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# Land Tenure and Land Management Technology: A Case Study from the Central Ethiopia

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## Abstract

Land in Ethiopia is a public property. Farmers have use right to transfer or lease use rights of agricultural land. Thus, land tenure systems under the existing public ownership of land derive from official allocation by local government authorities and/or through transfer of land use rights. Farmers' practice of leasing agricultural land in the country is mostly limited to a few years, for instance to maximum of three years in one agreement. The common types of transaction of agricultural land include inheritance, cash renting, sharecropping and gift. The process and act of land transfer among land users, however, is often non-transparent. The transaction usually takes place informally. The land lease market (sharecropping and cash rental) is constrained, inter alia, by lack of clear rules and regulations for secure and transparent land lease transaction. Such situation is therefore expected to influence farmers to differentially manage leased-in and own land parcels in terms of application of sustainable land management technologies. On the other hand, however, most of the agricultural land in Ethiopia requires conservation-based land management technologies. The objective of this paper is to analyze land tenure systems and examine the impact of land tenure systems on the use of land management technologies and draw policy lessons.

## 1. Introduction

Land in Ethiopia is a public property. Farmers have use right to agricultural land and right to transfer or lease use right of agricultural land. Thus, land tenure systems under the existing public ownership of land derive from official allocation by local official government authorities and/or through transfer of land use rights. Farmers' practice of leasing agricultural land in the country is mostly limited to a few years, for instance to maximum of three years in one agreement. The common types of transaction of agricultural land include inheritance, cash renting, sharecropping and gift. The process and act of land transfer among land users,

however, is often non-transparent. The transaction usually takes place informally. The land lease market (sharecropping and cash rental) is constrained, inter alia, by lack of clear rules and regulations for secure and transparent land lease transaction. Such situation is therefore expected to influence farmers to differentially manage leased-in and own land parcels in terms of application of sustainable land management technologies. On the other hand, however, most of the agricultural land in Ethiopia requires conservation-based land management technologies.

The highland of Ethiopia which provides a living space for more than 90 % of the country's human population and for 75 % of livestock population of the country suffers from severe soil erosion averaging 42 tons of soils per hectare per year on cultivated lands (Hurni, 1993). Most of the soils show negative nutrient balance; and up to 2 % of total crop production is lost annually due to soil erosion alone (Koppel, 1996). The physical land forms and features (e.g. steep slopes) are one of the main factors that aggravate erosion by causing runoff, spatial separation of farms, and irregular shapes of land plots and scattered settlements. According to FAO (1986) about 75 % of the Ethiopian highlands are estimated to need soil conservation if they are to support sustained cultivation. Under such scenario, development and application of sustainable land management technology and practices is not debatable. There are, however, constraints on application of sustainable land management technologies, one being land tenure institution.

The objective of this paper is to analyze land tenure systems and examine the impact of land tenure systems on use of land management technologies and draw policy lessons. The analysis starts-off from the premise that less of sustainable land management technologies are applied on leased-in (shared-in and/or rented-in) land parcels compared to own land parcels. The paper is based on case studies carried out in three woredas in East Shewa and North Shewa zones in Ethiopia.

The paper is organized as follows. The second section discusses some conceptual points relating to land tenure and sustainable use of land resource. The third section describes the case study areas and data collection methods, while the fourth section discusses the results of the data analysis. The final section presents summary and conclusions.

## 2. A Conceptual Framework: Land Tenure, Sustainable Land Management and Production Intensification

### 2.1 Production intensification

In the subsistent oriented agriculture of the Sub-Saharan African countries, increased food production plays a primary role in alleviating food insecurity (Delgado et al., 1988), the central development agenda in the Sub-Saharan African countries. Farm food production is the most significant contributor to farm household food security. Under the context of declining landholding per household and diminishing arable land availability in the country, increase in food and agricultural production is possible only through intensification of farm production. Production intensification in this case is use of increased average inputs of labor or

capital on smallholding, either on cultivated land alone or on cultivated and grazing land, for the purpose of increasing the value of output per hectare' (Tiffen et al. cited in Okike et al, 2001). Intensification process results, in practice, from: an increase in the gross output in fixed proportions, due to inputs/factors expanding proportionately, without technological changes; a shift towards more valuable outputs (e.g. cash crops); or; a technical progress that raises land productivity (Carswell, 1997 cited in Okike et al, 2001).

Production intensification, as a process of increasing output or value from a given land unit, implies the need for sustainable land resource base un-degraded for continuous use. Retaining and enhancing soil fertility potential of farm land is the core objective of sustainable land management. This, in turn, implies the importance of applying appropriate land management technologies and practices, along with improved production technologies and inputs..

Production intensification is thus a function of investments on land management technologies and practices (e.g. stone terraces, soil bunds, drainage ditches, crop rotation, manuring, contour ploughing etc.), use of improved inputs on the farm plot (e.g. labor, oxen power, seeds, fertilizer,) and use of irrigation. Other production intensification factors include quality of farm plot, household characteristics, agro-ecological factors like rainfall and altitude, and prices of crop outputs and inputs. The focus of this paper is on technologies that contribute to the long term improvement of soil fertility, organic matter, soil depth and soil workability (i.e. sustainable land management technologies).

## 2.2 Land tenure and land management

Decisions on improved production input use, land management practices and cropping patterns depend on: profitability factors of crop production; land tenure system (which may affect the future returns from current practices); household's total endowments of land, labor, oxen and other assets; household access to roads, markets, credit and other services that affect ability to purchase or hire inputs, and; other community level factors such as agroecology.

The impact of land tenure systems on intensification can be measured via its impact on the decisions of use of land management technology, improved production inputs and cropping pattern. This paper focuses on the impact of land tenure system on use of land management technology.

It is obvious that enhancing land quality through improving soil fertility, soil structure and organic matter and controlling soil erosion and land degrading cropping and pasturing practices contribute to production intensification and sustainable land use. Application of sustainable land management practices like rotation, agro-forestry and inter-cropping are generally influenced negatively by the fragmentation and diminution of farm plots, for such sustainable land management practices need a consolidated and considerably large farm size. Small farm households face higher overhead cost of application of sustainable technology per unit of land area. On the other hand smallholders are generally less risk tolerant, as they work under risk-prone environment.

With insecure land tenure and transaction, farm households may have less incentive to invest in land management (Feder and Feeny, 1993), as it takes relatively longer time to reap the benefits expected from investment on sustainable land management practices. On the other hand, the household may increase investment if the investment can in turn increase security of tenure (Besley, 1995), for example, by having perennials and erosion control structures on the farm. Generally, however, legally secure land tenure and transaction is expected to improve land use efficiency and long term investment on land.

## 2.3 Institutional support services and land management

Farmers' access to inputs, knowledge and skills delivering institutions is an essential condition to enhance technological change and thus to accelerate production intensification.

For example access to irrigation water and management know-how permit higher cropping intensity and reduce crop failure rates, and is expected to increase crop yields. Since most of the technological innovations are input-embodied (e.g. fertilizer, high yielding crop varieties, pesticides, herbicides etc.), supply of the inputs to farmers at the right time and price is crucial to increase crop productivity. Generally, farmers with relatively small farm size have poor access to extension service, for the inclination of the extension service (workers) is generally towards external input using large farmers. This situation marginalizes small farmers from using improved technologies. This again is aggravated by the preference of input supply organizations for large and better-off farmers, for they are considered to be dependable clients to use the services at larger scale. An exploratory study conducted in Adamitullu-Jidokombolcha woreda in East Shewa indicated that landless and the near-landless groups have usually less access to improved inputs and extension services (Negatu, 2002)

Sustainable land management technologies are knowledge and skill intensive; for instance, it requires knowledge and skill for preparation and applying organic fertilizers (e.g. composting), for selection of compatible crops for inter-cropping and legume trees for agro-forestry practices, and for controlling soil erosion and water-logging. This situation asserts the crucial role of extension service and farmers training in the promotion and application of sustainable technologies.

Physical access to markets, product marketability, input availability and prices are also important factors that influence farmers' decisions on cropping pattern, technology and input use.

Lack of alternative sources of fuel energy and population growth would often result in increased use of crop residues and dung for fuel rather than for fertilizing soil. These situations can also lead to a reduction of fallowing practice or shortening of fallow cycles. Population pressure, however, may have positive impacts on land management (Boserup, 1965). By increasing the value of land relative to labor, population growth may induce farmers to undertake labor intensive investments in land management, such as planting trees, constructing stone terraces, composting and mulching (Pender, 1988 cited in Benin, 2002).

### 3. Data and the Case Study Areas

The data used in this paper were collected from three woredas (districts) - Gimbichu and Adamitullu-Jidokombolcha (AJK) woredas in East Shewa zone, and Moret & Jiru woreda in North Shewa zone. The data was collected using a structured survey questionnaire from heads of randomly selected households. The data for Adamitullu-Jidokombolcha (AJK) were collected in 2001, while that of Moret & Jiru and Gimbichu in 1995.

(i) Adamitullu-Jidokombolch (AJK) woreda

The woreda is located 165 km south of Addis Ababa in East Shewa administrative zone, Oromiya region. The woreda is one of the drought prone and least food secure woreda in East Shewa zone. The woreda has two types of agro-ecologies - woinadega (mid altitude with moderate temperature and rainfall) that constitutes about 40 % of the woreda area and kola (hot and semi-arid) that comprises 60 % of the land area of the woreda. In general, the altitude of the woreda ranges from 1350 to 1850 m.a.s.l. The annual rainfall ranges from 450 mm to 761 mm. The dominant (65 %) soil type in the woreda is light (sandy loam), 25 % of sandy soil and the remaining 10 % being other soil types including vertic soil (for full description of the case area, see Negatu, 2002).

(ii) Gimbichu woreda

Gimbichu woreda is located 85 km south-east of Addis Ababa in East Shewa Administrative Zone (Oromiya Region). Gimbichu area is characterized by undulating to rolling lands, with some areas of nearly level plain (LUPRD, 1986). More than 85 % of the Gimbichu area is found on altitude of more than 1800 m.a.s.l. The annual average rainfall in Gimbichu is on average 900 mm. The area is generally characterized by dega-woinadega agro-ecological characteristics

(iii) *Moret & Jiru woreda*

Moret & Jiru woreda is located in North Shewa Administrative Zone (Amhara region) about 200 km north-west of Addis Ababa. The *woreda* has two distinct agro-ecological domains: (1) highland plateau with annual average rainfall of about 900 mm and soil dominated by the vertisol type, and (2) gorge areas with rugged topography, non-vertisol dominated soil, a less reliable rainfall pattern and higher temperatures (kola-woinadega) compared to the highland plateau of the same *woreda*.

Major resource endowments of households in the case areas

Land is an important and key productive asset. Size of land holding in the study areas seems to vary considerably. While the average land holding per household in Moret & Jiru is 7.2 *timad*<sup>1</sup>, that of farm households in Gimbichu and AJK is 9.6 *timad* and 7.3 *timad*, respectively.

Normally, a pair of oxen is required to plow a farmland. On average, a household in Moret and Jiru owns 1.3 oxen, while that in Gimbichu and AJK owns 2.4 and 2 oxen, respectively. These two resources generally determine the wealth status of households and their potential to apply improved technologies.

Table 1: Land and oxen endowments of farm households in the case areas

Resource	Moret & Jiru N=96	Gimbichu N=96	AJK N=97
Landholding, <i>timad</i>	7.2 (0.37)	9.6 (0.47)	7.3 (4.20)
Oxen number	1.3 (0.07)	2.4 (0.13)	2 (1.0)

Note: N = sample size; figures in parentheses are standard errors; 1 *timad* = 0.25 ha.

Source: Negatu, 2002 and Negatu, 1996.

#### 4. Land Tenure Systems

Agricultural land in Ethiopia is publicly owned and farmers do have use-right to land. They have also right to lease or bequeath the land they possess. Regional or federal governments do have legislative power to conduct land redistribution whenever they find it necessary. Four types of land tenure systems have been identified in all the three woredas.. These are: (1) own land – land parcels owned by a household as a result of official land allocation, inheritance from parents or other mechanisms; (2) sharecropping systems in which operated land parcels are obtained as a result of sharecropping agreements; (3) cash rental tenure system in which operated land parcels are obtained as a result of cash rental agreement, and; (4) gift/borrow land tenure system in which operated land parcels are obtained as gifts or borrows from parents, relatives/friends for short or permanent period The sizes of land parcels operated

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<sup>1</sup> One *timad* = 0.25 hectare

under all these tenure systems vary from woreda to woreda, from a community to community, and from a household to household.

#### 4.1 Own land tenure system

The dominant land tenure system in the three woredas is the own-land. About 90 % farm parcels operated are owner-operated. It has been reported that 89 % surveyed plots in the highland Amhara region are owner-operated (Benin, 2002). This indicates land transaction in the areas is limited. Most farmers operate mainly their own farm holdings.

The fragmentation of farm land in AJK woreda is limited on average to 2.5, while in the other two case areas it reaches up to 4. This could be attributed to the topography of the land which is dominantly flat, and to the similarity of the soil type and fertility across the Peasant Associations (communities) in AJK which, if otherwise, could have resulted in more fragmentation in order to allocate households land parcels of similar quality during the official land distribution as was done in the other case areas.

#### 4.2 Lease system (cash rental and sharecropping arrangements)

##### Sharecropping

The case study in AJK woreda indicates that 24.2% of farm households entered sharecropping agreement either as land taker or land giver. Farmers in the same area had reported that share cropping transaction has declined over last one decade (Negatu, 2002). Sharecropping agreement among farmers is entered often for short period, mostly for one season. The main reason for short period sharecropping agreement is that land givers themselves want to operate the parcel soon, expecting better weather situation and/or better access to purchased inputs. Some land givers (20% in the case of AJK) preferred short term sharecropping fearing that they may lose their parcels to others including lessees in case dispute arises with the lessee or in case official land redistribution takes place during the contract period (insecure land transaction practices).

##### Cash rental

The case of AJK indicates that 26.5 % of sample farm households were involved in land rental transaction. Involvement of farm households in cash rental agreements seems more than that in sharecropping system. Cash-rental land tenure practice like sharecropping is limited to short periods because of the reasons mentioned above for the case of sharecropping.

The observation in the three case study areas indicate that farmers who are better endowed with labor, oxen and cash lease-in land, while the less endowed ones lease-out some of their farm parcels. Similar results have been reported for Ada and Lume woredas in East Shewa (Negatu et. al, 1994).

Generally, lessees do have almost full control on what to grow and which inputs to use. Inputs that may not provide benefits within a year's period are not often applied by lessees (e.g. manure and soil conservation practices). This is mainly because of short period lease-holding during which all benefits of sustainable technologies applied may not be accrued. Lack of clear legalized rules that assure land leasing without fear of risk of loosing tenure on leased-out land parcels aggravates the problem.

#### 4.3 Rules and regulations on land transactions

Clear regulations and rules as to how to proceed and carry out open and formal land transactions both for sharecropping and rental transactions are important conditions to make land transaction efficient. Awareness and knowledge of farmers on existing regulations and their confidence in efficient and transparent implementation of the regulation by concerned government agencies would have a significant role in making the existing land tenure systems and land use efficient. The sample households were asked if they were aware of any rules and regulations regarding sharecropping and cash rental land transactions. According to the case of AJK, only 28.8 % of the sample households indicated the existence of some rules and regulations on cash rental transaction, while the rest indicated that there was no such rules or they were not aware of any (Table 2). With regard to sharecropping, 62.1 % of the sample farmers in the same area claimed that there were no rules and regulations they know about. In general, farm households in all the case areas were not fully clear about their rights and regulations on land transaction. It seems that there is lack of clear rules and regulations for that may facilitate farmers' formal and open land transactions. I.e. any existing rules and regulations are not made clear and transparent for farmers. Lack of such clear regulations on land transactions may result in low benefits to transacting parties, which could have been higher under otherwise condition.

Table 2: Farmers' awareness of any official rules on cash rental and sharecropping in AJK woreda, (N=132)

Item	Percent
Are there rental rules	
Yes	28.8
No	42.4
Don't know	28.8
Are there sharecropping rules	
Yes	3.8
No	62.1
Don't know	34.1

Source: Negatu, 2002

## 5. Land Tenure Systems and Land Management Technology

### 5.1 Cropping pattern and input use

The major crops grown in terms of land allocation in AJK woreda are maize, teff, haricot bean and wheat, while wheat and teff are the major crops in Moret & Jiru and Gimbichu woredas. Before the introduction of chemical fertilizer around 1974/75 in the highlands of Moret & Jiru and Gimbichu woredas, farmers had been using manure, rotation of cereals with legumes, fallowing, and fallowing land after opening a wide furrow across the field, in order to maintain and improve soil fertility. These traditional methods of maintaining soil fertility are now very limited, and are to a large extent replaced by increased use of chemical fertilizer.

Improved agricultural technology, embodied or non-embodied (management practices) are important factors that enhance farm productivity and production. Table 3 shows the level and extent of applications of improved inputs and land management practices that contribute to sustainability of the land resource. Use of chemical fertilizers (DAP and Urea fertilizer in this case) are generally limited, and much more limited in low land areas where rainfall is most unreliable. As indicated in Table 3, chemical fertilizer in AJK woreda is applied on a limited number of farm plots. For instance, DAP and Urea were applied in AJK woreda only to 19.3 % and 16.6 % of owned farm parcels, respectively. The proportion of leased plots applied with fertilizer (14.6 % for Urea and 14.9 % for DAP) is comparable with the proportions of

farm parcels applied with fertilizer. However there is a considerable difference in the average amount of fertilizer applied to own-farm parcels and to leased-in parcels. The average per *timad* (a quarter of a hectare) application rate of Urea and DAP were 24.2 kg and 28.4 kg., respectively, while per *timad* application on leased-in parcels were 14.7 kg Urea and 15.4 kg. DAP.

Manure was applied to the highest proportion (25.5 %) of crop plots under own land tenure systems compared to the proportion of plots (10.6 %) under lease systems. A study in Amhara highland showed that own plots are associated with greater likelihood of applying manure (Benin, 2002). However, the same study reported that leased-in plots (cash-rental and sharecropping) are associated with use of more improved seeds and fertilizer.

The study in AJK woreda shows that, though on small number of plots, intercropping (0.03 %), alley cropping (0.46 %), double cropping (1.15 %) and irrigation (2.7 %) practices were applied only to those plots under own land tenure systems (Table 3). In the study conducted in the Amhara region (Benin, 2002) showed that owner-operated plots are associated with more stone terraces, contour plowing and crop rotation. This may indicate the tendency of farmers to apply such practices with long term benefits on relatively tenure secure plots. This simply implies the need for long-term secure lease system which may ensure farmers benefits of investment on land.

Table 3: Input use and land tenure systems in AJK woreda

Input/technology	Owner-operated plots	Leased-in plots	Total
Urea, kg/ <i>timad</i>	24.2 (16.6) N=30	14.7 (14.6) N=7	21.9 N=37
DAP, kg/ <i>timad</i>	28.4 (19.3) N=43	15.4 (14.9) N=7	26.36 N=50
Manure			
Applied plots	111 (25.5)	5 (10.4)	116 (24.0)
Non-applied plots	324 (74.5)	43 (89.6)	367 (76.0)
Inter-cropping			
Applied plots	1 (0.03)	0 (0.0)	1 (0.21)
Non-applied plots	434 (99.97)	48 (100.0)	482 (99.79)
Alley cropping			
Applied plots	2 (0.5)	0 (0.0)	2 (0.4)
Non-applied plots	433 (99.5)	48 (100.0)	481 (99.6)

Irrigation			
Applied plots	9 (2.07)	1	10 (2.07)
Non-applied plots	426 (97.93)	47	473 (97.93)

Note: N = number of plots; figures in parentheses are percentages. Irrigation is practiced only in Elka-Chelemo kebele (village) in which some plots have access to the irrigation scheme on Zuway Lake.

Source: Negatu, 2002

## 5.2 Major constraints on use of land management technologies

### 5.2.2 Chemical fertilizer

The major constraints on fertilizer use, as indicated by the sample farmers, are cash/credit shortage, insufficient supply of fertilizer and others like low product price in that order (Table 4). The constraints on the use of chemical fertilizer for farmers in Moret & Jiru and Gimbichu are: difficulty of getting the amount of fertilizer they require; unavailability of fertilizers at the time they want to purchase, and the ever increasing price of fertilizer.

The observation in the highland case areas is that most farmers would like to continue use of chemical fertilizer even if prices continue to rise, as they believe that it is very difficult for them to do without it. According to farmers' responses, the highlanders would like to apply different strategies of sustaining their soil fertility: (1) making effort to find other ways of getting cash, for example through fattening cattle and sheep for sale; (2) applying fertilizer to a smaller proportion of the cultivated land but at a higher rate, and (3) planting the remaining farmland with pulses and traditional varieties of cereal crops without fertilizer or with small amounts of fertilizer, and (4) asking or lobbying for government subsidy on fertilizer.

### 5.2.2 Use of manure and crop residue

Manure use in the highland areas is highly limited. If farmers apply any small amount of manure, they apply it mainly to homestead farms. Constraints to manure use are the difficulty of getting a sufficient quantity of manure (relative to crop nutrient requirement) and difficulty of transporting it to distant crop fields. Manure use is also observed by the farmers to aggravate weed infestation in field crops. Therefore, they prefer to apply the small amount of manure available (left over manure from dung-cake preparation) to homestead crops such as garlic. In all the case areas, the grain crop residues are grazed by animals or collected for fuel, leaving only those which are difficult to collect.

The deterioration of biomass return to soils in the case areas is immense. This biomass deterioration could be linked, as argued by Hurni (1993), first, with the absence of alternative sources of fuel energy; secondly it is related to shortage of feeds, a problem aggravated by shortage of grazing land due to increasing population and expansion of crop farming into grazing and marginal lands. The decreasing trend in the number of livestock per household also aggravates manure shortage. Although there is a tendency of growing eucalyptus trees (which are also used as a fuel source), it is in a limited scale by a small number of growers. In general, lack of biomass causes soil deterioration which consequently results in a decrease in organic matter, soil fertility and agricultural productivity. It is estimated that one per cent of the annual decrease in soil productivity in the highlands of Ethiopia is caused by biological deterioration (ibid: 37).

### 5.2.3 Cropping pattern

Based on the percentage of responses in AJK woreda, the major constraints to inter-cropping include lack of compatible crops and unsatisfactory return from the practice, in that order (Table 4). As shown in the same table, the major constraints on alley cropping are lack of compatible trees, lack of skills and know-how, and lack of awareness.

The major constraint on double cropping as indicated by 94.7 % of respondents in AJK woreda is unreliable rainfall. In all the three case study areas, there is no sufficient rain during belg (short rain period) season to grow crops. Double cropping is only possible with farmers who have access to irrigation water, like Zuway lake in AJK woreda.

Rotation of cereals with legumes is an important practice of improving the soil fertility and structure. Farmers, however face different problems to follow a regular pattern of rotation. The major constraints include poorly yielding legumes, preference for staple cereals and lack of awareness about the practice (Table 4).

### 5.2.4 Erosion control practices

Water erosion of crop fields in both highland areas was not as crucial as the other production constraints (e.g. poor soil fertility). A considerable number of farmers, as revealed in farmers focus group discussion, in Moret & Jiru and some in Gimbichu woreda make furrows around the borders of a farm (*degelle*) for guiding flowing water out into gorges or wasteland. They

also used furrows across a farm to harvest flowing water and pass it out along one line. The informants in Moret & Jiru plateau indicated that farmers grow grass strips on farm borders and make stone bunds to control soil erosion. Some farmers also construct earth bunds around their fields. The problem with stone bunds is that they favor growth of weeds inside or near the stones, which become a source of further weed infestation of the crop fields. Re-forestation activities were being carried out on communal hills and escarpment-sides in the gorges of Moret & Jiru woreda by the local communities (Peasant Associations) under the guidance of the extension workers of the woreda. The issue is, however, sustaining the activities and broadening the involvement of farmers in planning the purpose, incentives and implementation of the activities. As it stands now, there seems to prevail limited incentives for households to participate in such communal forestation activities.

Table 4: Major constraints on sustainable land management technologies

Constraints	Number of respondents (%)
<b>Fertilizer Constraints</b>	
Cash/credit shortage	105 (79.5)
Insufficient supply	10 (7.1)
Others (low product price, unfavorable weather etc.)	17 (12.9)
<b>Intercropping Constraints</b>	
Lack of compatible crops	72 (54.5)
Unsatisfactory return	27 (20.5)
<b>Alley cropping constraints</b>	
Lack of compatible trees	50 (37.9)
Lack of skills & know-how	27 (20.5)
Lack of awareness	20 (15.2)
<b>Rotation constraints</b>	
Poor yielding legumes	38 (28.8)
Preference for staple cereals	30 (22.7)
Lack of awareness	25 (18.9)

Source: Negatu, 2002

#### 5.2.6 Waterlogging control methods in vertisols

In Moret & Jiru woreda, all crops (except teff) grown in vertisols are planted on handmade broadbed and furrow (BBF). This method has been practiced for many generations, as the respondents claimed (*Gena meret ena semay sayitefer* = since antiquity ancient times). For teff, a limited number of furrows are made across fields to drain off excess surface water. In the discussions with the individuals and groups, it was revealed that handmade BBF has also been used on light soil (*Chebere* or *bushla*) for many years. They claim BBF is also useful on non-vertisol (light soil) for controlling cutworms and other soil-borne insects (*messek*), and it is conducive to application of fertilizer. In general, however, using local BBF on light soil depends on the nature of the soil and land topography. For very light soil and sloping land they prepare a flat seedbed (Negatu, 1996).

In Gimbichu, waterlogging is one of the major production constraints in vertisol farms of the *woreda*. Many farmers in the woreda prepare ridge and furrow seedbeds for wheat, the most sensitive crop, and grow other crops (e.g. pulses) either late in the rainy season or on non-vertisol or free-draining lands. The local ridge and furrow seedbed type is farmers' innovation that has disseminated from farmer to farmer since the mid-1970s. The practice of delaying planting time would expose the crops to terminal drought or heat stress, which generally reduces the potential yield of the crops. Some farmers in this woreda also make furrows across or around the fields to drain-off excess surface water.

#### Application of improved BBF

The improved BBF made using the broad-bed and furrow maker (BBM) developed and promoted by a consortium of research organizations involving the ex- International Livestock Center for Africa (ILCA), the ex-Institute of Agricultural Research (IAR), and Ministry of Agriculture (MOA) was on demonstration for some years in Moret & Jiru woreda since 1986/87. Some farmers tried the improved BBF on their farms in 1989/90, but found it inappropriate and discontinued its use. They claimed that since the furrows made were shallow, they could not drain off heavy rainwater effectively during the later half of July, when the dry-planted crop is about one month old. As a result, early (dry) sown wheat was damaged by waterlogging. On the other hand, early seedbed preparation for dry planting on BBF is difficult due to the dryness of the land and the fact that oxen are weak due to lack of feeds during this period. On the other hand, repeated plowings would damage soil structure

and expose soils to erosion. Farmers observed also that delayed planting faces muddy soil upon which it is difficult for oxen to pull the broad-bed maker.

The heaviness of the BBM, its demand for extra labor and its sensitivity to land topography, and erratic amount and distribution of rainfall are conditions that limit use of the improved BBF technology. Moreover, the price of the implement (BBM) was unaffordable for most of the farmers. The extension support and intensive promotion of the technology by extension agencies without addressing its inherent constraints would thus make its use unsustainable.

## 6. Concluding Remarks and Implications

Farm households in the study woredas are smallholders. They practice mixed farming systems. They operate mostly their own farm parcels and lease-out only a small proportion of their own farm parcels. Farm parcels obtained in lease marketing (shared-in and rented-in parcels) are very limited in number. Besides, farmers are not provided with clear and transparent operational rules and regulations on land-lease marketing, and most of the transactions are done informally and remain insecure.

Use of technological inputs seems to vary between owner-operated and leased-in plots. Farmers apply on average more of DAP, Urea and manure to owner-operated farm plots compared to that on leased-in plots.

The main constraints to technological inputs are lack of cash/credit and insufficient supply of the inputs. The major constraints of sustainable land management technologies are lack of compatible trees and high yielding legume varieties and associated know-how and skills, which imply the need for stronger research and extension in agro-forestry and mixed cropping systems.

The findings of the study point to the need (1) for transparent and legally secure operational rules and regulations that facilitate open land transaction and (2) for policy and administrative regulations that ensure secure and long-term land lease system in order to enhance use of sustainable land management technologies.

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