FIT-FOR-PURPOSE LAND CONSOLIDATION: AN INNOVATIVE TOOL FOR RE-ALLOTMENT IN RURAL ETHIOPIA

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ABSTRACT

Access to agricultural land is vital for reduction of hunger, poverty, food insecurity as well as economic development. The current land tenure system in Ethiopia has been argued as a root cause for food insecurity: high parcel fragmentation impedes agricultural production. One activity that could improve food security is land consolidation, specifically, agriculture re-allotment. In Ethiopia the central government allows land consolidation on voluntary bases, however, not yet land consolidation has occurred. New approaches for invigorating and implementing land consolidation could be considered.

The main research objective underpinning this research is to investigate the nature of different land consolidation initiatives, mainly agricultural re-allotment practices in the Netherlands, and to determine if, and how, they might be adapted for re-allotment activities in Ethiopia. The study is underpinned by primary data collected in field surveys undertaken in one administrative Kebele of the Fagetalakoma Wereda in Amhara Region. Additionally, secondary data collected form governmental organizations supported the research activities. The data was used to develop a show-case. The show-case consisted of an innovative and fit-for-purpose re-allotment approach for rural Ethiopia, and application of the approach to produce a re-allotment plan for the selected Kebele.

The design of the re-allotment plan (show-case) was carried out in a GIS environment: ArcGIS acted as the main data analysis tool. Re-allotment practices from the Netherlands were used to inform the approach. The methodology developed to fit rural Ethiopian purposes consisted of three main steps: 1) Determining which plots could be relocated based on the collected desires of farmers, the researchers own perspective, the setting of the criterion, and identifying relocated plots; 2) Exchanging plots among the owners (the swapping approach); and 3) Identifying and mapping the relocated new owners designed plots with different colours.

The new approach determines the land owner list for reallocation based on priority order through consideration of the rank value which has been given for the criteria such as 'plots have farm houses', 'household have one or more plot without farm house', 'existing plot inside a "block"', 'plots belong to the same owner and adjacent to each other' and 'plot exists in the dominant class of soil inside a "block"'. Hence, the approach showed the situation before and after re-allotment process. The results of the new approach are evaluated based on evaluation factors to ascertain whether the situation of the farmer was improved or not after re-allotment.

The new approach shows an advantage for the study area in general, and for the relocated farmers more specifically. The approach was innovative, repeatable, and unique for Ethiopia. Most of farmers improve their concentration of plots, plot sizes and reduce the distance between their farmhouses and plots. This means farm size and structure is improved. It is hypothesized that these structural improvements would have a positive impact for agricultural productivity for farmers and for Ethiopia more generally.

Key words: Land consolidation, Agricultural re-allotment, Land bank

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GLOSSARY

Algorithm: A step-by-step problem-solving procedure, especially an established, recursive computational procedure for solving a problem in a finite number of steps.

Block: A block is a part of the land area that contains the same type of land use, quality of the soil and it is often delimited by larger roads, i.e., a block is made up of many plots.

Criterion: A principle or standard by which something may be judged or decided (Criteria- is plural form).

Fit-for-purpose: Something that is fit-for-purpose is good enough to do the job it was designed to do. Or the ability of a product or service to fulfil the intended requirement

Food security: Food security implies the state of having sufficient and equal access to food and exists if all people at all times have the potential to meet their need for an active and healthy life (Rockson et al., 2013)

Land banking: "Land banking is the structural acquisition and temporary management of land in rural areas by an impartial State agency, with the purpose to redistribute and/or lease out this land with a view to improve the agricultural structure and/or to re-locate the land for other purposes with a general public interest" (Damen, 2004).

Land consolidation: "Land consolidation means a comprehensive re-allocation procedure of a rural area consisting of fragmented agricultural or forest holdings or their part" (Vitikainen, 2004)

Land re-allotment: Land re-allotment is a core part of land consolidation which comprises the distribution of property to different person i.e., division of property into different portions according to each one contribution (Grossman & Brussaard, 1989).

Neighbouring plots: Plots that are adjacent (connected) to each other and owned by a single owner.

Parcel: A parcel is a quantity of land identified for taxation purposes; it means a piece of land that represents a legal estate. Each parcel of land has got its own real property rights and unique ownership.

Plot: A small piece of land, generally used for a specific purpose (i.e., farm plot).
(Note: *The name* ***plot*** *was used in this study to mean* ***any plot before re-allotment*** *and* ***designed plot*** *used for* ***any plot after re-allotment***.)

Rank: The position of an item in any ordering or sequence. Or a degree of value in a graded group is rank

Value: An assigned or calculated numerical quantity (i.e., numeric point assigned to rank).

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1. INTRODUCTION

The term food security implies the state of having sufficient and equal access to food. It exist if all people at all times have the potential to meet their need for an active and healthy life (Rockson et al., 2013). In developing agrarian societies access to agricultural land remains vital for food security: it enables a reduction of hunger, poverty, as well as economic development. One of the aims of the Post-2015 Development Agenda is "empowering small-scale food producers and food insecure communities": rural communities, especially smallholder farmers, play an important role in the sustainable management of natural resources that are critical for global food security (FAO, 2013).

Delivering food security in Ethiopia is not just a question of enabling food production and supporting small-scale farmers. It is important to know how the food is produced, imported and distributed to rural and urban populations, and it should be considered what infrastructure and marketing systems determine the flow of food (FMS, 2012). This remains a very complex issue in the country. All these issues depend on the land tenure system. In Ethiopia farmers do not hold ownership rights over the land; they have use right only. Thus, it can be argued that the current land tenure system is the root cause for food insecurity in the country: land is highly fragmented and further investment is arguably discouraged by unclear rights. Food insecurity has been an inescapable and predominant reality in the lives of far too many Ethiopians. Small-scale farmers in particular have suffered, year after year, harvest after harvest.

One of the methods that may assist the food security system in Ethiopia in an efficient way could be to utilize land consolidation, especially agriculture re-allotment. In Ethiopia, the government allows land consolidation on a voluntary base; however, as yet there is little evidence of any significant land consolidation. This study is the first of its kind: the design of the land consolidation plan is based on one of the approaches that are implemented in Europe, specifically in the Netherlands. There is no research conducted prior to this study on how the European approach could be used for land consolidation design in Ethiopia. Thus, it is hoped the thesis may contribute to the new method in the area of land consolidation particularly agricultural re-allotment plan for Ethiopia's rural settings.

1.1. Background of the study

Life in many rural areas is characterized by decreasing opportunities to get a decent living in both the agricultural and non-agricultural sectors. To combat such problems, a continent union such as European Union designed and implemented a specific policy on rural development. The policy is designed to reduce differences between urban and rural areas by making land consolidation part in integrated rural development (FAO, 2003).

According to Vitikainen (2004), "Land consolidation means a comprehensive re-allocation procedure of a rural area consisting of fragmented agricultural or forest holdings or their part". The first land consolidation initiative was introduced in Denmark in the 1750s in order to establish privately owned land and to free people from the obligation of nobles land lords (FAO, 2003). In the Netherlands, the first act of land consolidation was issued in 1924 and 1938. However, substantial consolidation really started after World War II in the framework of a land development project integrated with infrastructure and landscape development. It aimed to improve the agricultural productivity and to minimize production cost (Belay, 2010). Land consolidation has been used as an effective instrument for rural development to

enhance the quality of rural life in the improvement of infrastructure, employment, housing, environment protection, agricultural production and economic and social status of rural household. In addition, it become a gate for sustainable improvement of general livelihoods in rural areas (Thomas, 2004).

Land re-allocation is an important sub-concept relating to land consolidation. It has been described as the key component of land consolidation. Rosman (2012) described, "The driving force behind land consolidation is the improvement of land use through land re-allocation" thus, the re-allotment plan is the core part of land consolidation. The re-allocation process can easily minimize transportation expense and labour cost to the land owners, since different owners can be allocated as the most advantageous position from various point of view. This means most farmlands should be located near the farm houses from ecological point of view. This offers the possibility to get property located at a location that enables cost conserving (Buis and Vingerhoeds, 1996). The process of re-allotment in the Netherlands was designed and is still designed to restructure land parcels and to ensure a more efficient performance of working activity in agriculture. The process is used to improve efficiency with large parcel of land and improved form, reduction of distance between the farmhouse and parcels, reduction of cost for the farmers and improved parcel layout. Thus, this results in more land available for cultivation and thus higher yields (Buis and Vingerhoeds, 1996). In the case that land re-allocation only aims to reduce the fragmentation and to merge the scattered and uneconomically shaped parcels of farms, voluntary land exchange is cited as the simplest and fastest land consolidation measure.

Land banking is another important and related concept. It can also address both farm size and segregation of use and ownership. Land banking activities are believed to stimulate the emergence of regions with middle-sized farms that have many parcels (Hartvigsen, 2005). The conclusion from the Dutch land bank experience is that a successful implementation of land consolidation is dependent on land banking (Damen, 2004).

Meanwhile, in Ethiopia, land is considered the common property for the entire nation, nationalities and people of the country. However, land is not subject to sale or other means of exchange. The 1995 Ethiopian constitution Article 40 sub Art 4 states that, "Ethiopian peasants have the right to obtain land and protection against eviction" Moreover, the majority of peasants depend on agricultural production to generate income for their subsistence. However, the size and fragmented nature of land holdings and the level of security farmers' have undermines incentives to make investments in their land. One of the arguments provided by policy makers to keep rural land under public ownership is the assumption that rural land plays a social security role i.e., in terms of guaranteeing some form of livelihood through the granting of free access to a piece of land. The current government considers that private ownership of land will lead to concentration of land in the control of the one who have the ability to buy and to evict poorer peasants. This resulting in landlessness, and rural-urban migration (Nega et al., 2003).

On this point, the review of literature indicates that there is no conclusive evidence showing the relationship between land ownership and those positive social and economic attributes of tenure. However, there is a general consensus among many researchers that the room for sustainable intensification is very much limited where peasant agriculture is characterized by fragmented and mini-plots of uneconomic size operated by subsistent farmers. Despite the fact that fragmentation of land holding forms the major problem in Ethiopia, virtually no scientific attention and attempts have been made to address the problem and design a suitable land consolidation approach. Land consolidation is a broad application as understood by (Thomas, 2004). Thus, this research intends to adapt and apply a re-allotment approach in the Ethiopian context by investigating agricultural re-allotment practices carried out

in the Netherlands, focused on agriculture structure with distance reduction and maximization of concentration of lot.

1.2. Statement of the problem

The literature review revealed fragmentation of land holding forms a major structural problem for agricultural production growth in Ethiopia. Land consolidation is assumed as one potential solution in this study, however, to date, no scientific attention has been given towards the design of a suitable re-allotment methodology in the Ethiopian context. Land consolidation as an approach has not been tested. Specifically, methods derived for the successful European context, for example from the Netherlands, have not been applied with a view to determining if they deliver beneficial social and spatial issues outcomes in Ethiopia. Therefore, studies aimed at designing an innovative fit-for-purpose tool for agriculture re-allotment (or show-case), once for creating visible and improved farm structures are missing. The proposed research aims to address this problem.

1.3. Research objectives

1.3.1. Main objective

Based on the above problem description, the main research objective for this research is to investigate the nature of different land consolidation initiatives, mainly agricultural re-allotment practices in the Netherlands, and to determine if, and how, they might be adapted for re-allotment activities in Ethiopia.

1.3.2. Specific objective

- To evaluate land consolidation initiatives in the Netherlands with specific focus on agricultural re-allotment practices;
- To adapt and apply a fit-for-purpose re-allotment approach (show-case) in the Ethiopian context;
- To evaluate the applicability of the identified/designed approach and recommend possible further work.

1.4. Research questions

Question for sub-objective 1

- ✓ What were, and are, the objective of previous and contemporary agricultural re-allotment practice in the Netherlands?
- ✓ What were, and are, the main re-allotment instruments or criteria being utilized in the Netherlands?
- ✓ What are the strength and weaknesses of the of agricultural re-allotment practice in the Netherlands?

Question for sub-objective 2

- ✓ What is the current status of rural land parcels arrangements in Ethiopia?
- ✓ Which re-allotment instruments are fit-for-purpose, and criteria can be best applied to the Ethiopian setting?
- ✓ How can farm houses be included in an Ethiopian re-allotment plan?
- ✓ How can agricultural land banking be facilitated in the context of Ethiopia land policy? What are the necessary conditions?

Question for sub-objective 3

- ✓ Is the identified approach suitable to rearrange land use rights in the Ethiopian context?
- ✓ What are the strengths and weaknesses of the approach?
- ✓ What changes are needed to improve the identified re-allotment approach?

1.5. Scope of the study

Although, comprehensive land consolidation is a broad application as understood by (Thomas, 2004), the paper research limits itself to the design of re-allotment plan with distance reduction and maximization of concentration of lots being the key focus. Only methodologies from the Netherlands will be considered and adapted in the study. The Netherlands practice of agricultural re-allotment was selected due to the following reasons. The first reason is, relative to other countries which are already implementing land consolidation, the Dutch land consolidation is implemented in a highly comprehensive fashion and the process presents a highly fascinating process for agrarian restructure. This may be a good practice to adapt in a well developed and implemented system, however, its applicability in the Ethiopian context is relatively unknown and should be recognized a limitation of the study. The second reason is, relatively to other countries, different methods for re-allotment are developed and used in different land development project in the Netherland's and are already adapted by other countries like Turkey. This provides the option to select one of the developed methods that will be adjusted to the Ethiopian case. Finally, the design of the re-allotment plan was carried out based on GIS approach. This approach needs support and interaction with expertise; thus, the experts very familiar for these methods are collaboratively working with the researcher in this study.

1.6. Conceptual framework

The general conceptual framework of this study is framed on the adaption or application of the Europe land consolidation approaches, particularly the Netherlands method of re-allotment plan, to re-design a new re-allotment plan for Ethiopia's rural setting and to indicate how the new design/method i.e., the land consolidation tool, can address the problems caused by current land tenure system.

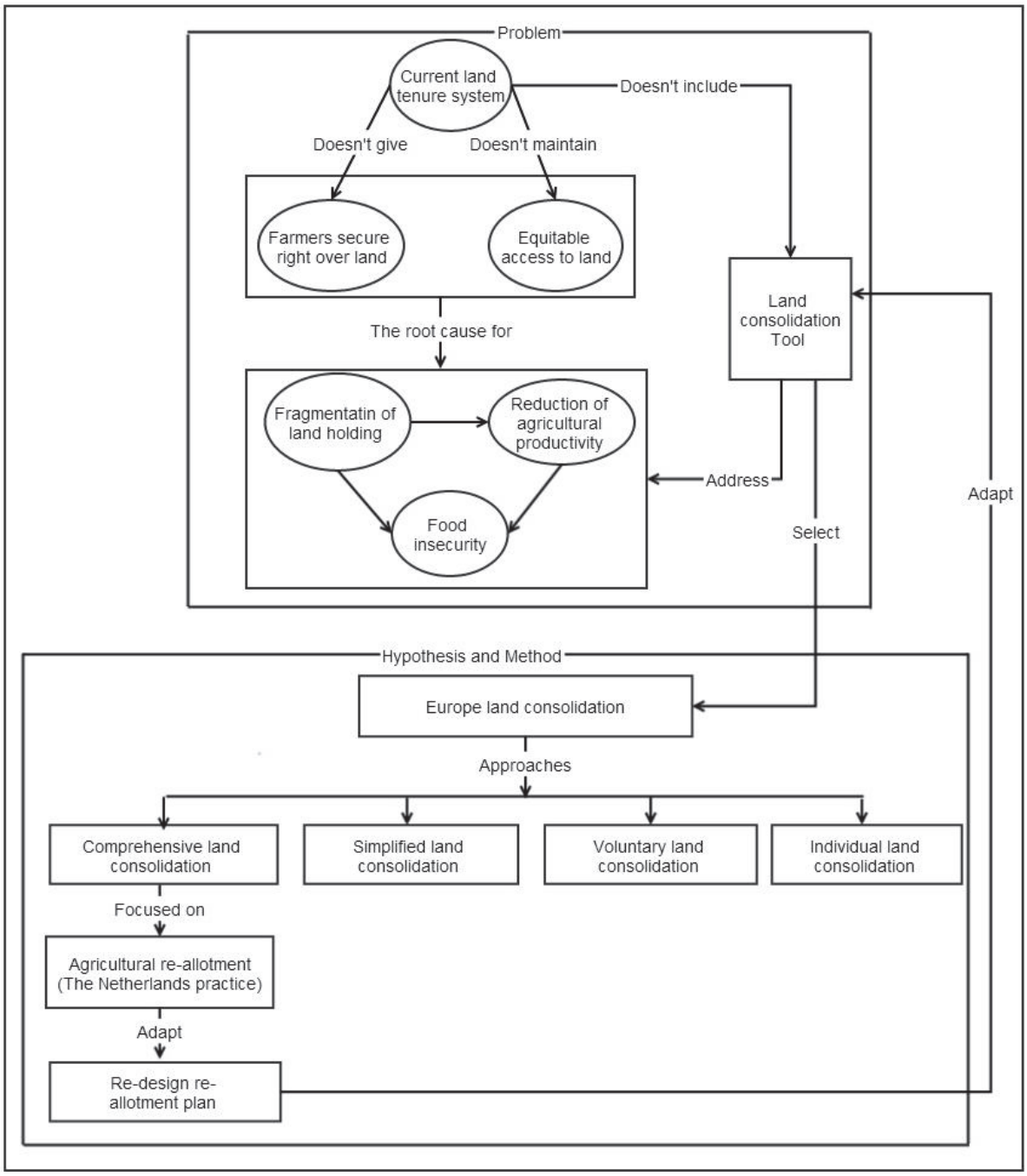

Figure 1. 1 The conceptual framework

1.7. Thesis structure

The thesis has been structured in seven chapters. The outlines of each chapter are described below.

The Introductory chapter consists of introduction, background problem statement, research objectives and research questions, scope of the study and conceptual framework.

The second chapter deals with the concept and theory, based on relevant studies related to land consolidation and agricultural re-allotment practice in the Netherlands. It includes land policy issues in

Ethiopia, the general concept of land bank, the general concept of land consolidation and agricultural re-allotment, the history of land consolidation in the Netherland's, land consolidation and implementation in Europe, the strength and weakness of agricultural re-allotment in the Netherland's and the re-allotment algorithm and system used in the Netherlands.

The third chapter deals with the method carried out to accomplish the research. It includes the research techniques, the study area, source of data and acquisition method, data analysis, the design of re-allotment plan and evaluation of the new plan.

The fourth chapter presents a brief introduction about the study area of Amhara National Regional State and the Fagetalakoma Wereda by including the profile of the selected Tafoch Dambule Kebele.

The fifth Chapter present the existing situation, result and discussion of the study which were collected during the field work and mainly based on the primary and secondary data analysis.

The sixth chapter presents the criteria setting for the re-allotment plan (show-case), the detailed land owners' re-allotment procedures, and the results and evaluations of the results of the show-case.

Finally, chapter seven present the conclusion of the study and the recommendations drawn by the study.

1.8. Conclusion

As a conclusion, generally food security implies the state of having sufficient and equal access to food. Specifically for the Ethiopian case, food security is most definitely not just a question of food production and small-scale farmers. It is a complex issue which also includes the distribution of products to rural and urban populations throughout the country. In addition, the current land tenure security system of the country affects the increment of agricultural productivity which mainly is contributed to the fragmentation of land. Based on different research one of the methods that may assist the food security system to insure food production in efficient way could be served by land consolidation especially the agriculture re-allotment for Ethiopian case. Land consolidation is a means of re-allocation of fragmented land which includes a comprehensive re-allocation procedure. However, to date, no scientific attention has been given towards the design of a suitable re-allotment methodology in the Ethiopian context. Thus, this study is the first in its kind and the design of the land consolidation plan is based on one of the approaches that are implemented in the Netherlands.

2. LITERATURE REVIEW

2.1. Introduction

This chapter seek to review literature on land policy issues in Ethiopia, agricultural land banking, land consolidation and agricultural re-allotment. Although, the policy, the goals and types of land consolidation are briefly stated in this chapter, the key aim of the literature review was mainly focused on how existing research suggests agricultural re-allotment could answer some of the research questions relating to the first specific objective of the study. The chapter included specific sections such as land policy issues in Ethiopia, the concept of land bank, the concept of land consolidation, land consolidation in Europe, the history of land consolidation in the Netherlands, the objectives of agriculture re-allotment practice in the Netherlands, the concept of agricultural re-allotment and re-allotment algorithms and systems.

2.2. Land policy issue in Ethiopia

Land tenure system in Ethiopia before 1975 was one of the most complex in the world and had not been carefully studied (Nega et al., 2003). The country's complex recent history produced various forms of land ownerships and use. From 1975 to 1991, the land reform provided public ownership of all rural lands and the right to own the land is vested in the state. However, the reform produces additional problems such as fragmentation of holdings, land degradation, tenure insecurity and inefficient allocation of land. Moreover fragmentation was considered as a very serious problem in some Regions of the Country (Nega et al., 2003; Teka et al., 2013).

In 1995 the new federal constitution was adapted and provides the right to ownership of rural and urban land, as well as of all natural resources exclusively vested in the state and in the people of Ethiopia. The new Federal constitution that was adopted in 1995 does not give farmers secure right over the land they use, and does not maintain equitable access to land. It is one of the root causes for poverty, food insecurity, and limited access for citizen on land and the reduction of agricultural productivity (Hoben, 2000).

Gebreselassie (2006) stated that "farm fragmentation is one of the main structural problems of subsistence farming in Ethiopia. In 2000, for the cropping season, 87.4 % of rural households operated in less than 2 hectares; 64.5 % of them cultivated farms in less than one hectare and 40.6 % operated in 0.5 hectare and less. Such small farms are fragmented again on average into 2.3 plots, each with 0.35 hectare. Most of the plots are badly shaped, not adjacent to each other and not found on the same area so that these farms can only give 50% of the minimum income for the households to sustain life". The increasing in the decline of farm size and the level of fragmentation leads to the decline in soil quality, less fertility, less cash income as well as the use of less profitable technologies. Moreover, those small households' farmers face higher overhead costs for application for technology and sustainable land management activities. Thus, it is difficult to make sustainable and profitable use of modern farm technologies (Gebreselassie, 2006). In addition, in such kinds of land tenure systems, it is difficult to improve infrastructures and perform environmental protection for sustainable economic growth, social development, and sustainable rural livelihoods (Riddell and Rembold, 2002). The process of farm fragmentation made by the farmers is voluntarily to share part of their own farm to their children. Accordingly, fragmentation of landholdings is commonly regarded as a major structural problem to agricultural production growth in Ethiopia.

Currently, the government is attempting to shift the structure of agriculture from smallholder subsistence production to the commercialization of land and large-scale production. The main objective is agricultural modernization and rural transformation leading to food self-sufficiency and economic growth. However, land grab by foreign and domestic investors eventually affect the farm size of the rural households and contribute to the reduction of cultivated land for farmers (Alemu, 2012). In addition, according to Deininger et al. (2011) the total land transferred to investors in Ethiopia between 2004 and 2008 was 1.2 million ha. Assuming no changes to such plans, the evidence suggests that by 2014/15 the total land transferred to investors, domestic and foreign will measure 7 million ha or more; which constitute nearly one-third of the existing cultivated land in the country that implies a significant change to the existing agrarian structure.

The Federal government of Ethiopia encourages land consolidation only on the basis of voluntary exchange (Alemu, 2012). However, as far as the literature is concerned, land consolidation as well as re-allocation is not yet implemented in Ethiopia.

2.3. The concept of land consolidation

The concept of land consolidation or re-allotment consist of distribution of property to different persons i.e., division of property into different portions according to each one contribution (Grossman and Brussaard, 1989). Land consolidation is based on legislation in all countries. Land consolidation projects can have many goals in various sectors, for instance, village development, nature preservation and outdoor recreation and infrastructure. However, agriculture is the main type of land use.

Land consolidation is not only the simple re-allocation of parcels to remove the effect of land fragmentation. It has a broad application in economic and social reform (FAO, 2003). According to Thomas (2004) land consolidation is a combination of agrarian spatial planning and land readjustment. Comprehensive land consolidation represents agrarian structure to enforce the stability of farms together with agricultural production and to improve the physical infrastructure in rural area (Vitikainen, 2004).

Land consolidation has a close relationship with the four main function of land management: land tenure, land value, land use and land development (Williamson et al., 2010). The use of land and the right of ownership are basic within land consolidation. However, the right of ownership and use of parcels are not hold in the hand of the same person (Thomas, 2004).

Different scholars (Damen, 2004; FAO, 2003; Vitikainen, 2004) consider land consolidation as an instrument for rural development as well as a way for improving production and working condition in agriculture, forest area and rearrangement of agricultural land in rural areas. Moreover, land consolidation can be seen as a gateway for improving sustainable livelihoods in rural area (Buis and Vingerhoeds, 1996). It allows for improvement of tenure structure in support of rural development by addressing land fragmentation. Moreover, it can facilitate competitive agricultural production arrangements with fewer parcels that are larger and better shaped (FAO, 2003).

Land consolidation has different approaches such as comprehensive land consolidation which is the re-allocation of land parcels together with rural development including, village renewal, erosion control measures including building of natural reserves, construction of rural road, drainage, environmental protection, social infrastructure and public facilities such as sport ground. The second approach is simplified land consolidation which is the process of re-allocation of land parcels together with the use of land banks for the provision of extra land. The third approach is voluntary land consolidation which

involves small groups of voluntary peoples to address small problems by negotiating with the land holders. The fourth and the last approach of land consolidation is individual land consolidation that takes place in the informal way by excluding public facilities and without the involvement of the state (FAO, 2003).

Based on these approaches, a number of land consolidation projects are executed in different countries around Europe includes, the Netherland's, Germany, Denmark, France etc. in addition a number of pilot studies were carried out in Central and Eastern Europe countries Such as Albania, Hungary, Bulgaria and Check Republic (Sabates-Wheeler, 2002).

2.4. The concept of land bank

According to Damen (2004), "Land banking is the structural acquisition and temporary management of land in Rural areas by an impartial State agency, with the purpose to redistribute and/or lease out this land with a view to improve the agricultural structure and/or to re-locate the land for other purposes with a general public interest". Land bank help as instruments for solving the problems that may arise during a land consolidation project and provide land to fragmentation problems: they facilitate and balance allocated values and allocation claims (Jansen et al., 2010).

Land banks helps to transform land in terms of 1) place: one can sell in one location and buy in another location; 2) quantity: small parcels can be joined to larger parcels; and 3) quality: one can sell or give an amount of lower quality land in return for a smaller quantity of better quality land and vice versa. In addition, in land consolidation projects land bank can have a function as a land exchange bank and as a mediator in the transfer of use and ownership. For instance, If only two people exchange or buy and sell land; there are limited possibilities between these two parties. With a larger, well-managed land bank, there are many possibilities. The land bank 'combines' the land of many owners and can make much more combinations with the land available temporarily (Jansen and Wubbe, 2012). In land consolidation, a land bank can work as (Jansen and Wubbe, 2012):

- People agree to put their land, or part of their land into the land bank against certain conditions
- Landowners like to sell (a part of) their land to a land bank
- The land bank combines the parcels in the best way as much as possible according to the wishes of the Owners or users
- With the land the land bank has bought, there are new possibilities of exchange with the other owners
- The land bank gives parcels back to people in return of certain conditions
- The land bank sells the land to new owners according to the exchange plan
- Involving land-banking parcels can improve effectiveness in voluntary exchanges

2.5. Land consolidation and implementation in Europe

Many Western European countries have a long tradition of land consolidation. For instance in Denmark a land consolidation program started more than 200 years ago with the beginning of 1780s land reform: common use of agricultural farms was displaced by private ownership and private family farms were established (Hartvigsen, 2005). However, modern land consolidation practice emerged after World War II: the quality of rural and urban standard of living changed all over Europe (Thomas, 2006b).

Today, in majority of the European countries, land consolidation is one essential tool and an integrated part of a broader rural development (Hartvigsen, 2005). According to Thomas (2006a, 2006c), the Western Europe countries have different objectives to implement land consolidation, for instance "improvement of production and working conditions in agriculture and forestry, improvement of the

general use of land in rural areas, maintenance of existing and creating new employment in rural areas, improvement of the livelihoods of the rural population, and conservation and protection of the natural and cultural legacy". Hence, many projects are broadly executed in Austria, Belgium, France, Germany, Luxembourg, the Netherlands, and Switzerland, as well as in Finland, Norway and Sweden aim to readjusting unnecessary land division and promoting appropriate use of real property without changing the status of ownership. Even more, land consolidation had already been conducted in western Europe on an area of 38 million hectares of land (Vitikainen, 2004). Thus, it shows many changes in different conditions such as prosperous and efficient agricultural sector and strong economic development of rural area (Lemmen and Sonnenberg, 1986).

Several Western European countries have compulsory or voluntary land consolidation practices. For instance, in Denmark, land consolidation projects are executed voluntarily. Voluntary approaches are very important to understand the background and recent history of the countries and it's a good way to build up the necessary trust between the local landowners especially for pilot projects. In other countries, such as Germany, the Netherlands and Sweden the system of land consolidation can enforce the majority of the land owners against their need. However, only a small number of land owners are compulsory participants (Grossman and Brussaard, 1989).

The last year experiences in West and Eastern European countries with land consolidation demonstrate that land consolidation can be an effective and active tool to address the problem of land fragmentation and small farm size. In addition, it also an essential instrument for sustainable rural development. It includes improvements in agricultural production, employment, infrastructure, public facilities, housing and the protection of natural resources (Vitikainen, 2004).

However, land consolidation as a solution to address the problem of fragmentation is different from Western and Central European countries, i.e., Western Europe countries have been run-through only the problem of farm-size and internal fragmentation which one farm is divided in to too many parcels (i.e. number of parcels exploited by each user) and farm size problem (i.e. too many farmers in each square kilometre). However, Central Europe countries faced another types of fragmentation problems such as high numbers of owners and use fragmentation (i.e. large gap between ownership and use) (van Dijk, 2003). Therefore, the differences forced Central European counties to look for other alternatives and select appropriate instruments rather than land consolidation. Land consolidation seems to be a poor match with the Central European situation. For Central Europe, applying land consolidation is complicated and required willingness to the owners and/or users to invest in better parcelling situation, since most of the plots can have family property and the farmers have a strong bond with their land. It makes exchanging of parcels a more sensitive issue than in Western Europe. However, the situation that Western Europe used as a solution for farm size problem is land banking and it also found a better match to solve the problem of both farm size and segregation of use and ownership in Central Europe, since land bank acquire and redistribute parcels to owners or occupiers for farm enlargement as well as it reduce the gap between ownership and use by selling the parcels to the existing users. Thus, van Dijk (2004) concluded that "land banking is generally speaking makes a better match with the Central European land fragmentation than land consolidation does".

2.6. The history of land consolidation in the Netherlands

Land consolidation in the Netherlands started before 100 years ago without any law: farmers were exchanged parcels to improve their farm land. After World War II, the Dutch government introduced land consolidation to create effective agricultural sector. Meanwhile, land consolidation highly contributed to the desired objective. Thus, the processes of land consolidation were arranged by law. However,

farmers did not consider land consolidation: they thought land consolidation as something that just happened to them and they refused the process. Hence, between 1946 and 1957 request from the farmers for land consolidation decreased from 25% to 4%. In 1970 the ideas among land consolidation changed and the Dutch countryside was starting to change from a pure agriculture to other functions such as nature or recreation. Accordingly, the Land Consolidation of 1954 changed into the Land Use Act (Bergh, 2004).

Land development projects during the year of 1985 touches over the half of Dutch. By the end of the year 1985, 345 land development project had been completed on 837,000 hectare, another 110 project involving 663 hectare were in progress with other 71 project involving 374 hectare in preparation and project had also been requested for additional land. Moreover, other significant numbers of hectares are scheduled for land development. Comparing to other countries which are already implementing land consolidation, the Dutch land development is executed and still executed in a highly comprehensive and expensive manner, since the average Dutch project involves 6000 hectares relative to 1500 in Belgium and 800 in West Germany. As a result, the process presents a highly fascinating process for developing favourable agrarian structure and solution to problem of distorted farmland parcelling when a major infrastructural development like a highway encroaches into agricultural Region (Grossman and Brussaard, 1989).

In the 1990s voluntary forms of re-allotment came (back) into practice and Voluntary re-allotment was established. The process was based on voluntariness. After 2000, most of the large land consolidation projects under the Land Use Act came to an end. However, there are still a few projects still running from 1980ies and 1990s (Rienks et al., 2009). For instance, in 2012, there were 14 projects running, in an area of 212.000 ha (Kadaster, 2012).

In 2007, the Reconstruction Act of 1985 was replaced by the Law on the development of rural areas. Rural Areas Development Act provides two instruments to achieve goals that are formulated for the development of rural areas such as legal land consolidation and voluntary re-allotment. The legal land consolidation has a mandatory character and it has more certainties in achieving multiple goals, compared to the voluntary forms of land consolidation. During voluntary forms of land consolidation the participation was carried out voluntarily and based on the wishes of the farmers (Kadaster, 2012).

In general, according to vein den Brink et al. (2004), in Netherland two different planning systems co-exist: the Dutch system of spatial planning which is always focused primarily on the urban domain and the agricultural land consolidation for rural land use. This traditional re-allocation of land is under pressure because of far-reaching consequences of land consolidation which is used for a wide range of functions in rural areas and urban fringe zones as instrument. This is due to the dominant urban – rural discourse that does not match the prevailing situation such as the complexity of institutional structures and the density of interaction with and between authorities, shareholders, stakeholders and experts. Currently, on the other hand, there is a trend towards a more comprehensive approach to both urban and rural planning, which can be described as metropolitan landscape planning.

2.6.1. The objectives of agricultural re-allotment in the Netherlands

The Dutch government adapted different measures to achieve agricultural objectives includes improvement of position of agriculture and horticulture, improvement of income, improvement of working conditions, improvement of water control, improved parcelling situations and an efficient use of ground, safe and effective access to the rural area. In addition, it also includes improvement of infrastructural facilities to the development of rural area as well as improvement quality of village life.

Other objectives are improving quality of landscapes, safeguarding development, and managing natural area and cultural and historical features. These objectives can be implemented for a specific land development project which is planned to solve problem caused by the existing land arrangement for the function of country side. To achieve these aim and objectives, the Dutch government involved to a land development activity on average of 36,000 hectare pre year under the land development act (Grossman and Brussaard, 1989).

2.6.2. Strength and weakness of agricultural re-allotment in the Netherlands

According to (Damen, 2002; Grossman and Brussaard, 1989; Kool, 2013) agricultural re-allotment in the Netherlands has the following strength and weakness.

Strengths	Weakness
Acceptable according to the farmers	Rapid decrease of nature and landscape values
A much faster adjustment of agricultural structure to new technologies and make farming more efficient	Overproduction at the cost of environment and bio-diversity
The presently resulting prosperous and efficient agricultural sector	Large projects brought long implementation periods and high overhead costs.
Offer farmers the possibilities for high income and improved working conditions	Integration with deeper drainage caused gradual drying up of nature areas
Large and more rationalized shaped parcels located to the farm stead	

Table 2. 1 Strength and weakness of agricultural re-allotment in the Netherlands

2.7. The concept of agricultural re-allotment

Land re-allocation can be divided into two sub process such as land redistribution and land portioning (Demetriou et al., 2012). Land redistribution involves restructuring the land tenure based on legislation and other related documents that set out the principles governing this restructuring, rules of thumb and the experience of the planners. These factors are varying from country to countries. The output of this process is the preliminary plan which divides the area to be consolidated into land blocks and it also the input to the second process that comprises land re-allocation, i.e. land partitioning. Block-unit is a part of the land development area which contains the same type of land use, quality of the soil and it is often delimited by larger roads and waterways. The surface area and allocation value is determined for each block (Kik, 1990). The second process is land partitioning (re-parcelling). This process involves the subdivision of land into smaller 'sub-spaces' (i.e. land parcels) to produce a final re-allotment plan (Demetriou et al., 2012).

The re-allotment plan is influenced by different conditions such as country planning policy of the government, the view and wishes of owners and users, the situation in the train, the agro technological works, and also the management of agrarian establishments (Buis and Vingerhoeds, 1996). In addition, the design of re-allotment plan needs detailed and accurate information about existing parcelling situation. As Lemmen et al. (2012) summarized from different authors, and adapted here, design process may include:

- The representation of existing situations: existing ownership and land use (including mortgages, easements, informal rights that are not yet registered) and transactions there on, the allocation

compartments, the traffic network, tree stands, nature elements, the valuation (based on uniform fertility), and the structuring of values for allocation purposes, can all be considered.

- The representation of preferences of entitled parties: This concern new parcel relations i.e. the Persons-Group Persons-Rights: this can be very complex during the design process due to on-going land market, since entitled parties directly related to the Implementation of spatial planning; land market is on-going while the design of the intended situation for implementation in the field is being prepared.
- The design of new situation: this includes the results of the algorithm. This may need the interaction between land consolidation data base and model applied. Hence, the design needs to be changed to a new cadastral situation. .
- Survey data, this concerns both acquisition and management of boundaries to be implemented (set out) in the field

The process of re-allotment carried out by employing different software and/or algorithms. For instance, computer-aided design (CAD), a geographical information system (GIS) or a surveying engineering application and re-allotment algorithms such as Steeping stone algorithm, Transportation algorithm applied for the re-allotment calculation (Demetriou et al., 2011; Lemmen et al., 2012). The re-allotment calculation is determined based on the demand and supply of land. Thus, it is necessary to know where the land is in demand and where the land is available. The demand for land is claim for re-allotment of an entitled party, which is referred to allocation value. Allocation value is the total exchange value for each farm; Actual land use or holding in terms of owned or lease estate is taken as the reference. Value allocation plan is the first step in creating a design of the allocation. The demand for land is concentrated at the location of farm building. The supply of land is referred to the land available for re-allocation, which is called re-allotment space or block unit (Lemmen and Sonnenberg, 1986).

During the design of re-allotment plan, priority is given for farm parcel. Hence, farm parcels are designed before field parcels, since farm parcels has a set of locations and the protection of the existing farm parcels is a strict guideline during the re-allotment process. This limits the number of design alternatives for this kind of parcel. In addition, the design of both farm parcel and field parcels can be divided into two separate processes such as locating of parcels and shaping of parcels. Locating of parcel means appointing parcel, present in the before situation to form the basis of the shaping procedure. Shaping of parcel consists of expanding or dividing up the existing parcel. The necessary action determined by the difference in size between existing and desired size of parcel according to the value allocation plan. Therefore, the field parcels are located and shaped after all farm parcels are located and shaped (Buis and Vingerhoeds, 1996).

2.7.1. Summarized technical steps for designing re-allotment plan

The summarized technical steps for designing re-allotment plan as it is adapted from Rosman (2012)

1. Collection of data of the existing situation (ownership, tenancy, soil quality etc.)
2. Drafting of lists, maps of owners and parcels for public inspection and preference hearing,
3. Collection of preferences of land users (in a research project this can be simulated using models),
4. Elaboration of the value allocation plan,
5. Design of the parcellation by fixing parcels locations and formation of boundaries,
6. Drafting of lists of entitled parties, parcel maps etc. for public inspection and Preparation of legal document.

2.8. The re-allotment algorithms

The design of re-allotment plan supported by computerized design and calculation method (Lemmen and Sonnenberg, 1986). Many re-allocation algorithms are developed in diffident countries by different scholars in support of re-allocation plan. For instance, Finland (Tenkanen, 1987), Germany (Hupfeld, 1971; Schrader, 1971), The Netherlands (Kik, 1971, 1979; Lemmen and Sonnenberg, 1986) Turkey (Ayranci, 2007) etc.

The re-allotment algorithm can made by heuristic approaches which is based on experience from manual approach and or optimization approaches that are mostly based on linear programming with distance reduction and maximization of concentration of lots. Steeping stone algorithm, transportation algorithm, mixed integer programming, simplex method are some of re-allotment algorithm used in computerized design and calculation method (Lemmen et al., 2012). Some of re-allotment instruments which are used in the Netherlands are listed below.

2.8.1. Stepping stone algorithms and systems

In optimization approach, stepping stone algorithms is one of the example provided by Kik (1971). In this method, factors such as number of plot are negligible and mainly based on the average distance. The average distance is minimized between the farms and allocated plots in the process. The disadvantage is difficult to understand by allocation experts. However, it was very useful in exploration of the possible effects and cost and benefits calculation of land consolidation during preparation phase (Lemmen et al., 2012).

2.8.2. Automation of the re-allotment plan for land consolidation (ATOR)

According to (De Vos, 1982) the so called Automation of the re-allotment plan for land consolidation (ATOR) is a pioneer implemented heuristic approach that concerns the administrative plan. This approach concerned on the persons to be allocated, the size of land and the place. The desired parts value, alternative locations and weights related to each location used as input data for ATOR. The total contributed value determines the allocation claim based on the calculation of input data. In addition, the division can be based on models. For instance, for near the farm house 65%, at distance 35 % or directly based on preferences the right holders. The preference represents the vision of farmer on the future of structure of the farm. Those data's concerns the demand for land. Supply of land is represented by data on allocation compartment. Demand and supply for land should be in balance. Thus, land banks can be contributed to facilitate this process (Jansen et al., 2010). The ATOR system has proved to be useful in many land consolidation projects, since the method is based on manual approach and easily understandable by re- allocation experts relative to steeping stone algorithm (Jansen et al., 2010; Lemmen, 1990; Lemmen and Sonnenberg, 1986; Rosman, 2012).

2.8.3. Allocation and adjustment model (AVL)

According to Lemmen and Sonnenberg (1986) AVL which is abbreviated in Dutch also available in the allocation and adjustment model. In this approach, farm models are defined based on farm. Farm modelling is preference of parties for each farm alternative. AVL has more advanced functionality which is not possible in ATOR, i.e., the total contributed value for the farm is related to each farm models and the location within one farm model is flexible within given margins (Lemmen and Sonnenberg, 1986). For instance, in ATOR it is not possible to put 55-75% nears the farmhouse and 35-55% at distance. The goal of the system is to select as many as farm models with a high priority as possible. Thus, the AVL system is very flexible in representation of preference of entitled parties. However, due to the applied of algorithm i.e. mixed integer programming with a comprehensive mathematical model, it's difficult to understand for re-allotment experts. The system has been used in few re-allocation projects but is not further operationalized.

2.8.4. TRANSFER

Currently, the ATOR system has been developed into the system called TRANSFER. This system combines the benefit of both ATOR and AVL. Which means the system can use the heuristic approach from ATOR combined with flexible parcel-values as in AVL and it makes the approach easy and usable in practice. The TRANSFER system has been applied very successfully, since in many years land consolidation projects in the Netherlands and operational now in the Dutch Kadaster as a basic re-allocation algorithm for formal land consolidation programme (Rosman, 2012).

2.9. GIS enviroments for land re-allotment

One of the land consolidation instrument used in the Netherlands is a voluntary based re-allotment that used to improve agricultural structure in an area on a voluntary basis. MapInfo, ArcGIS, ArcView and Geo-Media together with Access database are the main designing tools used to perform the re-allotment process. During the process, public meeting and interactive group sessions are prepared to inform the land owners and to design new re-allotment plan. Hence, participants are selected in project areas, geo data's are prepared, and participants are divided in to smaller group of parallel session. While, the participants are asked to indicate if the parcels are available for re-allotment (yes/no), regarding their wishes to the new allotment and discuss possibilities for exchange. In addition, the owner differentiates their own plots and prepares the re-allotment plan together with the re-allotment expert. Then, the expertise digitized the area based on the wishes of the land owners on real time. Within a short time, the result is available and each land owners receive a map and the re-allotment plan prepared based on their wishes (Louwsma, 2013; LTO Nederland, 2013).

2.10. Conclusion

The land tenure system in Ethiopia can be considered through chronological lenses: pre 1975, 1975 to 1995 and post 1995 (Nega et al., 2003; Teka et al., 2013). All of these different land tenure systems are the main source of structural problems of subsistence farming in Ethiopia. Specifically, the current land tenure systems is one of the root causes for poverty, food insecurity, and limited access for citizen on land and the reduction of agricultural productivity.

In such kinds of land tenure systems it is difficult to improve infrastructures and perform environmental protections for sustainable economic growth, social development and sustainable rural livelihood. To combat such kinds of problems there is need for all-inclusive land management approaches that can be broadly applied in economic and social reform. This all-inclusive method of land management should include the land tenure, land use, land value and land development functions. It also should include a land banking system that helps in solving problems by providing land in case of fragmentation problem.

Land consolidation is one of the all-inclusive methods that can be used to overcome such kinds of problems in the society. Land consolidation is successfully implemented in Europe; especially the Netherlands land consolidation method is one of the best practices implemented in the country. In Europe, land consolidation is done in compulsory or voluntary basis depending on the countries policy. Land consolidation can be applied in urban settings or rural settings depending on the purpose of the application. Land consolidation in rural application is considered as a means of rural development to adjust the agricultural structure to new technologies, which results a prosperous and efficient agricultural sector and strong economic development in rural area.

Land consolidation has its own strengths and weakness. Most of the countries illustrate the strength and improved the agriculture, income, working conditions, water control, parcelling situation and access to the rural areas. Currently land consolidation is not implemented separately for rural and urban application.

Some of the advanced countries in land consolidation such as the Netherland take a step towards to a comprehensive approach land consolidation to both urban and rural planning, which can be described as metropolitan landscape planning for better management of resources. Land re-allotment is implemented in different countries using different re-allocation algorithms such as the Stepping stone algorithm, transportation algorithm, mixed integer programming, simplex method and TRANSFER which is the benefit of both ATOR and AVL algorithms. These algorithms differ in usability, simplicity or complexity, performance and selection of criterion's to perform the re-allocation. In addition, especially in the Netherlands, GIS tools including MapInfo, ArcGIS, ArcView and Geo-Media together with access database also applied as a main re-allotment instrument for voluntary re-allotment process.

3. RESEARCH METHODOLOGY

3.1. Introduction

This chapter described the approaches used for the collection of data required for the research in order to achieve the overall objectives of the study. This chapter has three phases. The first phase was the data collection and analysis phase which was used as the main input during the design of the re-allotment plan and also to answer some research questions. The second phase was the design phase which was the main part of the research and used to achieve the main research objective of the study. The third and the last phase was the evaluation phase in which the design method was evaluated using different evaluating criteria. The aim of this chapter is to illustrate how the research methodology was designed and enables the achievement of the study. The descriptions of each method were illustrated in different sections of the chapter.

3.2. Overarching research design, approach, and techniques

The research was initiated with a literature review in relation to the objective. The review was carried out with the purpose of establishing a theoretical framework to more fully understand the concept of land consolidation particularly agricultural re-allotment practice in the Netherlands to adapt and apply re-allotment approach in the Ethiopian context. In addition, primary data from sample households, and governmental representatives were collected. Applicable software and/or algorithm were identified for the designing of the re-allotment plan and finally evaluation criteria were used to evaluate the results. The process of the research approach is illustrated in the Figure 3.1.

The attention of employing qualitative and quantitative methods in research was increasing among researchers. It allows benefiting from the insight that the two methods provide clarity when used in combination. In addition, the combination of qualitative and quantitative components was one of the most effective evaluation researches (Babbie, 2012). Thus, in this study, both qualitative and quantitative research methods were used as a research approach. Qualitative method was used to collect data relevant to the perception and willingness of farmers and other governmental bodies on re-allotment of farm plots and farm houses (i.e., agricultural re-allotment) and other basic information using semi structured interview and questioner. In addition, quantitative method was used to collect data on land holding size; number of plots per household, plot distance from main residence area, and plot distance from the main road from the sample households. This data's were collected to accomplish the first phase of the research and to create qualitative and quantitative input for the design phase, which was a separate process to data collection.

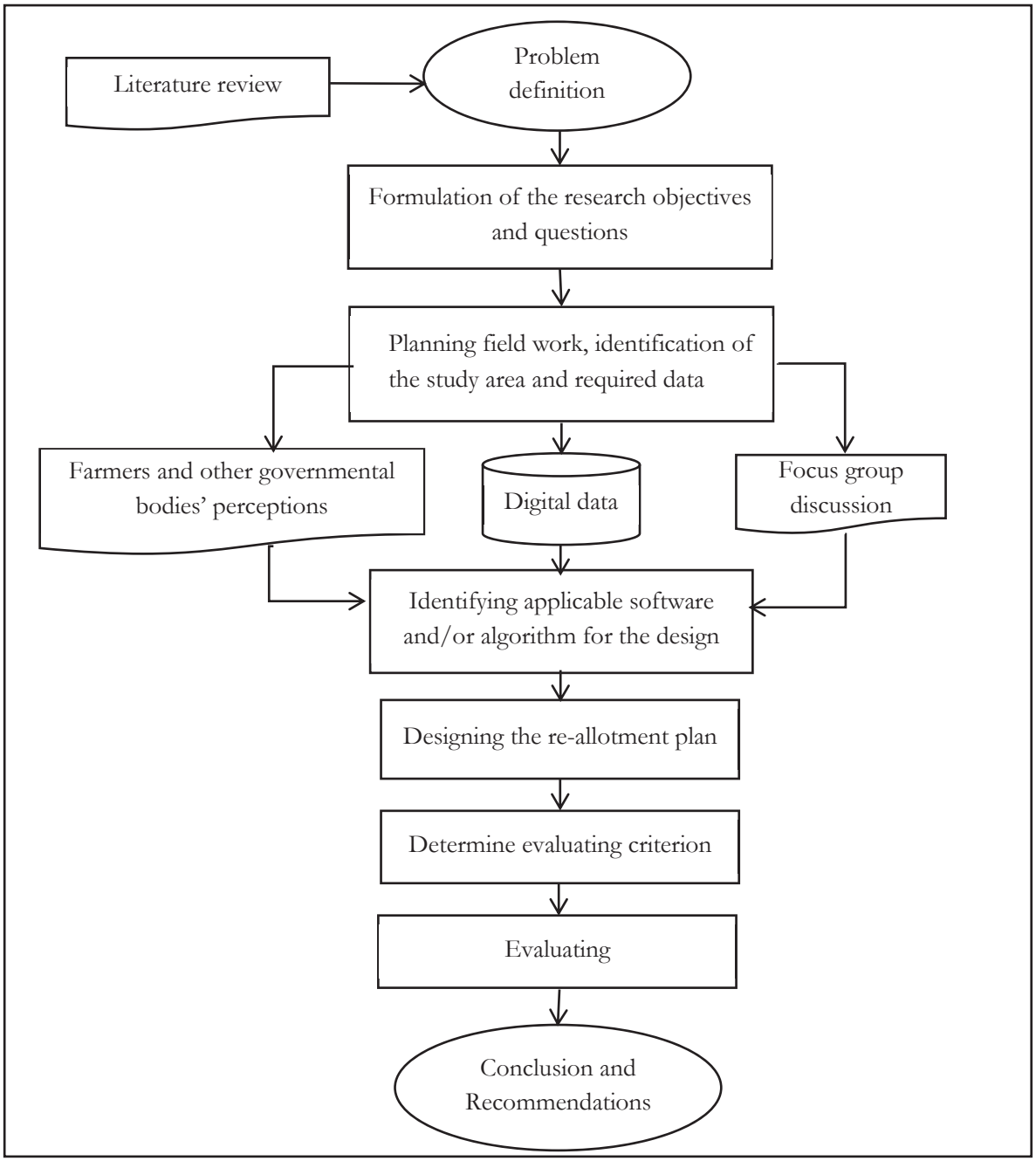

Figure 3. 1 The research design

3.3. Data source and acquisition method

To adapt land consolidation tools for the Ethiopian rural setting, to address the problems caused by current land tenure system, to participate farmers and fill the knowledge gap about the agricultural re-allotment and to indicate the adapted design/method fill the gap, the study was based on both primary and secondary data. Primary data was collected through survey. Secondary data was collected from governmental organization at Federal, Regional and Wereda level. The source and method used to obtained data for this research are described below.

3.3.1. Primary source of data

Most of the data required to answer the research questions were collected from primary source through depth interview and questioner. These techniques were used to collect data such as land size, total land holding size, distance from the main residence, distance from the main road, problem of water, factors for low agricultural productivity and willingness for agricultural re-allotment.

3.3.1.1. Questioner

Primary data were gathered mainly through questionnaire. The survey captured information related to demographic characteristics, land holding size, number of plots, and plot distance from main residence, location of plot from the base map and farmers' willingness to reallocate plots of land. The survey was conducted in participatory approach through the study area base map. The household questioners are presented in Appendix – I.

3.3.1.2. Participatory approach

According to FAO (2003) participatory approach is one of land consolidation principle in which farmers participate in the preparation of detailed plan (re-allotment plan). Therefore, such kind of system allows the designer to meet farmers view. Hence in this research, a participatory approach was part of data collection method so as to conducting household survey as well as to design a re-allotment plan as a show-case after data collection. To make the collection of data participatory, base map was printed for the selected study area (refer Chapter 4). Hence, the sample households in the selected village would be able to identify their plots from the base map. The base map included different features like rivers and churches; these features were helpful as a reference for the farmers to easily identify their plots from the base map. In addition, guidance and brief explanation of the base map was part of the field work to assist the farmers to identify their plots, in the meantime each household were interviewed during identification of their plots. The Wereda Land and Environmental Protection office personnel were intended to support the participatory approach by explaining the household survey was for studying purpose and encouraging the farmers to participate during the survey.

For the household survey a total of 70 sample households were selected from the study village: 8 days were allocated to finish the collection process. The researcher spent total of 8 hours per day; 7 hours on site which included time to travel from one farm household to other, 30 minutes on average for interview and 1 hour to travel from the place where the researcher was located on to the selected village. The figures are presented in the following Table.

Total households	Total day	Total time per day	Total time on site per day	Average interview time	Total time travel to the site	Interviewed households per day
70	8 days	8 hours	7 hours	30 minutes	1 hours	10 - 15

Table 3. 1 Total time used to collect data from the selected village

3.3.1.3. Interview

Interview with three relevant Governmental bodies from Federal Minister of Agriculture, Regional Bureau of Environmental Protection and Land Administration and Wereda Land and Environmental Protection office were conducted in Addis Ababa and Bahir Dar and necessary information was obtained using semi-structured interview. The collected information included the current situation of rural land parcels arrangement, existing land tenure problems, the possibilities of re-allotment activity and the possibility of agricultural land banking in Ethiopia. The interview questions are presented in Appendix – I.

3.3.1.4. Focus group discussion

After field data collection in the study area, data storage and management; discussion with re-allotment expertise form the Dutch Kadaster was also conducted at the main office of the Dutch Kadaster in Apeldoorn, the Netherlands. The discussion used to select the applicable software's and re-allotment algorithms for this study and also to collect information about the Dutch land re-allotment experiences and obtained necessary information.

3.3.2. Secondary data

Secondary data was collected to analyse the possibilities of agricultural re-allotment practice and to design suitable agricultural re-allotment plan as a show-case. The secondary source of information include, cadastral data of the study village and different consultancy report such as assessment of rural land valuation and compensation practice, impact of land certification in Amhara Region, tenure and administration study and current version of IT strategy report in national rural land administration information system study (NRLAIS). A visit was made to Federal Minister of Agriculture, Amhara Regional Bureau of Environmental Protection and Land Administration, and Wereda Land and Environmental Protection offices. The reference materials includes journals, report, books, internet websites were also recognized as a main source of information. Moreover, previous research topics conducted in similar topic have been reviewed and these presumed to be the major source in supporting the concept of topic under study. The secondary data collected during filed work is presented in the table below.

No	Level	Data source	Type of data	Data type
1	Federal	Ministry of Agriculture	Consultancy reports	Hard copy
2	Regional	Bureau of Environmental Protection and Land Administration	Cadastral data	Topocad data
3	Wereda	Land and Environmental Protection Office	Cadastral data	Hard copy

Table 3. 2 Secondary data sources

3.4. Data analysis method

3.4.1. Qualitative analysis

The research strategies employed in this study combined both qualitative and quantitative methods. Qualitative data was gathered from the selected households and review of documents were compiled, organized, summarized and interpreted on the basis of agricultural re-allotment practice and its possibility.

3.4.2. Quantitative analysis

The primary data collected from the selected households was summarized by employing the so called SPSS statistical tool. During the process, descriptive statistical method was used to only analyse the major survey results. It should be noted that the result were only significant for the study area: they did not statistically describe the broader Amhara region or Ethiopian context.

3.5. The design method

3.5.1. Geo-database

Creating geo-database and database schema was the first step of the design process. Hence, Geographic Information System is an appropriate tool to collect, store, manage, analyse and display spatial data; the geo-database includes the plot and house of the farmers feature classes along with other auxiliary data were created using ArcGIS software. In addition, three different database tables were created i.e., person information database, owner database and user database. These tables were used to differentiate the owner of the plot, the user of the plot and the owner and user of each plot. While, each sample household farm plots and each sample household farm houses were digitized form the study area base map using ArcGIS software. Finally the plot and farmers house feature classes were joined with the created database tables to extract different information during analysis.

3.5.2. Adaption of the re-allotment approach

The study aims to adapt and apply a re-allotment approach by investigating agricultural re-allotment practices carried out in the Netherlands, focused on fit-for-purpose, nature friendly innovative tool which allows the land scape elements (i.e., vegetation along fence lines) on agriculture structure with distance reduction and maximization of concentration of lot. The GIS tool including MapInfo, ArcGIS, ArcView, and GeoMedia (Louwsma, 2013; LTO Nederland, 2013) were the tool used to design the re-allotment plan in the Netherland especially during voluntary re-allotment projects. Thus, the design of the re-allotment plan (show-case) was carried out in ArcGIS according to the investigation of agricultural re-allotment practice in the Netherland.

Hence, GIS was selected as a main analysis tool for this study, since it provides significant advantage and allow the user to store, manage and analyse data correctly, to easily update geographic information, modelling existing data and to make appropriate decision. In this study, GIS was used to analyse the information that was relevant to the design process as well as to incorporate the design and to implement the re-allotment plan. GIS shows characteristics that were useful when supporting the design as well as layout for the re-allotment plan (Essadiki, 2002; Essadiki and Ettarid, 2002; Essadiki et al., 2003). Moreover, plots were the central design element for re-allotment plan and the method combined different set of criteria to come up with the necessary design procedure, thus, specifically to reduce distance and maximization of concentration of farm plots.

The methodology used for the show-case consists of three main steps for simple analysis of agricultural re-allotment in GIS environment, which was inspired based on the Essadiki (2002); Essadiki et al. (2003) works on optimization of technical steps of rural land consolidation projects using a GIS; and exclusively by adapting the Dutch swapping approach (Louwsma, 2013; LTO Nederland, 2014) for voluntary agricultural re-allotment practice. The algorithm developed for this study was specific for Ethiopian case, since a single farmer may have more than one farm houses and the algorithm explicitly gave attention to these farm houses. In addition, re-allotment of plots should be done in the vicinity of farm houses and plots were concentrated with respect to those farm houses. At this end in the algorithm by Essadiki (2002); Essadiki and Ettarid (2002); Essadiki et al. (2003) were not considered the farm houses in its application. Thus, in this study the ranking for possible reallocation was ready for farmers that have more than one farm houses. In summary, the method was a process based re-allotment algorithm (Innovative Executable Procedure) solely designed (unique) for this specific study with different sets of proceedings which leaded to the same result (i.e., repeatable) if the users implement the same procedure.

The first step:

- Collect the farmers wishes based on the response of the farmers and the perspective of the researcher
- Set the criterion and determine the priority of the owners for re-allotment, which includes
    - ranking of each plot based on the criteria (determine the preferences)
    - assigned values to each ranked plots
    - calculate the value of rank for each plot and sum up by owner
- Determine the plots that would be relocated (i.e., low ranked plots that have no farm houses)
    - overlaying low ranked plots, and exclude common plots and farm houses by combining different criteria
    - calculate distance from farm houses and/or largest plots to the determined relocated plots

The second step:

- Exchanges of plots among the owners (the swapping approach), by allowing the land scape elements (i.e., vegetation along fence lines) in the study area as it presented. The steps includes
    - determination of re-allotment whether it was needed or not
    - determine whether the farmer has a house or not, to perform the re-allotment
    - exchange or reallocate the prioritized land owners in the possible shortest distance from their houses or largest plots

The third step:

- Identifying the newly relocated owners
- Mapping of the relocated designed plots with different colours like the Dutch approach

Moreover, the design of the re-allotment approach and implementation further expanded and briefly explained in chapter 6.

3.6. Evaluation

In order to choose the best practice and to carry out from the landowners' point of view, it is essential to have reliable fit-for-purpose methods to analyse the effects of land re-allotment. This observation brought up the need of the process of evaluating land re-allotment effects. This work was based on a study of the methods available for evaluating the re-allotment plan. The study focused on the evaluation methods used in the Netherlands.

The benefit resulting from land re-allotment should in all cases be greater than the costs and drawbacks. Thus, the study intended to determine the effects of land re-allotment and formulate a calculation method that can be used to help assess the possibility of agricultural re-allotment within the study area.

In the Netherlands, the cost-benefit analysis was carried out before and after completion of the Land re-allotment project, apparently for apportionment of costs. Most of the cost-benefit analyses take into consideration changes in: the area and shape of the plot; and the location and number of plots.

For this study, a cost-benefit analysis was not performed, since this was a case study, doing so was not feasible, and it lay outside the scope of the research. Instead, the evaluation analysis was based on measuring changes to location, shape, area and distance of the newly generated plots. Hence, the effect of re-allotment was evaluated in two different situations (before and after re-allotment) with the use of the following set of factors which offer significant advantages for landowners:

- Total Number of plots (i.e., including neighbouring plots) per landowner before and after,

- Total plot size before and after,
- Plot shape determination by the area-to-perimeter ratio before and after,
- Closeness of the plots to the farmer house before and after and
- Concentration of plots in terms of area-multiplied-by-distance from the farmer houses before and after

In addition, some of the questions such as:

- Is the situation improved after land consolidation? and
- Is the farmers are advantageous? Are also included in the evaluation.

3.7. Conclusion

The methodology was designed to achieve the research objectives and to answer the research questions. Hence, it was divided in three different phases. In the first phase; data collection and analysis phase, field data were collected from field survey through different data collection techniques including questioners, in depth interview and focus group discussion. Secondary data was also obtained from relevant governmental offices. In addition, a data base schema was created and all necessary data were managed in ArcGIS. The second phase was the design phase at which GIS was selected as a main re-allotment instrument to accomplish the design of the plan. The methodology used for the design consisted of three main steps for simple analysis of agricultural re-allotment in GIS environment, which was inspired by (Essadiki, 2002; Essadiki and Ettarid, 2002; Essadiki et al., 2003). The design method was a fit-for-purpose, repeatable and nature friendly innovative method, which allows the land scape elements in the study area as it presented. Their work on optimization of technical steps of rural land consolidation projects using a GIS underpinned the approach. Additionally, the Dutch swapping approach (Louwsma, 2013; LTO Nederland, 2014) for voluntary agricultural re-allotment practice was also adapted. The first step include collecting the farmer wishes based on the response of the farmers and the perspective of the researcher, determination of the sets of criteria based on the priority of the owners for re-allotment, and determination of the owners that will be re-allocated. The second step included; exchanging of the plots among owners and the third and the last step included identification and mapping of the new relocated owners' plots with different colours like the Dutch approach. In addition, the design of the re-allotment approach and implementation further expanded and briefly explained in chapter 6. Finally evaluating factors such as total number of plots (i.e., including neighbouring plots) per landowner, total plot size, plot shape determination by the area-to-perimeter ratio and closeness of the plots, concentration of plots in terms of area-multiplied-by-distance from the farmer houses and farmers advantage after re-allotments were used to evaluate the results of the show-case.

4. THE STUDY AREA

4.1. Introduction

This chapter gives a brief introduction about the location, administrative division, demographic characteristics, topography and climate of the Region and the description of the selected Fagetalakoma Wereda. It also briefly described the reason why the study area was selected for the new re-allotment design method.

4.2. Study area description

Amhara Region is one of the Regions in Ethiopia where rural land registration and certification has been carried out. This makes it appropriate to study the design of agricultural re-allotment plan based on existing farm land plots and farmers perception by selecting one village from the Cadastral surveyed areas. That is, data on land-use right boundaries is already available. Hence, Fagetalakoma Wereda was selected purposefully. In addition, accessibility and quality of the collected data were very necessary to achieve the objectives of this study. Thus, this Wereda was found to fulfil the necessary requirements.

4.2.1. Location

The Region of Amhara is located in the north western and north central parts of Ethiopia. The Region is geographically located between $8^0$36' N and $13^0$48' N latitude and $35^0$12' E and $40^0$24' E longitude. The Region shares common borders with the Regions of Tigray to the North, Afar to the East, Oromiya to the South, Benishangul/Gumuz to the South-West, and the Republic of Sudan to the West.

4.2.2. Administrative divisions

The Amhara Region is administratively structured into 10 zones namely Simen Gonder, Debub Gonder, Agew Awi, Mirab Gojjam, Misrak Gojam, Wag Himra, Simen Wollo, Debub Wollo, Simen Shewa and Oromia Zones. The administrative zones are further divided into 128 rural Weredas and the Weredas are subdivided into 3100 rural Kebeles which are the lowest administrative units in the Regional government structure.

4.2.3. Demographics

The population of Amhara Region in 2012 was estimated at 19.2 million giving an average annual growth rate of 2.3 per cent since 2007 census according to the Central Statistical Agency (CSA) of Ethiopia. The sex composition was 50.1 % men and 49.9 % women (CSA, 2012) About 88.5% of the population is estimated to be rural inhabitants, while 11.5% is inhabited in urban areas. With an estimated area of 170,752 square kilometres, the Region has an estimated density of 120.12 people per square kilometre.

4.2.4. Topography and climate

Amhara Region is topographically divided into two main parts, the highlands and lowlands. The highlands are 1500 meters above sea level and cover the northern and eastern parts of the Region. The highlands are characterized by chains of mountains and plateaus. For instance, Ras Dejen, the highest peak mountain in the country with the height of 460 meter found in this Region. The lowland part found with an altitude between 500-1500 meters above sea level and covers mainly the western and eastern parts of the Region.

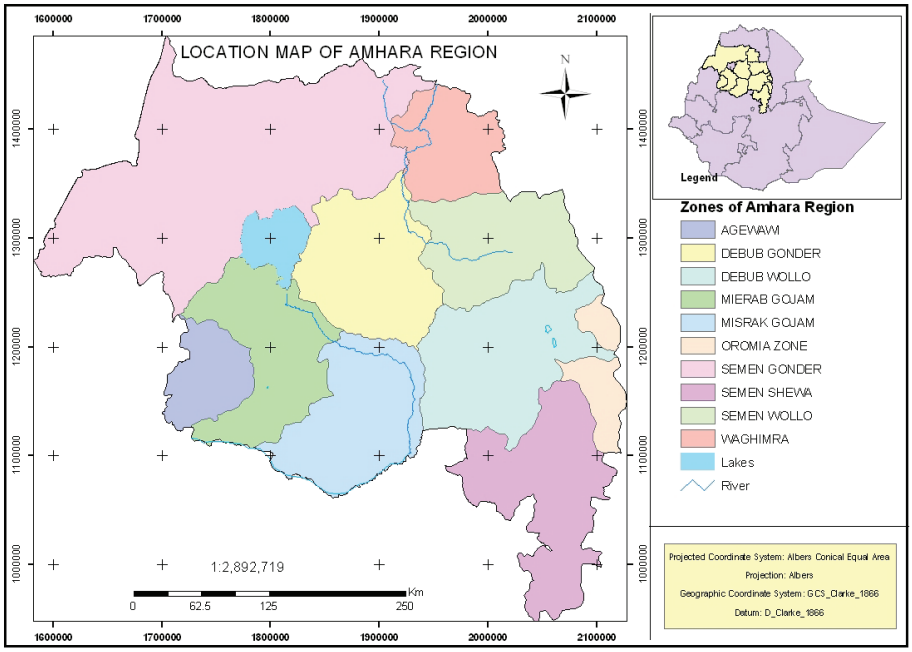

Figure 4. 1 Location map of the Amhara Region

The Region has three climatic zones such as "Dega", "Woina Dega" and "Kolla". The "Dega" zone found above 2,300 meters above sea level, the "Woina Dega" found between 1,500 - 2,300 meters above sea level and the "Kolla" zone found below 1,500 meters above sea level hot climate zone. These three zones cover 25%, 44% and 31% of the total area of the region respectively. The annual mean temperature of the Region ranges between 15^0C to 27^0C and get 80% of the total rainfall in the country. The highest rainfall occurs during the summer season, between which starts in mid-June and ends in early September. The mean annual rainfall recorded in the Region is the highest and in the range of 598.3 mm and 1692 mm (Actiontours, 2013; Ethiopian.gov, 2013)

4.3. Major economic activities

Agriculture is the main economic activity in Amhara Region. 87.4 percent of the household depend on agriculture only for their subsistence. The Region is one of the main staple foods -Teff producing areas in the country; barely, maize, wheat, oil seeds, sorghum, oats, beans and peas are major crops produced in large amounts (Ethiopian.gov, 2013). In addition, the lowlands of the Region highly produced cash crops such as sugarcane, sesame, sunflower and cotton. The water resources from Lake Tana, and including all rivers found in the Region have high potential for irrigation. According to BoARD (2008) "despite the potential for growing different crops in the Region, because of the population increase over the last thirty years farming practices in Amhara have largely been determined by the shortage of land and prevalence of very small holdings that have declined over the last decades". Low agricultural production, poor diversification and other income support options are also very low.

4.4. Wereda and Kebele description

4.4.1. Fagetalakoma Wereda

Fagetalakoma Wereda is one of the Weredas in Awi Zone of Amhara Region. The Wereda is sub-divided into 25 Kebeles. According to (CSA, 2012), Fagetalakoma has a total population of 129,650 of which male constitutes 49.6% and female 50.4%. From the total population 117452 (93%) reside in the rural areas of

the Wereda and engaged in agriculture. The Wereda has a total area of 61063 hectare, subsistence agriculture and mixed farming is carried out and crop production is the main income source followed by livestock production.

4.4.2. Tafoch Dambule Kebele

Tafoch Dambule Kebele was where data collected. In this Kebele, 70 households were selected for the household survey. All selected households are registered and have a certificate of land holding. Here, it is important to mention the level of certificate given to land holders. There are three steps in the certification process in the Region. The first one is the preliminary paper given to the landholder after registration. The second is primary book of holding granted to the holder with rights and obligation and holders photo attached to the certificate. The third one is secondary book of holding with map of the plot and necessary information attached to the certificate. In fact, secondary book of holding is not started in the Wereda. Therefore, all the selected households head have a primary book of holding and have a registration certificate, since the commencement of certification. This is because of uncertainty to identify the rightful landholder. However, the process is underway to provide the permanent certificate for the rest of landholders.

Land is the main economic asset for Tafoch Dambule Kebele. A large majority of the population is engaged in agriculture and subsistence agriculture and mixed farming is carried out. Crop production is the main income source of the rural households followed by livestock production. Farming practice in this Wereda has largely been determined by shortage of land and prevalence of very small holding that has declining over the few last decades. Moreover, the land is highly fragmented: on average one land holder can have more than 4 plots in different locations. The location map of the Wereda and the study Kebele is presented in the following Figure.

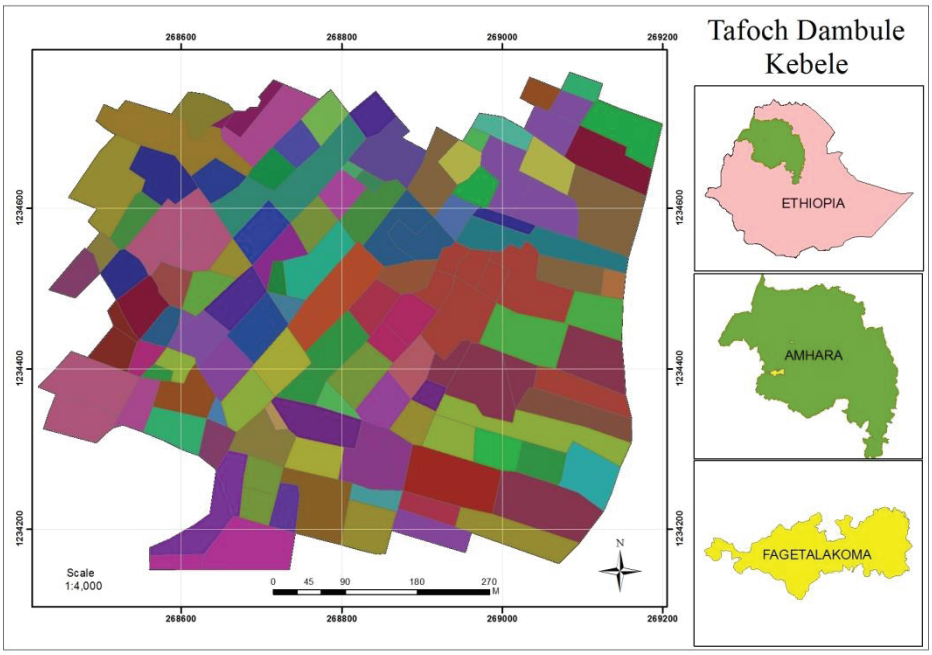

Figure 4. 2 Location map of the study Kebele and Wereda

4.5. Conclusion

The above description gives an overview of the location, population and economic activity of Amhara Region in general and the study Wereda in particular. The region has different agro ecological zones and land features which is suitable for growing a variety of crops and livestock production. Agriculture is the

predominant economic activity in the Region and Wereda, where about 87.4 percent of the households depend on agriculture only for their subsistence. Crop production is the main income source of the households followed by livestock production. However, Farming practice in this Wereda has largely been determined by shortage of land and prevalence of very small holding. Moreover, the land is highly fragmented. On average one land holder can have more than 4 plots in different locations. Thus, Tafoch Dambule Kebeleis was selected from this region for data collection and subsequent show-case of the reallocation design. In total, 70 households were selected and participated in the household survey. All selected households were registered and have a secondary book of land holding certificates.

5. EXISTING SITUATION: RESULT AND DISCUSSION

5.1. Introduction

This chapter presents the preliminary results of the study and was mainly based on the primary and secondary data collection and analysis. The chapter contains a section on the contextual information about the study area and a section and sub-section on preliminary results of the analysis of data that includes survey results on farmers' perceptions on their farm holdings, farmers' willingness for voluntary re-allotment and governmental officials' perception about the agricultural re-allotment plan from different offices.

5.2. Contextual information

Although the Amhara region seems to have high potential for agricultural, its infrastructure, socio economic development and social services like health, education, and water were found to be far worse in the Wereda including the study village. Agriculture is very dominant. Teff (staple food), barely, wheat, maize and wheat were major crops produced. However, farming was characterized by traditional methods with little surplus outputs. The ox-plough was highly used in the farming system; where oxen were less important for traction. Livestock provides a very important source of additional income via milk and meat production: livestock were the single most important store of wealth in the community. Basically, these smallholder farmers keep these domestic-animals for security purposes, mostly reserved for times of hardship so that they may sell them to buy food and other essential items. In some cases, these domestic-animals were reared as a small investment to enable farmers to earn extra income, since the size of their plots were not enough to produce more crops for local markets rather than their own consumption. Furthermore, the level of fragmentation of plots into two or three mini plots affects the quality of soils fertility and the economy status of the farmers. This was due to most of the households having many families and they were forced to subdivide their plots into another 4 or 5 mini plots according to the number of children they have. This process may not end until the next generation unless the number of unemployed people reduced or the number of plots and population is more balanced. Thus, it can be imagined that if the current level of farm fragmentation continues like this; the next generation will have much less or no farm plots to sustain life and to be self-sufficient. Therefore, the number of rural residents migrating to the urban areas for sufficient social service and other needs will increase drastically.

Figure 5. 1 The landscape in the study area - Left: farm fields with Teff crop and Right vegetation

5.3. Preliminary result and discusion

One of the main objectives of the study was to adapt and redesign an applicable re-allotment approach that suits the Ethiopian context. The results of the participatory approach, house survey, interviews with government officials and group discussion are now provided.

5.3.1. Results from participatory approach

During the participatory approach, at the beginning of the survey, there were some difficulties related to data collection. For instance, some peoples were afraid to providing the actual total size and number of plots they owned; some were not willing to locate their plots in the base map. One of the reasons was that the study survey was the first in its kind in the study area and there was knowledge gap in the community about agricultural re-allotment i.e., farmers were concerned about the re-location of their house and plots as if it was a new rule by the government and declined to give information about their perception. After detailed explanation of the aim and the purpose of the study, the sample households collaborate to provide the information required. Moreover, during the collection of the data, there were no overlapping claims from the sample households. Each household identified and located the farm plots owned only that were found in the boundary of the study village (i.e., there were some plots that were not located by the households because the plots were located out of the boundary of the study village).

Figure 5. 2 Farmers identifying the farm plots they owned

Figure 5. 3 The base map of the study area - Left: before delineation and Right: after delineation

5.3.2. Farmer's perception on the size of farm plot holding

To investigate farmer's perception on the size of farm plot holding, the following questions were raised to the study participants. level of fragmentation i.e. total number of plots and their size, distance form plots to the main residence, farmers willingness to relocate their plots and farm houses, the impact of re-allotment on agricultural productivity and the main problem for low agricultural productivity. The results are described in the tables below.

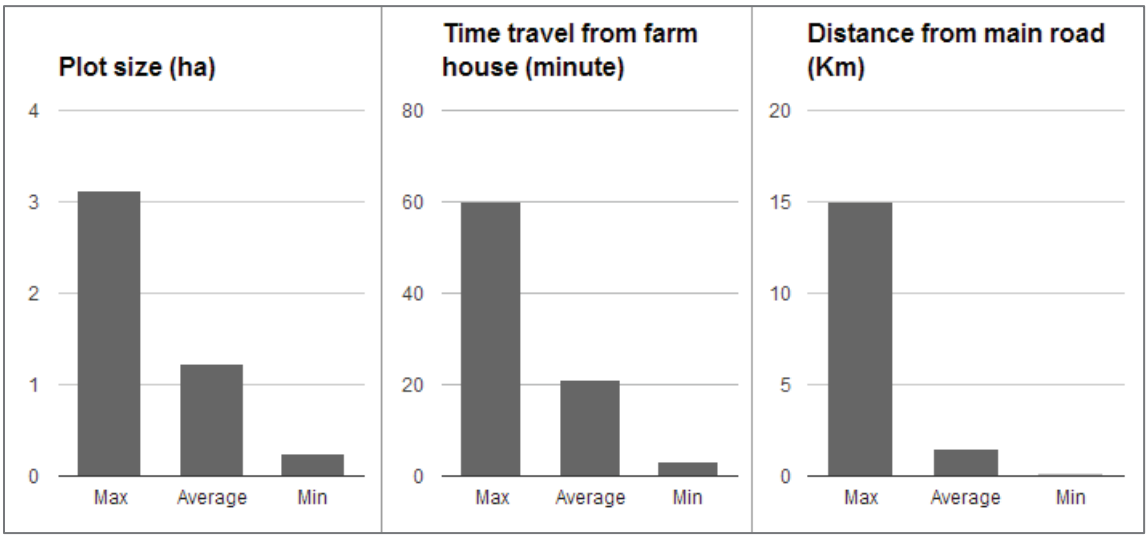

Figure 5. 4 Farmer's response on the plot size, time travel from farm house and distance from main road

The sample households' survey result showed that a single household may have an average of 4.75 plots in different locations. Figure 5.4 above shows, in the study area the maximum, average and minimum farm plot size was 3.13 ha, 1.22 ha and 0.25 ha, respectively. To reach at each of the plots from the main road one household may travel 15 Km on maximum, 1.5 Km on average and 0.1Km on minimum. A household may travel from their home to each plot 60 minute on maximum, 21 minute on average and 3 minute on minimum. According the responses of the farmers, the distance travel from one plot to the other was not considered as a problem, since they appreciate the current land plot arrangement in different places.

5.3.3. Farmer's perception on low agriculture productivity

Table 5.1 below indicates that the three most important reasons for low agricultural productivity were land shortage, shortage of water, and low quality of land. Sixty five or (93%) of the households said that land shortage was a serious problem for the reduction of their annual income, since they have very small size of plots and most of the households have many families.

NO	Assessment tool	Response	Frequency	%
1	What is the main problem for low agricultural productivity?	Land shortage	65	93
		Water shortage	53	76
		Productivity of land	39	56
		Land fragmentation	21	30
		Other factors (flood)	6	9
		Climate	1	1

Table 5. 1 Farmer's perception on low agriculture productivity

Shortage of water was the main reason for fifty three (76%) of the respondents. The sample households responded that there was no water source for irrigation purposes and mainly they practised rain fed agriculture in the village, which they described as difficult to become productive

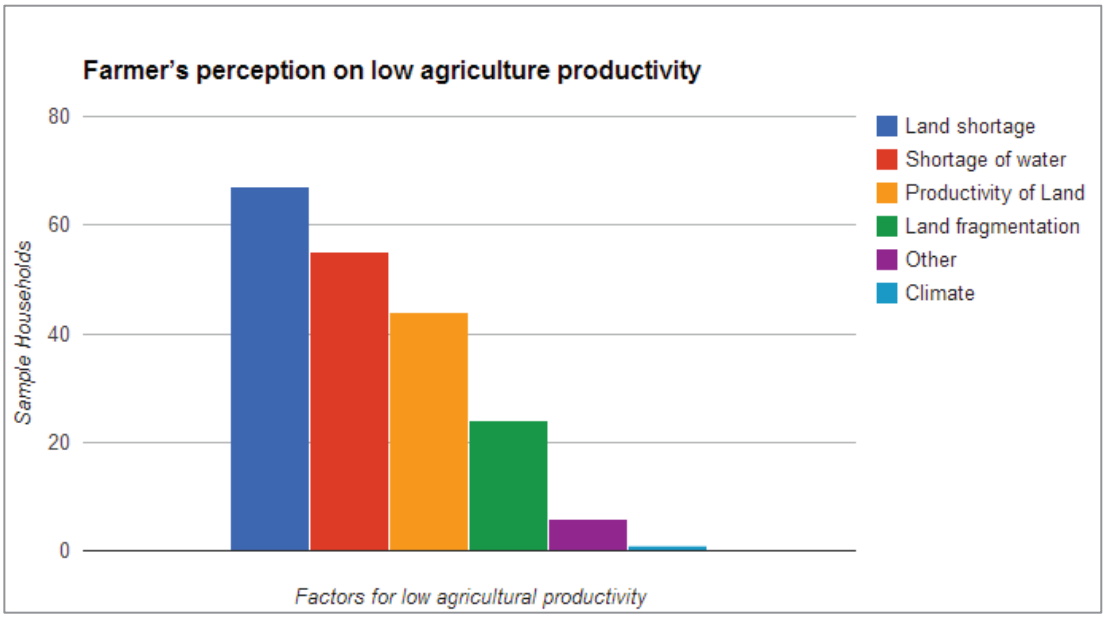

Figure 5. 5 Farmer's perception on low agriculture productivity

Thirty nine (56%) considered that low quality of land the reason for low productivity. They described that most of the plots were not even suitable to provide enough crop production and the quality of soil was different form plot to plot. Moreover, one of the reasons for half of the households not considered the re-allotment of farm plots was due to the differencing soils quality among the farm plots and they were not willing to exchange their plots among themselves. They want to make their plot productive on their own possession as it was.

Among the least acknowledged factors for low agricultural productivity was fragmentation of plots: most of the households appreciate the fragmentation of plots located on different places. The households reasoned out that fragmentation was providing them different farm plots with a variety of soil. In addition, the they mentioned that they were vulnerability to natural disasters (i.e., flood, wind) and fragmentation reduces the risk if the farm plot is located in different places and all the crops are not destroyed at the same time. Due to these reasons the farmers don't even consider the long distance travelled form one plot to the other plots as an issue. Generally there were three perceived advantages to land fragmentation: it allows for the use of several eco-zones, it permits crop scheduling, and reduces risk. In a place with important environmental variation, e.g. a mountain village, different parts of the community's land have unique micro-climates. Fields in different zones allow farmers to raise more kinds of crops.

A factor like flood was considered for low agricultural productivity by six (9%) respondents. In this case the flood and the climate were considered serious problems by the sample households. The last factor was climate which accounted for 1 % of the respondents. According to the response, there was no problem with the environment; the weather was good for crop production. More crops could be produced if the size of the plots increased and water shortage was reduced.

5.3.4. Farmer's willingness on agricultural re-allotment

Table 5.2 below indicates that all of the sample households have agricultural land. Out of 70 respondents only thirty one (44%) of them will consider re-allotment of farm plots. All households respond that the size of land holding was not enough to support their life. Fifty percent of the households did not consider land re-allotment as tool for the improvement of agricultural productivity as well as a means of rural development due to the problem of knowledge gap in the community i.e. the households feared that they would ultimately be evicted and become jobless due to farm mechanization facilitated by land re-allotment. In addition, half of the households accept the way of fragmentation due to their own reasons as mentioned in section 5.3.2.

No.	Assessment tool	Measure	Frequency	%
1	Do you have agricultural land	Yes No	70 0	100 0
2	Do you believe your land holding size is enough?	Yes No	0 70	0 100
3	Are you willing to participate in the re-allotment?	Yes No	31 39	44 56
4	Are you willing to re-locate your farm house?	Yes No	3 67	4 96
5	Do you believe farm re-allotment can improve your existing farm productivity and investments on your farm?	Yes No	35 35	50 50

Table 5. 2 Farmer's willingness on agricultural re-allotment

Further hampering potential use of re-allotment, all sample households would not consider re-allotment of houses during agriculture re-allotment. This was because most of the households have settled in one place with their families. Their children have also built their own house around their family plots, since the plots were coming from their families either by inheritance or by gift. Moreover, the farmers have been settled in the village for a long time and have a very tight relationship with their neighbours. Thus, the farmers emphasize more on the social value and the relationship among their families and neighbours than adapting to a new potentially more productive environment. Even if social value was more important, they also say it was impossible to settle in other locations, since they don't have enough money or insurance to build new houses.

5.3.5. Governmental bodies' perception on the possibilities of agricultural re-allotment and land banking

The interview with three governmental officials from Federal Minister of Agriculture, Amhara Regional Bureau of Environmental Protection and Land Administration and Wereda Land and Environmental Protection Offices was held during the field work. The purpose of this interview was to investigate the perception of these bodies on the possibilities of agricultural re-allotment and land banking. The result is described below.

All of the interviewed officials mentioned that shortage of farm land is a serious problem for Ethiopian rural households due to the increasing number of the population and the number of unemployed people in rural areas. They also related that shortage of land was a cause for fragmentation of land holding, since most of the household give half or less than half of their plots to their children when they reach their working age and make their own families.

The officers noted that the Ethiopian government allow land consolidation on a voluntary base. However, the officers especially from the Wereda and Regional land office did not consider land re-allotment as a solution for the fragmentation of land and low agricultural productivity. The officers suggest that farmers can be more productive by using chemical fertilizers and producing more crops, even in small plots of land.

The official form the Federal Minister of Agriculture considers that land re-allotment can be a solution for current status of rural land parcel arrangement and problem of agricultural productivity. In addition, as a governmental body he believe that the re-allotment plan should be made not only on voluntary basis but also be made compulsorily, since the households are not willing to participate due to the variation of soil quality and knowledge gap in the community.

For the question how agricultural land banking is facilitated in the context of Ethiopian land policy, the respondents mentioned that land banking has already existed in Ethiopia. They also mentioned two kinds of land banking schema, the large scale land banking for large scale investors and small scale land banking which was used to transfer land holdings from a diseased person to other person. Moreover, all officers' responded, since agricultural re-allotment is not yet implemented in Ethiopia, it is beyond their mandate to suggest that the current land bank system is providing support to the land consolidation process.

From the Dutch land bank experience, successful implementation of land consolidation depends on land banking. To facilitate and incorporate land banking in the Ethiopian agriculture re-allotment plan, first, there should be a study that examines the existence of land bank in Ethiopia. Land banking already exists in the Ethiopian land policy. Currently the government of Ethiopia is not using the land bank for land consolidation purposes, since land consolidation is not yet implemented in the country. Instead, land banking is being used to provide large agricultural land for large scale investment to the foreign and domestic investors. There is also small scale land banking in rural areas of the country where land is reserved in land banking for short period of time. This occurs when the owner of the land has passed away and if the plots were vacant and not claimed by their immediate family members. In addition, the transferred time of land from the land bank to other persons was very short due to shortage of land.

Unfortunately, the current land banking system of Ethiopia is not multi-purpose and does not support the land consolidation process. This was one of the problems encountered in subsequent re-allotment plan of the study. The only possible solution to this problem depends on the implementation of the government land policy, when land banking is directed towards to multi-purpose functions that support land consolidation process.

5.3.6. Result from focused group discussion

During the discussion, the experts clearly described that there were two possibilities of re-allotment process applied in the Netherland's, either a voluntary based or formal land re-allotment. In voluntary re-allotment, the process was based on the wishes of the farmers, by preparing interactive individual sessions with farmer to design new allotment plan, and also as well by interactive group session to discuss the possibilities of re-allotment to their holdings and to design the new plan. Thus, the farmers prepare the re-allotment plan together with the experts. In formal re-allotment, the system did not exclude farmers form the process; every farmer must participate in the re-allotment, since the aim was to improve the situation of the farmers (the farm size) and/or to keep the same status of the farmers. Hence, if the farmers were displaced from their original places, the government give them comparable farm size to the displaced farmers. Moreover, the expertise mentioned that for the design of re-allotment plan different kinds of software's have been applied. These include the GIS tools such as MapInfo, ArcGIS, ArcView and Geo-

Media together with Access database for voluntary re-allotment. In addition TRANSFER was also applied for complex re-allotment especially for the design of formal re-allotment plan (Louwsma, 2013; LTO Nederland, 2013)

5.4. Conclusion

Although, agricultural land is the main means used to generate income for small holders' farmers, the shortage of agricultural land has become a critical problem for many rural households in Ethiopia. Hence, as the results showed from the total of 70 sample households, 100% of the respondents have land shortage. A single household has on average 1.22 ha of land. In addition, most of the plots were fragmented and not adjacent to each other. One household may have on average 4.75 plots in different locations and travel on average of 1.5 km from plot to plot. In addition, most of the households lead many families with mini and fragmented plots so that they got difficulties to earn extra income for local markets, rather produce for their own consumption only. However, only 44% of the households consider that re-allotment may improve agricultural productivity. The other 56% did not consider the re-allotment as a solution for the improvement of farm structure as well as agricultural productivity due to knowledge gaps in the community. The farmers also provide different reasons not to consider the re-allotment plan as a solution. The first reason was variation of soil quality from plot to plot. Farmers want to keep plots in different places because these plots have a variety of soils. The second reason was if the farm plot is located in different places vulnerability to natural disaster (i.e., flood, wind) is reduced: all the crops will not be destroyed at the same time.

Meanwhile, according to the responses from the governmental officers, the government of Ethiopia encourage land consolidation on a voluntary basis. Also, agricultural land bank exists in Ethiopian rural and urban areas. However, the existing land bank did not support a service for land consolidation like other European countries that already implemented land consolidation, since it was not multi-purpose. The only possible solution to this problem depends on the implementation of the government land policy, when land banking is directed towards to multi-purpose functions that support land consolidation process.

6. DESIGNED SITUATION: THE RE-ALLOTMENT APPROACH AND IMPLEMENTATION

6.1. Introduction

This chapter presents the criteria for setting the re-allotment plan, the detailed land owners' re-allotment procedures, and the results and evaluations of the results of the show-case. To achieve the design process, a geographic information system (GIS) was engaged as a solution; here the plots were considered as the central design elements. Hence, the plots were digitized from the base map of the study area and all necessary data management and analysis were carried out in GIS.

The re-allotment process was implemented by first considering the wishes (preferences) of the farmers. These wishes were collected from the sample households' interview and the researchers own perspective. Thus, the first requirement wish of the farmers was then, farmers want to keep plots that have houses on it. In addition, as a second wish, the farmers want to keep plots that are adjacent and connected to each other's. Lastly, third wish, farmers want to have plots that are near to their houses. To fulfil the wishes of the farmers, hence, different criteria were seated and applied to perform the re-allotment.

6.2. Criteria setting for re-allotment plan

Criteria setting for re-allotment plan were one of the steps of the re-allotment process. In this case, criteria were seated according to the objectives of the study by investigating the Dutch practices of re-allotment plan for agricultural land. This includes, differentiating the plots which cannot be exchanged (from the demand perspective, i.e., house plot), differentiating the plots which can be exchanged (demand perspective) and differentiating the plots that the farmer want to have from the demand perspective (Louwsma, 2013; LTO Nederland, 2013). Based on these perspectives, five different criteria were seated and ranks were given to each criterion. Every rank was attributed with a value according to its importance. Value was a numerical point given to each rank. For example, higher rank gets higher value (point) and lower rank get lower value (point). In this case, the maximum value appointed was 10 and the minimum 0. Moreover, the value of ranks of each individual plot was calculated and summarized by owners. Therefore, the determination of landowners plot value in the re-allotment process was based on the sum of each plots values according to the criteria rank. In this way, owners were ordered to give priorities for those plots having higher sum values in the process, while, plots that have lower sum values in the process used as a relocated plots to the higher ordered owners (Figure 6.5).

The first criterion was based on the plot that cannot be exchanged from all sample households; these plots were characterized by having a farm house on them. These farm houses were the main asset of the farmers; during interview, the farmers confirmed that they don't want to exchange these plots during re-allotment process. Thus, plots which have farm house were taken as a "plus-value" when the first criterion was seated and high rank was given to these plots in the process.

The second criterion was based on the sample household that has one or more plot(s) and plot(s) that ha(s)(ve) no farm house on them. It was the fact that some farmers have more than one plot and have no farm house on the sample study area. Therefore, it was necessary to include this criterion for re-allotment plan to include these specific owners to perform the re-allotment process.

The third criterion was based on the existing plots inside the "block"; i.e., all plots have to be benefited from road network available. Figure 6.4 (Right) shows, sufficient road infrastructures are existed in the study area. Therefore, the study area was partitioned in to four different blocks to facilitate the re-allotment process; and labelled as block-one, block-two, block-three and block-four based on the main road that cross the area. So in this study "blocks" were used to set the criteria for re-allotment plan.

The fourth criterion was seated based on the plots belonging to the same owner that were adjacent (connected) to each other. As a matter of fact, some of the plots owned by the sample households were adjacent to each other and priorities gave to these plots in order to add more plots in the vicinity that belong to the same owner.

For the fifth criterion, the soil class of the study area were included. It was based on plots that the farmers want to have in the existing dominant class of soil inside a "block". For this case the soil map of the study area was extracted form EthioGIS (Zeleke et al., 2007) database and applied the criterion setting. The soil map consists of two kinds of soil classes in the study area. The dominant soil class was Dystic Fluvisoil which covers vast area of the study area and on the other hand, the second soil class i.e., Chromic Luvisoil occurs in a few places.

To illustrate the existing situation of farm plots arrangement before re-allotment in the study area and the soil map of the study area, the following maps were prepared for visualization.

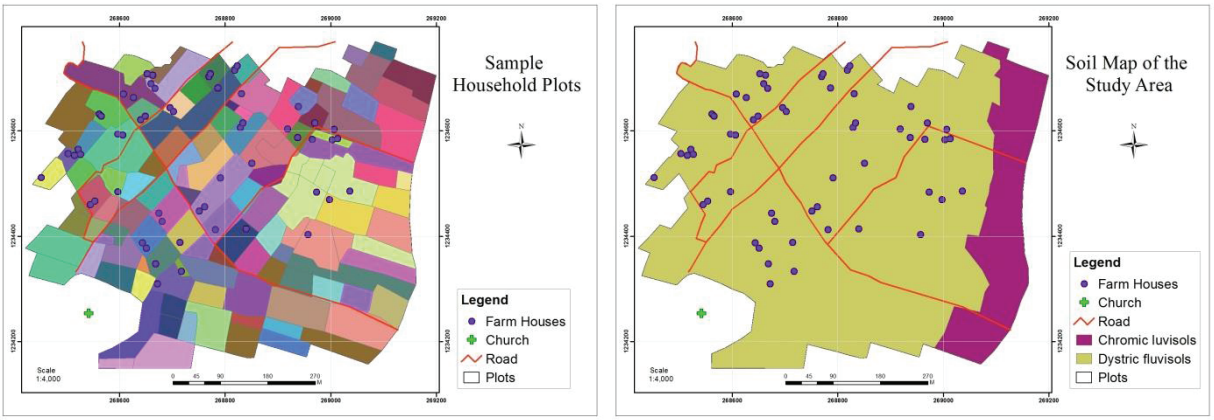

Figure 6. 1 Left: Sample household plots and Right: Soil map of the study area

As the Figure 6.1 shows the plots were classified into different colours; this was in according to the number of plots owned by a single household. From the total of 128 digitized farm plots, 41 plots were owned by 41 households, 44 plots were owned by 22 households, 12 plots were owned by 4 households and 20 plots were owned by 5 households. The remaining 11 plots were owned by other 11 owners who live outside the study village and used by other 6 households in the study village as additional plots. These plots (owned by others) were not considered during the re-allotment process, since the owners of these plots were not included and interviewed during the survey. According to the number of plots owned by a single household, plots owned by others and blocks created to facilitate the re-allotment process are illustrated in the figure below.

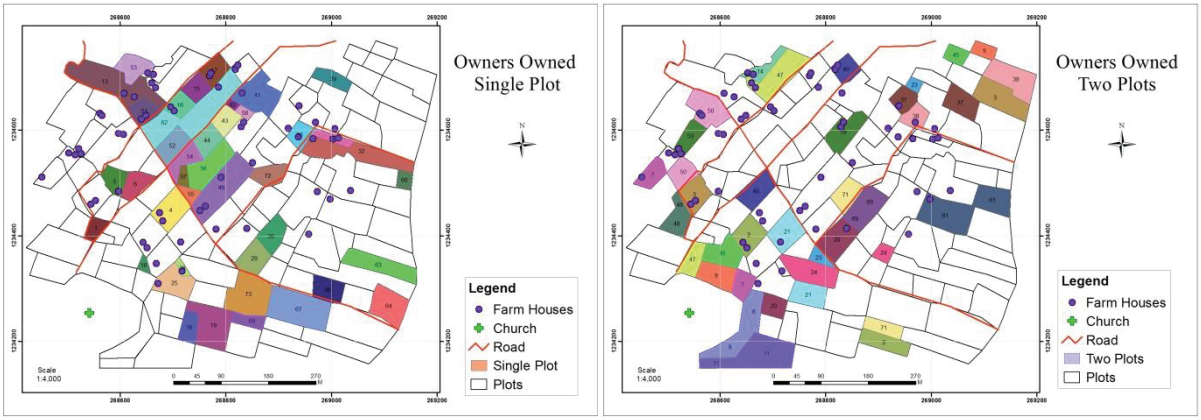

Figure 6. 2 Number of plots owned by owners (Owners by different colours owned one and two plots)

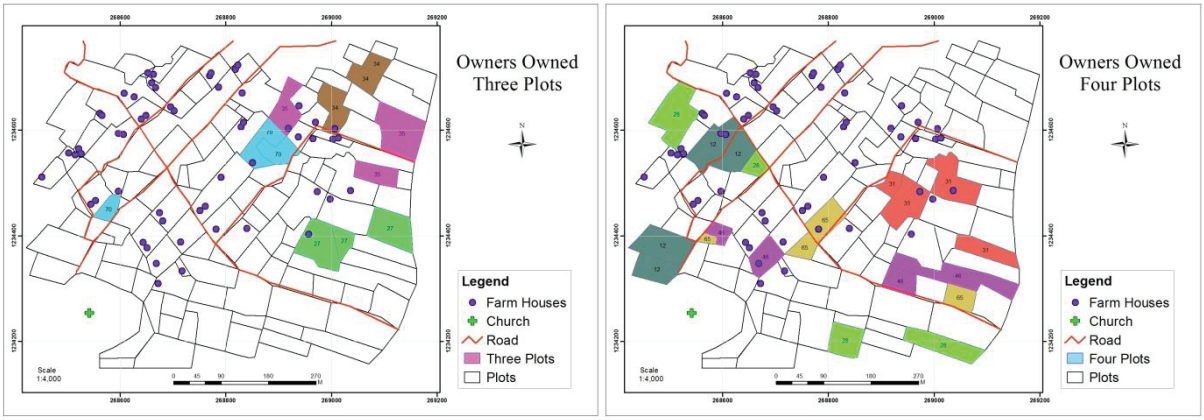

Figure 6. 3 Number of plots owned by owners (Owners by different colours owned three and four plots)

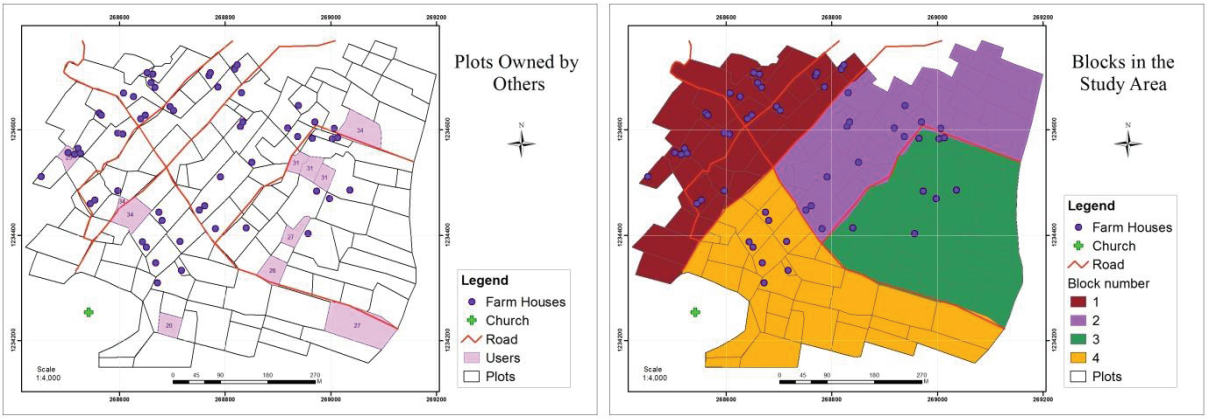

Figure 6. 4 Left: Plots owned by others and Right: Blocks in the study area

6.2.1. Criterion set

Figure 6.5 shows the detailed procedures, to set the criteria and to perform the calculation of the sum values per owners. The procedure used to prioritize the owners according to the value obtained, and to calculate the possible shortest distance from the farm houses and/or largest plots during the re-allotment.

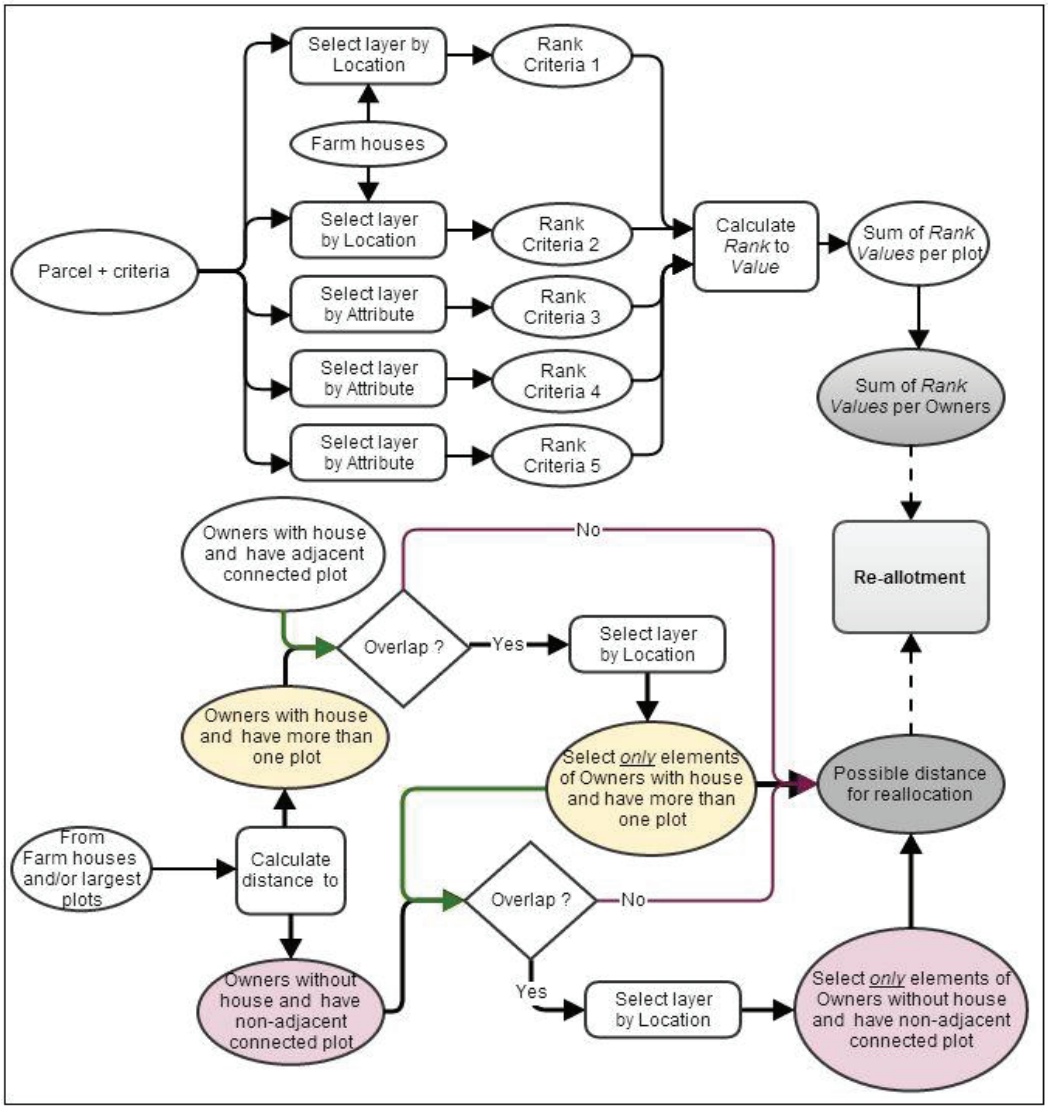

Figure 6. 5 Procedures to calculate the sum of rank values to owner and distances

Criterion 1: Plot that cannot be exchanged from all sample households (plots which have a farm house or a "plus-value") was seated as criterion 1. In the study area, some farmers' have more than one farm house in different plots, since enough land was not available for farmers and their families. Hence, they built houses on different plots from which they occupied. For this reason, the rank given to each plots depends on the availability of farm houses on each plot which belongs to the same owner. Higher ranks were given to the preference owners that have higher number of plots and houses.

Thus, the criterion was seated as when a farmer has:
4 plots and 4 houses - four houses on four plots and a house was located at each plot - Rank 1
4 plots and 3 houses - three houses on three plots and a house was located at each plot - Rank 2
4 plots and 2 houses - two houses on two plots and a house was located at each plot - Rank 3
4 plots and 1 house - a house was located on a plot - Rank 4
3 plots and 3 houses - three houses on three plots and a house was located at each plot - Rank 1
3 plots and 2 houses - two houses on two plots and a house was located at each plot - Rank 2
3 plots and 1 house - a house was located on a plot - Rank 3
2 plots and 2 houses - two houses on two plots and a house was located at each plot - Rank 1

2 plots and 1 house - a house was located on a plot - Rank 2
1 plot and 1 house - a house was located on a plot - Rank 1

Criterion 2: The sample household that have one or more plot and plot that has no farm house were seated as criterion 2. Higher ranks were given to the preference owners that have higher number of plots in the study area.

The criterion was seated as when a farmer has:
4 plots and has no farm house - Rank 1
3 plots and has no farm house - Rank 2
2 plots and has no farm house - Rank 3
1 plot and has no farm house - Rank 4

Criterion 3: The existing plot inside the "block". "Blocks" were created based on the available road infrastructure in the study area. Higher ranks were given to the preference owners that have higher number of plots in the specific blocks.

The criterion was seated as when a farmer has:
4 plots and owned 4 plots per block - Rank 1
4 plots and owned 3 plots per block - Rank 2
4 plots and owned 2 plots per block - Rank 3
4 plots and owned 1 plot per block - Rank 4
3 plots and owned 3 plots per block - Rank 1
3 plots and owned 2 plots per block - Rank 2
3 plots and owned 1 plot per block - Rank 3
2 plots and owned 2 plots per block - Rank 1
2 plots and owned 1 plot per block - Rank 2

Criterion 4: The plots belong to the same owner that was adjacent (connected) to each other (i.e., neighbouring plots) were seated as criterion 4. In other word, these are plots that the farmers want to keep it during re-allotment process. Higher ranks were given to the preference owners that have higher number of plots connected each other in the vicinity.

The criterion was seated as when a farmer has:
4 plots and 4 of them were connected - Rank 1
4 plots and 3 of them were connected - Rank 2 and the remaining one plot ranked as Rank 0
4 plots and 2 of them were connected - Rank 3 and the remaining two plots ranked as Rank 0 if they were not connected each other or suited in different places.
3 plots and 3 of them were connected - Rank 1
3 plots and 2 of them were connected - Rank 2 and the remaining one plot ranked as Rank 0
2 plots and 2 of them were connected - Rank 1
In addition, Farm plots that were not connected ranked as Rank 0

Criterion 5: Plot existence in the dominant class of soil inside a "block". Higher ranks were given to the preference "block" predominantly dominated by the dominant soil.

In a block all farm plots were found within a dominant class of soil - Rank 1
In a block more than ⅔ farm plots were found within a dominant class of soil - Rank 2

In a block ⅔ farm plots were found within a dominant class of soil - Rank 3
In a block less than ⅔ farm plots were found within a dominant class of soil - Rank 4

Meanwhile, ranks were assigned to values i.e., Rank 1 was assigned to value ten, Rank 2 value nine, Rank 3 value eight, Rank 4 value seven and Rank 0 value zero. This was to interpret the ranks given to each plot to numeric value, finally to sum up the criteria value obtained by each plot of land. A higher value given to higher ranks, i.e., Rank 1 was assigned to value ten. Values of rank were decreased as the rank of the plot decreased. Plots that have higher rank were used to prioritize the owners for re-allotment while plots that have low rank and have no farm house used as a relocated plots to the owner that achieved higher sum values during the re-allotment.

Finally, to calculate the possible shortest distance from the farm houses, plots which score Rank zero were taken into consideration and performed as follow. The first set of plots (owners with house and have more than one plot) which obtained Rank 0 in criterion 2, intersected with the second set (owners with house and have adjacent connected plots which was the combination of criterion 1 and criterion 4 used as a screen) to drive the third dataset which were only elements of the first datasets to eliminate the overlap plots and farm houses from the first set of plots between the two datasets. The fourth set (owners without house and have non-adjacent connected plots) which obtained Rank 0 in criterion 1 and criterion 4, intersected with the third dataset (used as a screen) to drive the fifth dataset which were only elements of the fourth datasets for the same reason. Thus, distances were calculated to the third and fifth dataset of plots to obtain the possible shortest distance for re-allotment plan.

The following figure illustrates the criteria set recorded on the plot shapefile from the GIS analysis. To record the above sets of criteria's, first criteria's were coded to simplify and easily identify based on their ranks. Second, the simplified codes were inserted into the attribute table of the plots and third values of criterion rank were summed for each plot as shown in the figure below. For example, Code: C1-NE-P4-H2-R3 interpreted as C1-Criterion 1, NE-Not Exchangeable, P-Number Plot, H-Number of houses and R-Rank. The lists of other codes are presented in Appendix - II.

USER_ID	OWNER_ID	PLOT_ID	Criteria_1	Criteria_2	Criteria_3	Criteria_4	Criteria_5	Area_ha	Id_1	Rank_sum
	38	A/B/47/21/295	C1-NE-P2-H1-R2		C3-EP-2P-2O-R1	C4-FWH-2P-0C-R0	C5-DSC-B2-R3	0.174088	38	27
	65	A/B/47/21/284	<Null>	C2-E-4P-R1	C3-EP-4P-2O-R3	C4-FWH-4P-2C-R3	C5-DSC-B4-R2	0.173631	37	35
	18	A/B/47/21/333	<Null>	C2-E-1P-R4		<Null>	C5-DSC-B4-R2	0.170285	36	16
	36	A/B/47/21/299	C1-NE-P1-H1-R1	<Null>		<Null>	C5-DSC-B2-R3	0.166053	35	18
USER/ 1	20	A/B/47/21/283	<Null>			<Null>		0.160041	34	<Null>
	27	A/B/47/21/302	<Null>	C2-E-3P-R2	C3-EP-3P-3O-R1	C4-FWH-3P-2C-R2	C5-DSC-B3-R4	0.159011	33	35
USER/ 3	27	A/B/47/21/302	<Null>		<Null>	<Null>		0.145686	32	<Null>
	70	A/B/47/21/1299	<Null>	C2-E-3P-R2	C3-EP-3P-1O-R3	C4-FWH-3P-0C-R0	C5-DSC-B1-R1	0.143863	31	27
	28	A/B/47/21/260	<Null>	C2-E-4P-R1	C3-EP-4P-2O-R3	C4-FWH-4P-0C-R0	C5-DSC-B1-R1	0.142304	30	28
	14	A/B/47/21/266	C1-NE-P2-H2-R1		C3-EP-2P-2O-R1	C4-FWH-2P-2C-R1	C5-DSC-B1-R1	0.14185	29	40
	34	A/B/47/21/293	<Null>	C2-E-3P-R2	C3-EP-3P-3O-R1	C4-FWH-3P-2C-R2	C5-DSC-B2-R3	0.13664	28	36
	31	A/B/47/21/301	<Null>	C2-E-4P-R1	C3-EP-4P-4O-R1	C4-FWH-4P-3C-R2	C5-DSC-B3-R4	0.136302	27	36
	69	A/B/47/21/305	<Null>	C2-E-2P-R3	C3-EP-2P-2O-R1	C4-FWH-2P-2C-R1	C5-DSC-B3-R4	0.135995	26	35
	68	A/B/47/21/271	<Null>	C2-E-1P-R4		<Null>	C5-DSC-B4-R2	0.135059	25	16
USER/ 5	31	A/B/47/21/301	<Null>		<Null>	<Null>		0.134928	24	<Null>
	46	A/B/47/21/280	<Null>	C2-E-4P-R1	C3-EP-4P-2O-R3	C4-FWH-4P-0C-R0	C5-DSC-B4-R2	0.126078	23	27
USER/ 5	31	A/B/47/21/301	<Null>		<Null>	<Null>		0.125611	22	<Null>
	1	A/B/47/21/1280	<Null>	C2-E-1P-R4		<Null>	C5-DSC-B1-R1	0.123867	21	17
	11	A/B/47/21/661	<Null>	C2-E-2P-R3	C3-EP-2P-2O-R1	C4-FWH-2P-2C-R1	C5-DSC-B4-R2	0.123308	20	37
	45	A/B/47/21/45	<Null>	C2-E-2P-R3	C3-EP-2P-1O-R2	C4-FWH-2P-0C-R0	C5-DSC-B2-R3	0.123224	19	25
	9	A/B/47/21/9	<Null>	C2-E-2P-R3	C3-EP-2P-1O-R2	C4-FWH-2P-0C-R0	C5-DSC-B2-R3	0.11023	18	25
	23	A/B/47/21/322	<Null>	C2-E-2P-R3	C3-EP-2P-1O-R2	C4-FWH-2P-0C-R0	C5-DSC-B4-R2	0.109284	17	26
USER/ 5	31	A/B/47/21/301	<Null>			<Null>		0.103332	16	<Null>
	33	A/B/47/21/300	C1-NE-P1-H1-R1	<Null>		<Null>	C5-DSC-B3-R4	0.103098	15	17
USER/ 4	25	A/B/47/21/1630				<Null>		0.101133	14	<Null>
	24	A/B/47/21/269	<Null>	C2-E-2P-R3	C3-EP-2P-1O-R2	C4-FWH-2P-0C-R0	C5-DSC-B3-R4	0.09955	13	24
	60	A/B/47/21/294	<Null>	C2-E-1P-R4		<Null>	C5-DSC-B3-R4	0.094896	12	14
	55	A/B/47/21/55	<Null>	C2-E-1P-R4		<Null>	C5-DSC-B2-R3	0.0843	11	15

Figure 6. 6 Attributes of plots from the criteria set

6.3. Landowner re-allotment algorithm

The methodology applied to determine the lists of landowners to be relocated inside the block and to re-allocate the land owners was based on the following procedure in three different steps.

I. First step

As it is illustrated in Figure 6.5, the following procedures were applied during the first step.

- Calculate the value of (criterion) rank for each plot, on the basis of criterion priorities inside of each block.
- Calculate the sum values of (criterion) rank for the landowner.
- Determine the plots that would be relocated and calculating distance from farm houses and/or largest plots.

II. Second step

The principle of re-allotment (the swapping approach)

Re-allotment was performed mainly based on exchanging of plots among the owners (LTO Nederland, 2014) that were existed in the study area. After the sum values per owner and the possible distance were calculated, owners were sorted based on priority. If re-allotment was needed to the first prior owner, the nearest comparable plots were allocated to the owner based on the steps in re-allotment illustrated in Figure 6.7. If the farmer has a farm house inside the study area, the possible shortest distance that was calculated from the farm house to the nearest plot would be relocated. Otherwise, if not, the possible shortest distance that was calculated from the owner largest plot would be relocated. The next step was identifying and relocating the comparable plot to the owner in terms of size that fit with the compensation. The new plot also provided with the new owner identifying number which was the same as with the existing owner identifying number and recorded under the name of the owner. The process was cyclic and continues based on the priority of the owners in the re-allotment process until the necessary exchange was completed. The process is explained in Fig 6.7 and the following procedures were applied.

- Determine the list of landowners to be relocated by priority order.
- Determine the landowners to reallocate, starting with the block which has the maximum value of landowners.
- Determine the landowners possessing the "plus value" in a specified block.
- Sort the possible relocated plots by distance and list all possible nearest plots relative to the farm houses or from the largest plots.
- Sort the possible relocated plots by area and list all the possible comparable area
- Reallocate the prioritized land owners in the possible shortest distance from their houses and/or largest plots; and proceed the same way with others plots by eliminating each time the relocated landowner. i.e., designed plots were created by considering the wishes of the farmers as described in the criterion setting of the study (Figure 6.7).

The swamping approach is cyclic and it should be stopped somewhere at the final iteration at which the participated plots included and reach to the maximum relocation process. Thus to prevent the algorithm from relocating of the same plots that were relocated back to the original location, and to stop the algorithm after maximum relocation process, the *stopping rule* was conveyed. Hence, for stopping rule, the plots attribute table designed to include some columns to record the re-allotment process that would be referred by the algorithm during the process. For example, from the Table 6.2, *Owner ID 2* has two plots (*Plot 1 and Plot 2*) before re-allotment and one of the plot need to be relocated to the plot that has farm house. Thus, based on the re-allotment process *Plot 3* (*Owner ID 40*) was relocated to *Owner ID 2* after re-allotment and to prevent the algorithm from relocation of this plot (*Plot 3*), the attributes were filled with the same attribute with *Plot 1* except for the "Gain" attribute (normally filled on plots that have farm

house). And also the "Relocated_from" attribute filled with the *Owner ID* of *Plot 3* to indicate from where the plot was allocated during the process. Whereas, *Plot 2* attributes were filled with zero except the "New_Owner_ID" (which was not taken by the existing *Owners ID*). The "New_Owner_ID" was given to identify it later during the process. So this plot (*Plot 2*) was become part of the re-allotment process until it was relocated. Thus, the stopping rule to the algorithm was then, "Owner_ID" and "New_Owner_ID" must not be zero during the re-allotment process.

Before re-allotment	Owner_ID	Gain	Loss	Relocated_from	Replaced_by	New_Owner_ID
Plot 1(with farm house)	2					
Plot 2	2					
Plot 3	40					
After re-allotment	Owner_ID	Gain	Loss	Relocated_from	Replaced_by	New_Owner_ID
Plot 1(with farm house)	2	0.034	0			2
Plot 2	0	0	0	0	0	80
Plot 3	2	0	0	40	2	2

Table 6. 1 Stopping rule attributes used during re-allotment

- After the first temporary re-allotment completed, the swapping approach was repeated until satisfied result was obtained by the algorithm during the process.
- Finally, after all farmers participated in the re-allotment were relocated, the process was finalized.

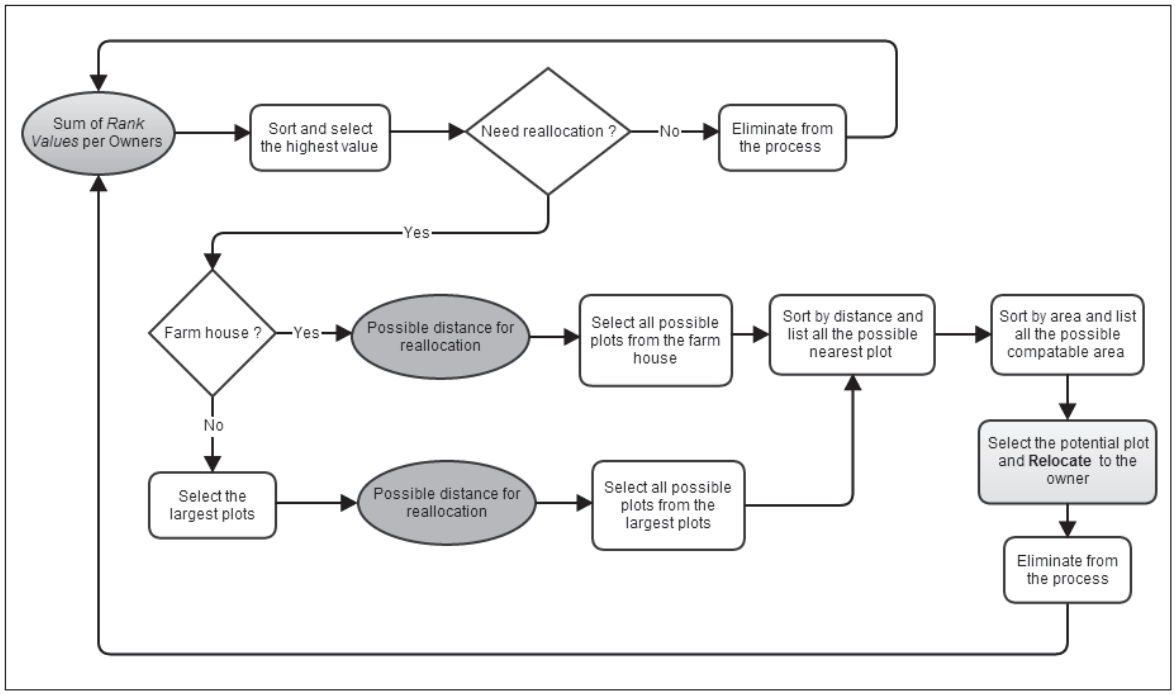

Figure 6. 7 Steps in re-allotment after calculating the sum of rank values to owner and distances

III. Third step

The procedure takes place after the process of re-allotment of farm plots during the third step:

- Each designed plot was identified by owners and differentiated by different colours like the Dutch approach – that was map making (Figure 6.11).

The overall methodology applied to reallocate the plots illustrated in the Figure 6.8, mainly four GIS layers used in the process, i.e., Plot, Farm-houses, Block and Soil layers. In addition, land owners record and plots record were used to drive the corresponding outputs.

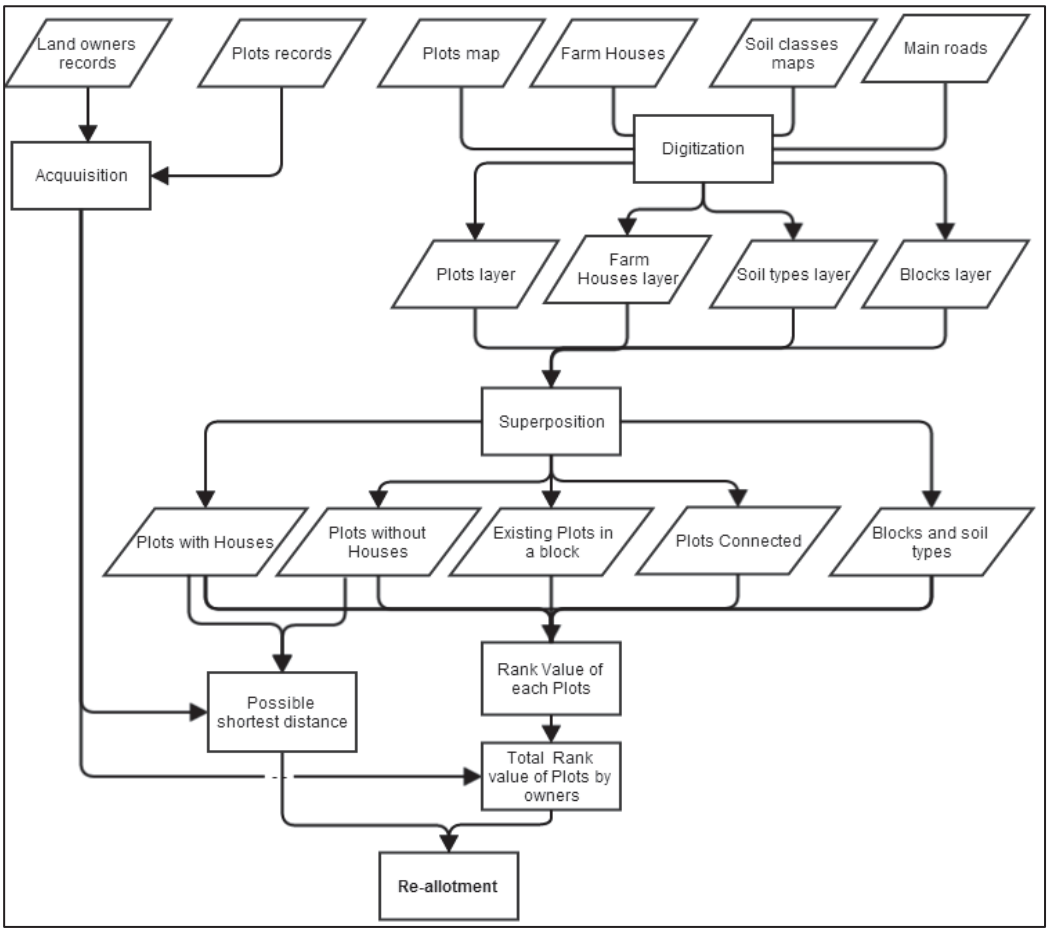

Figure 6. 8 The overall steps in the re-allotment

6.4. Result

Based on the farmers response, the left map represent the plots that cannot be exchanged from all the sample households, since these plots have farm houses. Meanwhile, allowing to the wishes of the farmers, the farm plots that can be exchanged were identified from the analysis of the criteria during the re-allotment process. Thus, plots that were wanted to be exchanged among the farmers showed in the right map of Figure 6.9.

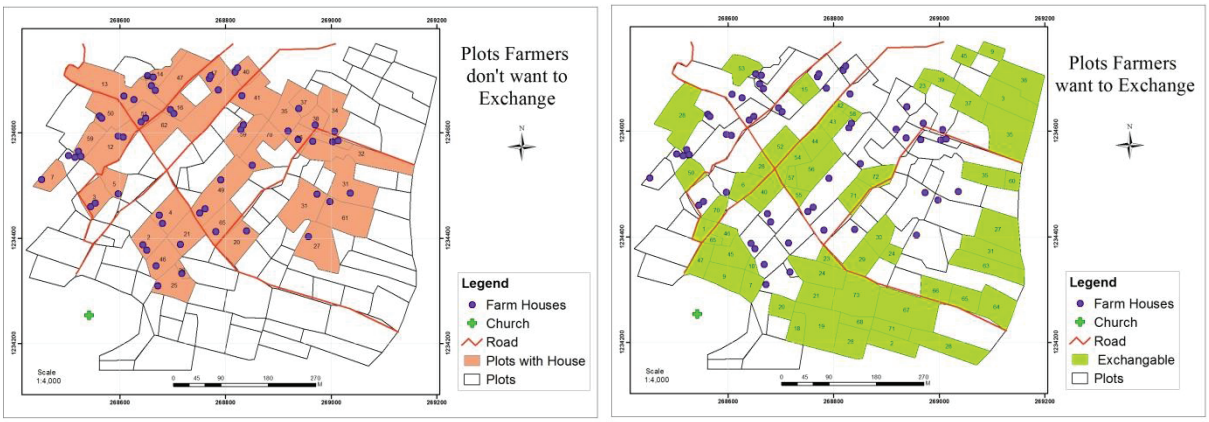

Figure 6. 9 Wishes of farmers

Among the farm plots in the study area, there were some plots owned by the sample households which were adjacent and connected to each other (neighbouring plots). In addition, the owners of the plots may have two or more connected plots in the study area. Thus, during the re-allotment process those connected plots were considered. Connected farm plots illustrated in the figure below.

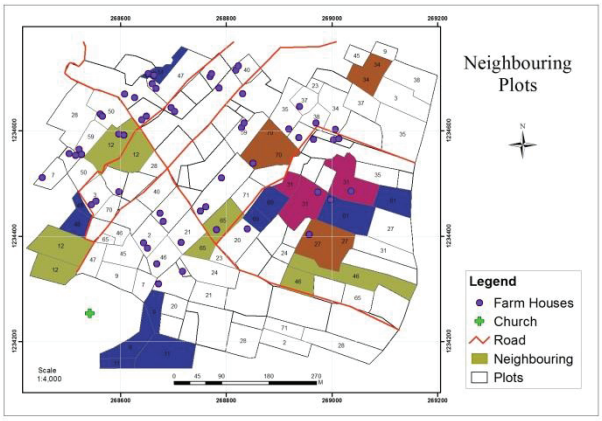

Figure 6. 10 Connected plots

During the re-allotment process, from a single owned 41 plots (by 41 households) only 5 plots were re-allocated and the rest plots not needed re-allotment and eventually excluded from the process. On the other hand, from the total 70 households, 30 households participated in the re-allotment process (Figure 6.11 and Table 6.2); and 25 of them were re-allocated during the process. At the same time, five owners (owned a single plots) were un-allocated due to shortage of land (or plots), since designed plots were allocated to prior owners in the list. While, the problem was mitigated by relocate the remaining owners' to the deducted gain area from the relocated owners' who get more lands during the re-allotment process. For instance, if the owner designed plots gain proportional size to un-allocated owner plot size, then the gain size was deducted from the designed plot and provided to the un-allocated owner (Table 6.3). As a standard, from the Dutch approach, when shortage of land occurred during re-allotment process, land should be accessed from the existing land bank as a replacement for owners who lost their plots. Since land consolidation is not yet implemented in Ethiopia and the existing land bank is not multi-purpose; it wasn't able to use and test the land bank concept in this study during application of the re-allotment process.

Although, the total number of designed plots decreased for 15 households from two to one, for 1 households from three to one, as well for 2 households from three to two and for 1 household from four to one. While, the remaining 11 households showed no change in terms of total number of designed plots after the re-allotment. In addition, 17 owners moved from their original blocks to the others different blocks. For instance, 3 owners moved from block-one to block-two, block-three and block-four, 3 owners from block-two to block-one and block-four, 7 owners from block-three to block-two and block-four, and lastly 6 owners from block-four to block-one, block-two and block-three. The results of relocated plots illustrated in different colours and plot that were excluded from the re-allotment during the process are shown with white colour in the figures below.

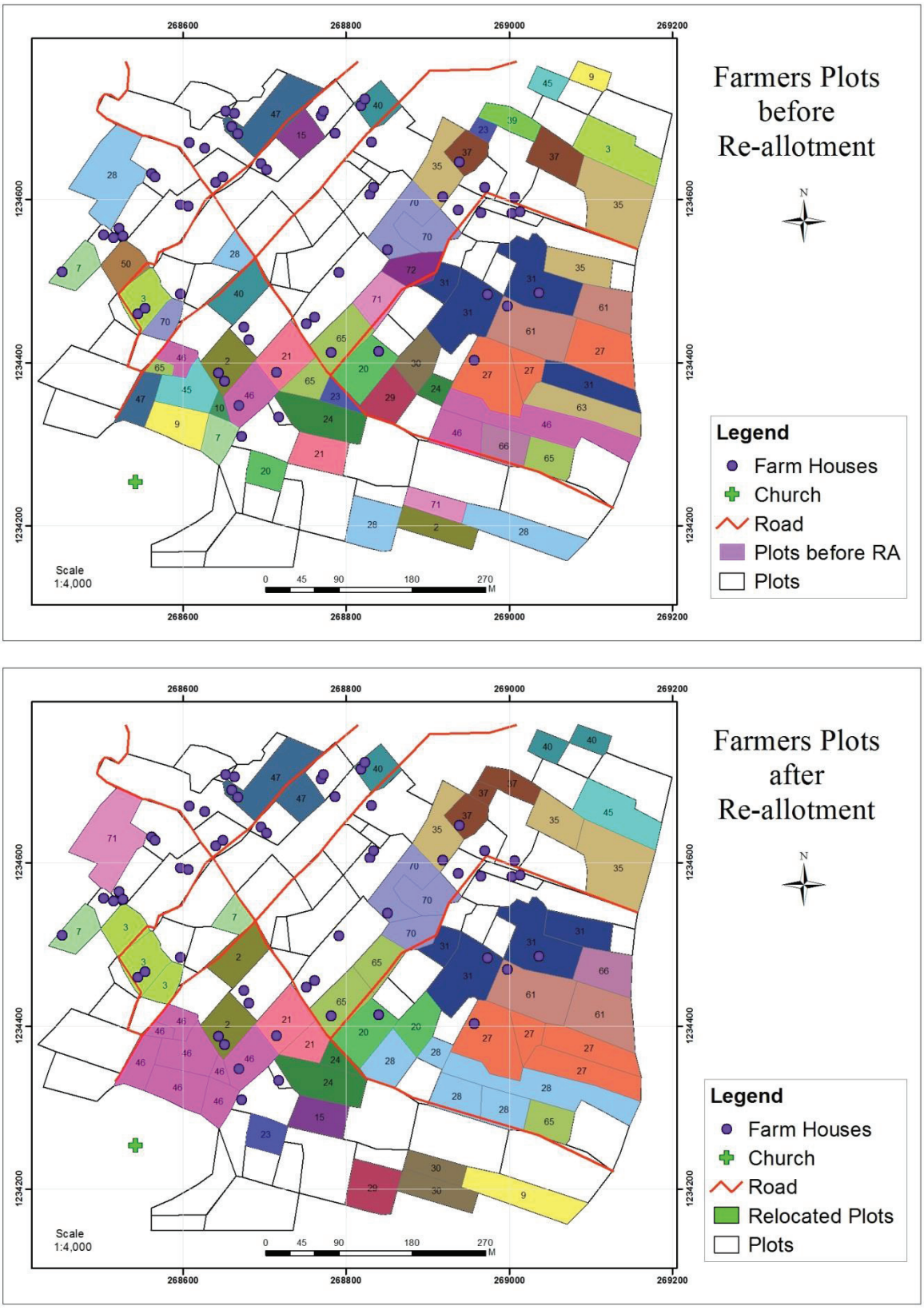

Figure 6. 11 Farmers plots before and after re-allotment

To illustrate the result more, the following outputs were selected and mapped from the sample households which were participated in the re-allotment process. For example, Figure 6.12 (Upper) shows owners of *Owner ID 3* and *9* owned two plots, owners of *Owner ID 27* and *70* owned two neighbouring plots in addition to a single standalone plot and owners of *Owner ID 46* and *65* owned two neighbouring plots in addition to two standalone plots before re-allotment. The Lower figure shows the output after re-allotment i.e., owners owned one total designed plot (*Owner ID 9, Owner ID 3* (with 3 neighbouring plots), *Owner ID 27* (with 4 neighbouring plots), *Owner ID 46* (with 8 neighbouring plots) and *Owner ID 70* (with 3 neighbouring plots)) and total two designed plots by *Owner ID 65* with 2 neighbouring plots. Some of the results of the re-allotment are presented in Appendix – III.

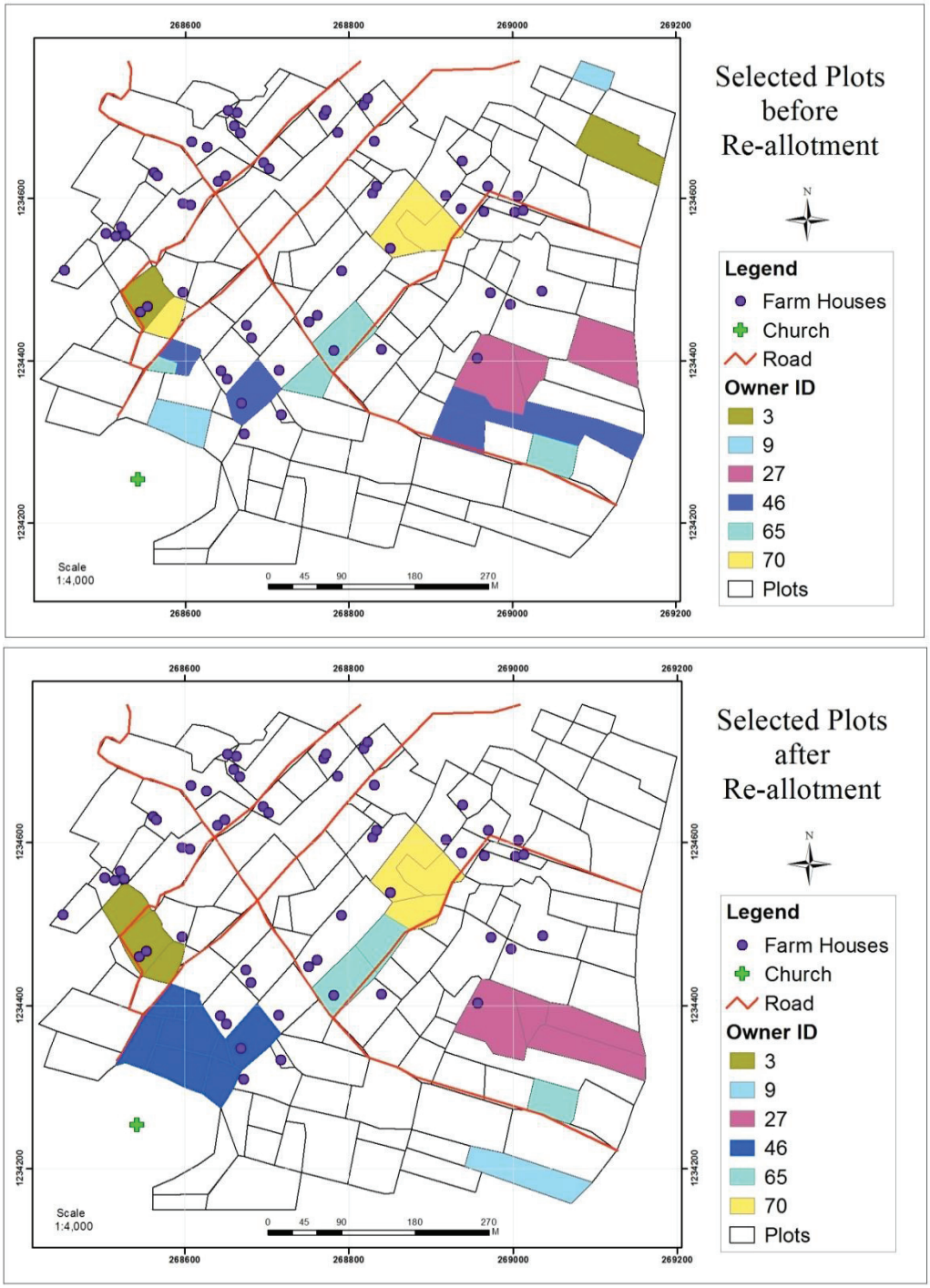

Figure 6. 12 Selected plot owner before and after re-allotment

As the Table 6.2 shows, from the total 30 relocated households, 12 households (40%) gained additional area and the sizes of their designed plots increased. In addition, also 12 households (40%) lose some areas from the size of their previous plots. The remaining 6 households showed no change in their holding. Maximum and minimum gain area after re-allotment was 0.083 and 0.003 ha, respectively. At the same time, the maximum and minimum losses of area from the total of 12 designed household plots was 0.101 ha and 0.006 ha.

No	Owner ID	Plot Owned *before* re-allotment		Designed Plot Owned *after* re-allotment		Sum *Area* in **ha** *before* re-allotment	Sum *Area* in **ha** *after* re-allotment	Sum *Gain* area in **ha** *after* re-allotment	Sum *Loss* area in **ha** *after* re-allotment	Sum *Area/Perimeter before* re-allotment	Sum *Area/Perimeter after* re-allotment
		Total-before*	**np***	**Total-after***	**np***						
1	2	2		1	*2*	0.554	0.587	0.034	0	24.031	26.301
2	3	2		1	*3*	0.733	0.632	0	0.101	27.918	33.828
3	7	2		2		0.373	0.339	0	0.034	21.064	19.864
4	9	2		1		0.405	0.445	0.041	0	21.059	12.558
5	15	1		1		0.187	0.27	0.083	0	10.799	12.531
6	20	2		1	*2*	0.523	0.594	0.071	0	24.934	26.621
7	21	2		1	*2*	0.598	0.501	0	0.097	26.672	24.01
8	23	2		1		0.168	0.176	0.009	0	12.774	10.533
9	24	2		1	*2*	0.514	0.524	0.01	0	22.265	21.207
10	27	2	*2*	1	*4*	1.179	1.179	0	0	43.332	37.936
11	28	4		1	*5*	1.555	1.55	0	0.006	53.434	57.343
12	29	1		1		0.271	0.339	0.069	0	13.098	14.714
13	30	1		1	*2*	0.248	0.248	0	0	12.221	9.749
14	31	2	*3*	1	*4*	1.555	1.487	0	0.069	51.767	52.367
15	35	3		2	*2*	1.315	1.317	0.003	0	44.01	44.751
16	37	2		1	*3*	0.465	0.42	0	0.045	23.946	26.507
17	40	2		2	*2*	0.479	0.416	0	0.063	23.801	27.642
18	45	2		1		0.425	0.457	0.032	0	21.297	15.007
19	46	3	*2*	1	*8*	1.349	1.349	0	0	45.58	69.68
20	47	2		1	*2*	0.7	0.675	0	0.025	24.258	24.681
21	61	2		1	*2*	0.856	0.856	0	0	31.255	29.879
22	65	3	*2*	2	*2*	0.793	0.801	0.008	0	41.194	37.831
23	66	1		1		0.246	0.315	0.069	0	12.45	13.644
24	70	2	*2*	1	*3*	0.748	0.822	0.075	0	30.106	32.353
25	71	2		1		0.419	0.419	0	0	21.099	7.865
26	10	1		1		0.048	0.033	0	0.015	4.821	4.555
27	39	1		1		0.178	0.154	0	0.024	9.323	8.341
28	50	1		1		0.212	0.199	0	0.013	11.86	10.136
29	63	1		1		0.413	0.413	0	0	11.955	11.96
30	72	1		1		0.219	0.21	0	0.009	11.305	9.111
Sum		56	11	34	50	17.727	17.727	0.501	0.501	733.628	733.628

np= neighbouring plots (Plots that are adjacent (connected) to each other and owned by a single owner)*

If Total-before =2 and np= 2, i.e., owner owned 2 plot in different place and one of the plot has 1 neighbour plot before re-allotment*

If Total-after =1 and np= 2, i.e., owner owned 1 designed plot and this designed plot has additional 1 neighbour plot after re-allotment*

Table 6. 2 Comparison of plots before and after re-allotment

In the meantime, for 19 households (63.33%) the total number of designed plots (i.e., including neighbouring plots) decreased. While, the total numbers of designed plots remains the same for 11 households (36.67%). Although, the area-to-perimeter ratio of 15 households (50%) increased, while it also decreased for 15 households (50%) after re-allotment.

Owners that gain more area during the re-allotment (designed plots) and later shared the gained area to the un-allocated owners								
No.	Owner ID	Sum Area in ***ha*** *before* re-allotment	Sum Area in ***ha*** *after* re-allotment	Sum Gain area in ***ha*** *after* re-allotment	Sum Loss area in ***ha*** *after* re-allotment	Sum Area/Perimeter *before* re-allotment	Sum Area/Perimeter *after* re-allotment	Area gained *after re-allotment* **Shared with Owner ID**
10	27	1.179	1.455	0.276	0.000	43.332	49.891	63
13	30	0.248	0.446	0.199	0.000	12.221	19.884	50
19	46	1.349	1.503	0.154	0.000	45.580	78.021	39
21	61	0.856	1.026	0.170	0.000	31.255	34.435	10 and 63
25	71	0.419	0.629	0.210	0.000	21.099	16.976	72
Sum		4.051	5.059	1.007	0.000	153.486	199.207	
Owners that were un-allocated during the process and later relocated by reducing proportional gain size from the designed plot of the farmers who get more lands during the re-allotment process								
29	63	0.413	0.413	0.000	0.000	11.955	11.960	27 and 61
28	50	0.212	0.199	0.000	0.013	11.860	10.136	30
27	39	0.178	0.154	0.000	0.024	9.323	8.341	46
26	10	0.048	0.033	0.000	0.015	4.821	4.555	61
30	72	0.219	0.210	0.000	0.009	11.305	9.111	71
Sum		1.070	1.008		0.062	49.263	44.103	

Table 6. 3 Relocated the remaining owners by reducing farm size from designed plots after re-location

In Addition, from the total of 16 households who had farm houses and relocated, the designed plot distance were reduced for 12 households (75%) and relatively the distance were increased only for 4 households (25%) from their farm houses. Maximum and minimum distance decreased after re-allotment was 522.6 m and 41.25 m, respectively. At the same time, the maximum and minimum distance increased was 221.19 m and 8.97 m, as presented in Table 6.4. Although, the area of designed plots multiplied-by-distance from the farm house decreased for 14 households (87.5%), while it increased only for 2 households (12.5%) after re-allotment.

Before re-allotment						After re-allotment						
Owner ID	Plot number	Distance from Farm house (m)	Sum distance from houses to plots	*Area* in **ha** *before* re-allotment	*Area-Multiply -by distance*	Designed Plot number	Distance from Farm house (m)	Sum distance from houses to plots	*Area* in **ha** *after* re-allotment	*Area-Multiply - by distance*	Distance decreased	Distance increased
65	Plot 1	44.77		0.174	7.77	Plot 1	297.73		0.229	68.20		
	Plot 2	297.73		0.229	68.17	Plot 2	87.94		0.236	20.71		
	Plot 3	210.83	553.33	0.054	11.46			385.67			167.66	
20	Plot 1	201.92	201.92	0.176	35.63	Plot 1	50.37	50.37	0.248	12.47	151.55	
46	Plot 1	270.51		0.257	69.39	Plot 1	76.93		0.248	19.04		
	Plot 2	376.31		0.677	254.82	Plot 2	22.95		0.048	1.11		
	Plot 1	93.99		0.126	11.85	Plot 3	120.71		0.212	25.58		
						Plot 4	107.09		0.054	5.82		
						Plot 5	93.99		0.126	11.85		
						Plot 6	47.09		0.177	8.32		
			740.80			Plot 7	64.16	532.90	0.302	19.36	207.90	
2	Plot 1	328.55	328.55	0.263	86.39	Plot 1	102.11	102.11	0.297	30.28	226.44	
31	Plot 1	167.22		0.347	58.02	Plot 1	117.26		0.136	15.98		
	Plot 2	56.53	223.75	0.136	7.71	Plot 2	56.53	173.79	0.278	15.74	49.96	
61	Plot 1	120.07	120.07	0.315	37.781	Plot 1	129.03	129.03	0.484	62.48		8.96
27	Plot 1	157.18		0.484	76.11	Plot 1	147.54		0.413	60.95		
	Plot 2	66.18		0.159	10.52	Plot 2	66.18		0.159	10.52		
			223.36			Plot 3	144.86	358.58	0.347	50.27	0.0	135.2
35	Plot 1	211.31		0.689	145.54	Plot 1	211.31		0.689	145.54		
	Plot 2	188.69	399.99	0.278	52.55	Plot 2	147.44	358.74	0.281	41.46	41.25	
31	Plot 1	117.86		0.136	16.07	Plot 1	117.86		0.278	32.82		
	Plot 2	129.41	247.28	0.347	44.91	Plot 2	58.63	176.49	0.136	7.99	70.79	
37	Plot 1	118.58		0.281	33.34	Plot 1	49.72		0.058	2.90		
						Plot 2	80.96	130.68	0.178	14.42		12.10
21	Plot 1	112.94	112.94	0.270	30.52	Plot 1	41.21	41.21	0.174	7.16	71.73	
3	Plot 1	609.98		0.457	278.55	Plot 1	29.28		0.144	4.21		
						Plot 2	58.1	87.38	0.212	12.32	522.60	
7	Plot 1	279.74	279.74	0.177	49.40	Plot 1	212.46	212.46	0.142	30.23	67.28	
40	Plot 1	282.18		0.297	83.69	Plot 1	224.96		0.123	27.72		
						Plot 2	278.41	503.37	0.110	30.69		221.2
47	Plot 1	346.63	346.63	0.212	73.44	Plot 1	78.13	78.13	0.187	14.62	268.5	
70	Plot 1	286.48		0.144	41.21	Plot 1	39.59		0.219	8.66		
	Plot 2	53.04	339.52	0.262	13.88	Plot 2	53.04	92.67	0.262	13.88	246.89	

Table 6. 4 Distance from farm houses before and after re-allotment

6.5. Evaluation

The following section presents the evaluation of show-case result after the re-allotment plan was designed and performed. Evaluation was based on the predefined factors that were defined and discussed in the methodology chapter to ensure whether the correct generation was achieved. The evaluation was performed when the generation of the designed plot was completed. Location, size, shape, concentration of designed plots, farmer advantage and distance of the newly generated designed plot were considered as the main factors for evaluation.

The overall results of comparison of plots before and after re-allotment based on factors such as, total number of plots, total plot size, and plot shape determination is presented in Table 6.2, while, closeness of the plots to the farm house is presented in Table 6.4. From these two tables the following result (Table 6.5) is summarized based on gain and loses of area in terms of number of plots, size, shape and distance for owners participated in the re-allotment process.

The first factor for evaluation was the total number of plots per landowner before and after re-allotment. From total of 19 owners whose number of designed plots decreased, 9 owner gain an area from the re-allotment, while, 6 owners lose an area and 4 owners neither gain nor loss. In the meantime, 3 owners gain, 6 owners lose and 2 owner neither gain nor loss an area from the total of 11 owners whose number of designed plots showed no change. From the total of 30 relocated owners', 13 of them gain, 11 of them lose and 6 of them neither gain nor loss an area from their designed plots during re-allotment. In this case the re-allotment process was considered as an advantageous for most of the owners in terms of gain area as the total number of designed plots decreased (*i.e., neighbouring plots included were counted as a single plot*), which was referred as designed plots were concentrated around the farmers houses.

From Table 6.5, the second factor, i.e., total designed plot size showed that 12 owners gained an area from the re-allotment. In the meantime, 12 owners lose an area and 6 owners showed no change. Form the total of 30 owners, 24 owners showed change in total designed plot size they owned after relocation. This result showed that the re-allotment process had the same result on both the gain and loses of an area from the relocated owners. The main reason of this effect was coming from the absence of land bank system during the re-allotment process. Besides, almost for half of the farmers situation in terms of designed plot size was improved after re-allotment.

The third factor was designed plot shape determination by the area-to-perimeter ratio before and after. When area-to-perimeter ratio increased means relatively the shape of the plot become shortened (i.e., the sides of the plot become shorter but not similar), where as if the ratio decreased, the shape of the plot become elongated (sides of the plot become longer). From total of 15 owners whose area-to-perimeter ratio increased, only 6 owners gain an area from the re-allotment, while, 7 owners lose an area from their designed plot and 2 owners neither gain nor loss. In the meantime, 6 owners gain, 5 owners lose and 4 owner neither gain nor loss an area from the total of 15 owners whose area-to-perimeter ratio decreased. This factor was mainly depending on the change in the total designed plot size and the perimeter of the designed plots and the result showed that it depends on the second factor and as well it has the same result as of the second factor.

The fourth factor was closeness of the designed plots to the farmer house. From the total of 16 owners, distance was decreased for 12 owners who have a farm plot and participated in the re-allotment process. Among these, 8 owners gain, 3 owners lose and 1 owner neither gain nor loss an area from the re-allotment. In the meantime, 1 owner gain, 1 owner loses and 2 owners neither gain nor loss an area from the total of 4 owners whose designed plot distance was relatively increased from their houses. Over all 9 owners gain an area and 4 owners lose and 3 neither gain nor lose, in this case the re-allotment process was considered as an advantageous in terms of the closeness of designed plots to the owners' house. The re-allotment shortens the distance travel by farmers.

The fifth factor was concentration of designed plots around the farm house in terms of Area of designed plots multiplied-by-distance from the farm houses. From the total of 16 owners, designed plots were concentrated for 14 owners who have a farm plot and participated in the re-allotment process. Among these, 9 owners gain, 4 owners lose and 1 owner neither gain nor loss an area from the re-allotment. In the

meantime, only 2 owners neither gain nor loss an area from the total of 2 owners whose designed plots concentration was relatively diminished from their houses. Over all 9 owners gain an area and 4 owners lose and 3 neither gain nor lose, in this case the re-allotment process was considered as an advantageous in terms of the concentration of designed plots to the owners' house. The re-allotment concentrates designed plots for most of the farmers.

The situation of designed plot size after re-allotment was improved only for 12 owners, while 6 owners showed no change on their status from the total of 30 households with Maximum 0.083 ha and minimum 0.003 ha gain area after re-allotment. Most of farmers were advantageous in terms of concentration of designed plots (in terms of total number of designed plots) which accounts 63.33% and closeness of relocated designed plots to their home (75.00%) and among those 67.00% of owners gain an area from the relocation process. In addition, designed plots were concentrated around the farm houses for 87.5% farmers. As in general the re-allotment brings concentration of designed plots, gains in size and shortens distances to farm houses. It can be said that the applied re-allotment was advantageous and improves situations for ⅔ of the participated farmers in terms of concentration of designed plots, for more than half of the participated farmers in terms of total designed plot size and shape; and shortens distance almost for ⅔ of the participated farmers in terms of closeness. There was improvement of farm size and farm structures for farmers after re-allotment. Thus, this re-allotment should be considered as a tool to improve the farm size, shape and distance in the study area and it should be implemented voluntarily to the ground (reality).

		Total	Percentage	Gain	Loss	Neither gain nor loss
Total number of designed plots that includes also neighbouring plots*	Decreased	19	63.33%	9	6	4
	No change	11	36.67%	3	6	2
	Total	30		13	11	6
Total designed plot Size	Increased	12	40.00%	12	0	0
	Decreased	12	40.00%	0	12	0
	No change	6	20.00%	0	0	6
	Total	30		12	12	6
Shape	Increased	15	50.00%	6	7	2
	Decreased	15	50.00%	6	5	4
	Total	30		12	12	6
Closeness	Increased (maximized)	12	75.00%	8	3	1
	Decreased	4	25.00%	1	1	2
	Total	16		9	4	3
Concentration of designed plots	Increased (maximized)	14	87.5%	9	4	1
	Decreased	2	12.5%	0	0	2
	Total	16		9	4	3

**If total number of designed plots included neighbouring plots, those neighbouring plots were counted as a single plot*

Table 6. 5 Comparison of result after re-allotment

Evaluation of the show-case in terms of the research questions of the study was concluded as follow:

1. Suitability of the identified plan to rearrange land use rights in the Ethiopian context

The re-allotment process executed based on exchange of plots among the owners and the owners have the rights to exchange plots, it was not affect the land use rights of owners. Hence, the relocated owners get comparable and more structured designed plots, thus, it makes the new situation suitable to rearrange land use right in Ethiopian context.

2. The pros and cons of the approach

Advantages of the approach

- It can be said the situation was improved after the re-allotment process
- Improved situation based on farmers wishes
- Distance between farmhouses and designed plots were reduced. It is related to the reduction of time travel to farm plots, and labour cost
- Concentration of lots. Most of designed plots were concentrated around the farm houses.
- The farm sizes were improved. Since the preliminary survey result showed most of the households have shortage of land, thus, the new situation improves of the size of designed plots. (This would be associated with the agricultural productivity)
- The approach was new, unique and nature friendly in its kind for the Ethiopia case
- It also leads the same result if any user applied the same process, i.e., it is repeatable.

Dis-advantage of the approach

- Some households loses areas form their existing size of plots

3. The changes that are needed to be improved to the identified re-allotment approach
    - The new approach better improved if it incorporates with additional re-allocation programs and/or algorithms and/or plug-ins for ArcGIS.

6.6. Conclusion

The design of re-allotment plan (show-case) was generally designed and implemented in three steps. 1) Determining which plots could be relocated based on the collected desires of farmers; 2) Exchanging plots among the owners (the swapping approach); and 3) Identifying and mapping the relocated new owners designed plots with different colours. The design of re-allotment was executed with the aim of distance reduction and maximization of concentration of lots based on wishes of farmers by considering five different set of criteria. The plots that cannot be exchanged from all sample households plot (plots that have farm houses), sample household that have one or more plot and plot that has no farm house, the existing plot inside the "block", the plots belong to the same owner that was adjacent (connected) to each other (i.e., neighbouring plots) and plot existence in the dominant class of soil inside a "block". Each criterion has given a rank and value to determine the prior owner participated in the re- allotment process. Hence, the maximum value given in the process was 10 and the minimum was 0. Therefore, the determination of landowners plot value in the re-allotment process was based on the sum of each plots values according to the criteria rank. In this way owners were ordered to give priorities for those plots having higher sum values in the process, while, plots that have lower sum values in the process used as a relocated plots to the higher ordered owners. Moreover, the value of the ranks of each individual plot was calculated and summarized by owners. In addition, plots which scores Rank zero were taken in to consideration to calculate possible shortest distance from the farm houses and/or largest plots and relocated to the owner who get higher rank based on the Dutch swapping approach. Lastly, the wishes of the farmers and the result before and after reallocation mapped for visualization.

The process involved 30 households form the total 70 households, since the other 40 households don't need re-allotment based on the criterion given. According to result obtained from the re-allotment, from

the total of 30 households participated, the situation of designed plot size after re-allotment was improved only for 12 owners, while 6 owners showed no change on their status from the total of 30 households with Maximum 0.083 ha and minimum 0.003 ha gain area after re-allotment. Most of farmers were advantageous in terms of concentration of designed plots (in terms of total number of designed plots) which accounts 63.33% and closeness of relocated designed plots to their home (75.00%) and among those 67.00% of owners gain an area from the relocation process. In addition, designed plots were concentrated around the farm houses for 87.5% farmers.

Although, the show-case was evaluated based on evaluation factors before and after the re-allotment, which includes total number of designed plots (i.e., including neighbouring plots) per landowner, total designed plot size, designed plot shape determination by the area-to-perimeter ratio, closeness of the designed plots to the farmer house, concentration of designed plots in terms of area multiplied by distance from the farmer houses and the improvement of situation and farmers advantage. Generally, as the evaluation showed, farmers were advantageous and the situation was improved in terms of concentration of designed plots, distance reduction and improvement of farm sizes and the study suggested implementing the re-allotment to the reality.

7. CONCLUSION AND RECOMMENDATIONS

7.1. Revisiting the research objectives and questions

This study revealed shortage of land was a big problem for the study area. As other sources indicated, it was not only a problem for the study area; it was also a problem for the whole country. These small holder farmers are forced to subdivide their plots to their children when they reach working age, hence, the problem leads to fragmentation of land holding and low agricultural productivity. In addition, the current land tenure system takes the big share for being a root cause of land fragmentation and consequently food insecurity. In Ethiopia, food (in) security has been an inescapable and predominant reality in the lives of far too many Ethiopians and small-scale farmers in particular. Thus, the study aimed at creating visible and structured farm plots for small holder farmers in Ethiopia by adapting a method for restructuring farm plots from other experienced countries. In the meantime, land consolidation is one of the all-inclusive methods that can be used to overcome such kind of problems. Land consolidation is successfully implemented in Europe; specifically the Netherlands land consolidation method was one of the best practices implemented in the continent. Thus, the study was focused on the adaption of the Dutch re-allotment approach or practices and the researcher achieved the goal of the study.

The objective of the study was to investigate the nature of different land consolidation initiatives, mainly agricultural re-allotment practices in the Netherlands, to determine if, and how, it might be adapted and apply a fit-for-purpose re-allotment approach in Ethiopia, and to evaluate the applicability of the identified/designed approach and to recommend possible solutions. To achieve these objectives and to answer the related research questions, literatures were reviewed; data was collected and analysed along with the development of the re-allotment methodology to construct the show-case. The results of the show-case were evaluated based on the evaluation factors and recommendations forwarded for the entire study.

In relation to the first three research questions for sub-objective 1, I was dealing with the objectives of previous and current agricultural re-allotment practice of the Netherlands, the main instruments and criteria used to achieve the objectives and the strength and weakness of the approach. As a result related studies were reviewed and all questions were answered. The objectives of to apply the land consolidation and/or re-allocation in the Netherlands includes the improvement of position of agriculture and horticulture, the improvement of income, the improvement of working conditions, the improvement of water control, and parceling situations, improvement of infrastructural facilities to the development of rural area. In line with, countries in Europe have different objectives to apply the land consolidation and/or re-allocation. However, the procedure used to implement the land consolidation is more or less similar.

To achieve these agricultural objectives the Netherlands and to improve positive impacts of the re-allotment, different land reallocation methods and/or algorithms were developed and applied and are still applying by different scholars for formal as well as for voluntary re-allotment practices. This includes stepping stone algorithm, Automation of the re-allotment plan for land consolidation (ATOR), Allocation and Adjustment Model (AVL) and TRANSFER for formal re-allotment and the GIS tools such as MapInfo, ArcGIS, ArcView and GeoMedia with Access database for voluntary re-allotment practices. These algorithms differ in usability, simplicity or complexity, performance and selection of criteria to

perform the re-allocation. TRANSFER, which benefit from both ATOR and AVL algorithms, has been applied very successfully for many years in land consolidation projects in the Netherlands and remains operational in the Dutch Kadaster. It was a basic re-allocation algorithm especially for formal land consolidation.

The achievement of all these objectives (the Netherlands) has advantages in efficient agricultural sector and much faster adjustment of agricultural structure to new technologies, make farming more efficient as well as more rationalized shaped parcels and improvement of farmers' productivity and income. The weaknesses of land consolidation recorded were the rapid decrease of nature and land scape values and long implementation period and higher overhead costs.

The second four research questions under sub-objective 2 that were dealing with the Ethiopian rural land parcel arrangement, the re-allotment instruments or criteria needed to fit-for-purpose; the farm houses during re-allotment and the possibilities to facilitate agricultural land banking and the conditions to use it were answered after the field data were collected and analysed.

The field data was collected from the rural parts of Ethiopia, Amhara Region, Fagetalekoma Wereda. Totally of 70 households were participated during the survey. The region has different agro ecological zones and land features which is suitable for growing a variety of crops and livestock production. Agriculture is the predominant economic activity in the Region and Wereda, where about 87.4 percent of the households depend on agriculture only for their subsistence. Crop production is the main income source of the households followed by livestock production. However, Farming practice in this Wereda has largely been determined by shortage of land and prevalence of very small and fragmented holding. This research discovered findings regarding the current rural land parcel arrangements. It also collected the wishes of the farmer to set on the criteria such as farm houses should not be relocated during re-allotment; and different perspectives farmers and government officers' perceptions about the agricultural re-allotment and the situation of the current land banking in Ethiopia.

The current status of rural land parcels arrangements in Ethiopia showed that almost all farmers in Ethiopia have small and highly fragmented plots of land. Specifically in the study area, farmers may have an average of 4.75 plots in different locations and may have a farm plot size maximum of 3.13 ha, average 1.22 ha and minimum 0.25 ha. In addition, farm plots may have farm houses and most of the households have settled in one place with their families. Their children have also built their own house around their family plots, since the plots were coming from their families either by inheritance or by gift. Further, the farm plots subdivided to a number of small fragmented plots based on the family size of the household. This was considered as one of the main reason for fragmentation in Ethiopian in general and particularly in the study area. The government also takes a big share for shortage of land, since the government provides very small and highly fragmented plots to the households.

Furthermore, the research question dealing with the re-allotment instruments or criteria that can be best applied to the Ethiopian setting and the issue of farm houses to include in the re-allotment plan were answered based on the newly designed re-allotment plan (show-case). The re-allotment plan was designed based on the Dutch approach by investigating the re-allotment instrument which was suitable for Ethiopian case. Based on the discussion with the experts of the Dutch Kadaster, the tools in the GIS environments such as MapInfo, ArcGIS, ArcView and GeoMedia were found to be more applicable for voluntary re-allotment practices in the Netherland. Thus, ArcGIS was selected to design the show-case for the Ethiopian case.

The methodology developed to fit rural Ethiopian purposes consisted of three main steps: 1) Determining which plots could be relocated. Different sets of criteria such as 'plots have farm houses', 'household have one or more plot without farm house', 'existing plot inside a "block"', 'plots belong to the same owner and adjacent to each other' and 'plot exists in the dominant class of soil inside a "block"'; were prepared based on the wishes of the farmers and also through utilizing the perceptions of the researcher. During the design process, each farm plot, ranked, valued and summed to given priorities to the owner for relocation of plots. Also, farm houses were considered and given high value ("plus value") to the owner who has these houses in the plot. 2) Exchanging plots among the owner based on the wishes of the farmers, plots were relocated using the swapping approach of the Dutch voluntary re-allotment practice. 3) Finally, identifying and mapping the relocated new owners designed plots. The relocated designed plots were identified by owners and visualized in maps with different colours like the Dutch agricultural re-allotment practices. Moreover, the results of the show-case were evaluated by considering different factors to certain whether the situation of the farmer was improved or not after re-allotment.

From the conclusion of the Dutch land bank experience, a successful implementation of land consolidation is dependent on land banking. Even though, land banking exists in Ethiopia, since the land bank was not multi-purpose and simply used for large scale investment for foreign and domestic investors and did not give any service for land consolidation/reallocation; and due to time limitations, it was not studied in this study and the absence of the land bank showed effect on the results of the show-case as described in the result.

Finally, regarding the research questions related to sub-objective 3 which were dealing with suitability of the newly designed method to rearrange land use rights in the Ethiopian context, the strength and weakness of the new method and the changes that needed to improve the new methods are answered based on the evaluation of the re-allotment. The re-allotment process was executed based on the exchange of plots among the owners and the owners have the rights to exchange plots. So it had no effect on the land use rights of the owners. Thus, the relocated owners get comparable and more structured designed plots that make the new situation suitable to rearrange land use right in the Ethiopian context.

The implemented method has advantages. It was a new fit-for-purpose, innovate, nature friendly method that keep the landscape elements (i.e., vegetation along fence lines) as it presented, particularly more for the relocated farmers, in general for the study area. And also the approach was repeatable, and unique for Ethiopia, since a single farmer may have more than one farm houses and the algorithm explicitly gave attention to these farm houses. Most of farmers were advantageous in terms of concentration of designed plots, gains in designed plot size and distance reduced between farmhouses and designed plots. Statistically, designed plots concentrate (in terms of total number of designed plots) for 63.33% of farmers and closeness to their home (75.00%) and among those 67.00% of owners gain an area. In addition, designed plots were concentrated around the farm houses for 87.5% farmers. There was a real improvement of farm size and farm structures for farmers after the implementation of the re-allotment. The improvement of designed plot size and the structure of designed plots would expect to have positive impact for agricultural productivity. However, it may take as a disadvantage for some farmers' that lose areas from their existing plots after relocation of plots. Meanwhile, if the existing land bank was able to give access to lands during the kind of re-allotment process, the problem may be mitigated like other country experiences, such as the Netherlands. The new identified re-allotment approach can be even better improved if it incorporates with additional re-allocation programs and/or algorithms and/or plug-ins for ArcGIS. Thus, this re-allotment plan should be considered as a tool to improve the farm size, shape and distance in the study area and it should be implemented voluntarily to the ground (reality).

7.2. Recommendations

Generally, the methodology for agricultural land re-allotment was successfully designed and implemented. It created a visible and structured plan of farm plots for small holder farmers in Ethiopia by adapting a method from other experienced countries such as the Netherlands. For reliable response on the results of the show-case it is recommended:

- To show the results of the show-case to the participated farmers and collect real feedback and perceptions about the situation after re-allotment process.
- To show the results of the show-case to the responsible government offices such as to Federal Minister of Agriculture, Amhara Regional Bureau of Environmental Protection and Land Administration and Wereda Land and Environmental Protection Offices in an effort to support further research and development activities

The improvements of the situation after the re-allotment, such as the concentration of designed plots, gain size and distance reduction between farmhouses and designed plots may be taken as a positive feedback of the show-case. So:

- The Regional government should take it as an initial step in consideration of the voluntary based land consolidation project in the Region and the government should consult the farmers to participate in the voluntary re-allocation program.
- The Amhara Regional Environmental Protection and Land Administration Bureau should make further pilot studies at Wereda level by implementing the re-allotment plan to overcome the real problem of the current fragmentation farm land with the direct involvement of the farmers. However, this should be done with great caution and take into account broader political, economic, social, environmental and technical issues.

In addition, further analysis on this method may contribute to enrichment of the research on land consolidation in Ethiopia. So, the recommendations from this study that needed more exploration are:

- Since this study purely focused on the agricultural re-allotment and the algorithm do not include the integration of the re-allotment with the development of infrastructure and land scape protection, attention should be given to multipurpose land consolidation in a further study.
- It is well known that the land bank is an instrument that is particularly suited for solving shortage of land during land consolidation and/or re-allotment for many European countries. However, as investigated in this study, the existing land bank in Ethiopia doesn't give any service for such kinds of problems, since land consolidation is not yet implemented in the country. Furthermore, due to time limitations the concept of land banking for agricultural re-allotment is not included in the developed algorithm and was not able to be tested it in the show-case. The absence of the land bank affected the results of the show-case of this study. Thus, it is highly recommended to make further study to test the advantage of existing land bank for re-allotment practice in Ethiopia.

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APPENDIXES - I

Household questioner:

Name of Household head ----------
Kebele ----------sub Kebele ----------
Household Code ----------
Parcel number----------

1. Type of Household
   Male headed ---------- Female headed ----------
2. What is the age of household head ----------
3. Do you have agricultural land? Yes ☐ No ☐
4. If yes, how big is the size of your land? _____ Tsemad (0.25 hectare)
5. How many parcels do you have in your possession at different place? _____
6. Can you tell me the maximum and minimum land holding size of your parcel (in hectare)?
7. How far is your plot from your residence? (Walking distance or kilometre)
   Minutes ☐ Hours ☐ Km ☐
8. Could you locate your plots from this image?
9. Which parcel you use for agricultural purpose?
10. Could you differentiate the parcels which are?
    a. in ownership but not in use
    b. in use but not in ownership
    c. in ownership and in use
11. Is there any road nearby to your parcel?
    a. If yes, could you locate from this image?
    b. No
12. What is the distance from your parcel to the nearby road?
13. Do you believe your land holding size is enough?
    a. If yes, why _____
    b. If no, why _____
14. Did you get your parcel registered? Yes ☐ No ☐
15. Do you get certificate of holding? Yes ☐ ☐
16. If yes, which level of certificate of holding do you have? (Circle that applies)
    a. Temporary (paper)
    b. Primary book of holding
    c. Secondary book of holding
17. What do you think are the main factors influencing your farm productivity and investments? (Circle all that apply)
    a. Shortage of land
    b. Lack of tenure security
    c. Fragmentation of land
    d. Poor quality of land
    e. Others, specify _____
18. Do you need if your parcels are concentrating together on same area?
    a. If yes, where do you prefer to concentrate? At what distance from your home?
    b. If no, why _____
19. Will you be willing if your farm house is re-located as your plots?
    a. If yes, where do you prefer to re-locate?

b. If no, why _____

20. Do you believe concentrating of parcels can improve your existing farm productivity and investments on your farm?
    a. If yes, how _____
    b. If no, why _____

Interview to governmental bodies (Federal Minister of Agriculture, Amhara Regional Bureau of Environmental Protection and Land Administration and Wereda Land and Environmental Protection Office):

This data is collecting for the purpose of conducting the research in the designing agricultural re-allotment plan for Ethiopia (Amhara region). Agricultural re-allotment (reallocation) is the mechanism of rural development in which different land owners can be allocated the most advantageous position. This means most farm lands located near the farm house with better shape and large size. Your answers are very important to achieve this research. Thank you for answering all questions.

Code of interviewer _____ Date
Collected _____ Organization _____
Name of interviewee._____ Male _____ Female _____
Position _____

1. Would you explain your responsibility in your organization
   _____
2. What is the current status of rural land parcel arrangement?
3. Do you believe the current land tenure system secured farmers tenure right?
   If yes, how_____
   If no, why_____
4. In your opinion what is the major problem in the current land tenure system what changes are needed to solve the problem?
5. What do you think are the main factors influencing farm productivity and investments? (Circle all that apply)
   i. Shortage of land
   ii. Lack of tenure security
   iii. Fragmentation of land
   iv. Poor quality of land
6. Do you believe the average land holding size of a house hold is enough for agricultural productivity?
   a. If yes, how_____
   b. If no, what kind of measure should be taken to improve agricultural productivity?
7. Do you believe agricultural re-allotment can improve the existing farm productivity and investments of farmers?
   a. If yes, how _____
   b. If no, why _____
8. Is the government encouraging agricultural re-allotment practice in Ethiopia?
   a. If yes, what kind of re-allotment criteria could be need?
   b. If no, why_____
9. Do you believe the current land tenure arrangement suitable to rearrange land use right?
   a. If yes, how_____
   b. If no, why_____

10. Do you believe farm houses can be relocated as farm plots?
    If yes, how _____
    If no, why_____
11. What is your opinion in the possibility of agricultural re-allotment practice in Ethiopia?
    _____
12. Is there any agricultural land banking practice in Ethiopia?
    a. If Yes, Do you believe agricultural land banking are needed to support agricultural re-allotment practice?
    b. If No, how can facilitate it in the context of Ethiopian land policy? What are the necessary conditions?

13. What is your opinion in the possibility of agricultural land banking in Ethiopia?

    _____

APPENDIXES - II

The criteria set recorded on the plot shapefile are coded and interpreted as follow:

Code: C1-NE-P4-H2-R3 interpreted as C1-Criterion 1, NE-Not Exchangeable, P-Number Plot, H-Number of houses, and R-Rank.

Code: C2-E-4P-R1 interpreted as C2- Criterion 2, E-Exchangeable, P-Number Plot and R-Rank

Code: C3-EP-4P-4O-R1 interpreted as C3- Criterion 3, EP-Existing Plot, P-plot, O-Owned and R-Rank

Code: C4-FWH-4P-4C-R1 interpreted as C4- Criterion 4, FWH-Farmer Want to Have Plot, P-Number Plot, C-Number of Connected Plots and R-Rank

Code: C5-DSC-B1-R1 interpreted as C5- Criterion 5, DSC-Dominant Soil Class, B-Block and R-Rank

Results of the re-allotment show-case; plots owned by owners: