It reduces intensive and perpetual fertilizer use on plots as this is not healthy for the sustainable practice of subsistence farming. Different crops provide different opportunities for the regrowth of biotic organisms thereby sustaining biodiversity. Furthermore, it gives farmers the opportunity to preserve landraces that do not use fertilizers. Cost-wise it minimizes farmers' dependency on purchased inputs. As indicated above, crop rotation in combination with fertilizer use can restore soil fertility quicker than repeated application of either of them alone on the same plot.

Similarly, returning crop residues to the soil, mixing ash and compound compost and applying tree and bush litter, all contribute to the economic and ecologically friendly use of chemical fertilizers. Organic residues (tree branches, leaves, bushes, ash and household refuse) are more effective as complementary inputs when they decay and decompose – *bisbashi*. When chemical fertilizers are added to soils treated with organic manure, soil nutrients are released gradually and become less sensitive to leaching, volatilisation, or fixation (Avnimelech, 1986). The use of indigenous soil fertility management practices as complementary can also render extension programs more relevant and useful, and thus, acceptable to farmers (Belay, 1998a, citing DeWalt, 1994).

5.2. Indigenous Farming Methods that may not require Chemical Fertilizers

Certain indigenous farming techniques may not require additional external inputs. For example, informants in Wele-Deneba areas said that *gai* should not be used in conjunction with chemical fertilizers. As already discussed, it is not wise to plant wheat and *tef* on *gai*-treated plots let alone to add fertilizers as this causes stems to fall early in the seed-bearing stage. A decision to apply fertilizers would result in wastage of money and incur debt, farmers said. Although critics point out that soil burning leads to shortage of nitrogen, it has the effect of boosting mineralization of soil nutrients that have been accumulated through long periods of fallowing. Soil nutrients mobilized in this way provide a healthy ground for plant growth.

Another indigenous farming method that may not require inorganic inputs is *chichit*. Crops grown on manure-treated soils can give reasonably higher yields without additional application of fertilizers, according to Dalota farmers. With support activities (eg wet-season ploughing, on-site conservation works, removing weeds in time) the way to attaining sustainable yields for 3 to 4 successive seasons is assured. The evidence from the survey questionnaire also indicates that 39% of the respondents identified manure as an effective method of improving farm productivity, followed by fertilizers, 25%.

Finally, it needs to be stressed that extension service at national, regional and local levels must support farmers who are trying to combine the different indigenous farming methods and modern extension inputs in an effort to improve soil fertility and grow crops in a sustainable manner. Most indigenous farming practices fit into rural people's local farming knowledge and can make farmers self-sufficient in their production decisions. This is in line with the goal of making subsistence agriculture sustainable. The effectiveness of indigenous farming, however, is affected by a number of factors including shortage of organic matter. Some of these factors (discussed below) affect the combined use of organic and in-organic inputs in a complementary manner.

5.3. Factors Affecting Combined Application of Organic and Inorganic Fertilizers

In an effort to improve soil fertility, farmers have three choices: apply organic matter and other indigenous farming methods, combine organic fertilizer with chemical fertilizers, or use chemical fertilizers only. Decisions are often made on the basis of consideration of a number of factors including, but not limited to, the following:

- Resource constraints (e.g. cash);
- Issues of measurement (e.g. matching plot size with fertilizer requirements);
- Location of plots (e.g. being steep or hilly);
- Scarcity of land; and

- Policy bias.

The above is by no means exhaustive and complete. Nevertheless, it can provide a starting point in efforts to find a desirable balance between indigenous and modern farming methods. The highlights of each are discussed below.

Resource constraints

Some of the indigenous farming techniques are resource-intensive and hence are beyond the reach of most rural households. For example, animal manure requires possession of livestock or money to buy manure from those who own animals, like the 81- year-old man in Sina kebele, Tarmaber, who bought some manure from his neighbour and applied on his 0.25 ha of land. Most households keep a limited number of cattle and hence unable to produce enough manure for their crops and this in turn is related to shortage of grazing land.

In the case of controlled on-farm manuring, labour, money and social networks are all important. Some households (eg the poor, the elderly) may not have access to labour and the kinship support they need. Acute shortage of cash is one of the factors standing in the way of acquiring fertilizers and seeds. The use of trees as sources of organic manure is likely to be limited where most indigenous trees that could enrich the soil are disappearing.

Problems of measurement

When a farmer applies manure or rotates pulses with cereals, he/she intends to spend less on chemical fertilizer. This requires land measurement, recording plot history (eg knowing the crop that was sowed in the previous year), and conversion of amount of organic fertilizer applied into chemical fertilizer equivalent, all of which are not easy for the largely illiterate farmer.

For example, a certain amounts of dry weight animal manure may be considered equivalent to certain amounts of DAP but in the case of animal manure it is not just the dry manure that is most important, its mixture with animal urine and slurries is also important. This might be somewhat difficult to measure and to account for the amount needed to produce a given crop.

Scarcity of land

Size of holdings influences choice of farming methods. For example, the practice of fallowing is disappearing because there is very little extra land in the community. Crop rotation is also related to availability of cultivable land. When holdings are too small, households are forced to concentrate on a limited number of staple crops to satisfy immediate consumption. The land issue is also related to meagre household income unable to pay for the purchase of fertilizers.

Policy bias

Official government support (eg credit) is biased toward those farmers willing to use chemical fertilizers. Indigenous farming methods are sidelined and are not given the attention they deserve. As their contribution to achieving sustainable rural livelihoods is being rediscovered and recognized in the form of organic farming in developed countries it is essential that government extension programs need to make their extension services (including training) available to farmers who are able to farm organically.

6. Conclusion

This study has shown that indigenous farming with its diverse ways of fertilizing the soils offers farmers locally available farming options not provided by modern farming technologies. Extension should be willing and ready to explore these opportunities. For this, the different farming systems in each region should be identified and extension people with a good exposure to the different indigenous farming systems should be deployed to serve farmers' needs.

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