

Chapter 2

Land Fragmentation

2.1 Introduction

The core topic of this research is the support of land consolidation through an Integrated Planning and Decision Support System (IPDSS). However, land consolidation has been traditionally an approach for solving the land fragmentation problem and hence it is considered necessary to firstly review the conceptual framework of this background problem. In particular, [Sect. 2.2](#) presents and discusses land fragmentation definitions, the associated problems, causes of the problem, advantages/disadvantages of this phenomenon and indicators used for measuring land fragmentation. [Section 2.2.3](#) then discusses three categories of available policies used to control land fragmentation. This is followed by [Sect. 2.4](#), which explores and discusses the extent of the problem at both a global and EU level providing relevant statistics for each country. Finally, [Sect. 2.2.5](#) focuses on the country case study, i.e. Cyprus. It begins with the historical evolution of the Cypriot land tenure system followed by the causes of the land fragmentation problem and the current land tenure trends based on agricultural censuses from 1946 to 2003. The associated land tenure problems are then examined in depth.

2.2 Land Fragmentation Review

2.2.1 Definitions

Fragmentation derives from the word ‘fragment’ which, according to the Oxford Dictionary, refers to a small or incomplete part or piece broken off, i.e. separated from the whole to which it originally belongs. Land fragmentation, which is also known as pulverization, parcellization or scattering [\[1\]](#), is defined in the literature as the situation in which a single farm consists of numerous spatially separated parcels [\[2–5\]](#). King and Burton [\[3\]](#) characterise land fragmentation as a fundamental rural spatial problem concerned with farms which are poorly organised at locations across space.

Van Dijk [5, 6] distinguishes four types of land fragmentation: fragmentation of land ownership; land use; within a farm (or internal fragmentation); and separation of ownership and use. Fragmentation of land ownership refers to the number of landowners who use a given piece of land. Fragmentation of land use refers to the number of users that are also tenants of the land. Internal fragmentation emphasises the number of parcels exploited by each user and considers parcel size, shape and distance as the main issues. Separation of ownership and use involves the situation where there is a discrepancy between ownership and use. It appears that Western Europe has addressed only the second and third types of fragmentation since the other two types can be regarded as problem specific to central European countries, as a result of the privatisation process after the collapse of communism in 1990. This chapter focuses on internal fragmentation.

There are contradictory considerations regarding whether land fragmentation is a problem or not which have stimulated multidisciplinary debate. This has been reviewed comprehensively by Bentley [1] who points out that land fragmentation is considered by agricultural policy makers as the source of ineffective agriculture and thus it must be prevented by legislative actions. Similarly, economists, although believing that land fragmentation can be adaptive under certain conditions, recognise that this phenomenon gradually becomes non-adaptive as technology improves and the relevant costs change [7, 8]. European geographers tend to agree with economists since they support the idea that land fragmentation is not well-suited to the twentieth century machinery and labour costs.

In contrast, non-European geographers suggest that land fragmentation can be really adaptive although some of them recognise a series of advantages and disadvantages. Anthropologists, on the other hand, see land fragmentation as a positive situation under which farmers can cultivate many environmental zones, minimise production risk and optimise the schedule for cropping activities. Many environmentalists consider that any intervention to land tenure structure to remove land fragmentation may have serious environmental effects in nature and even social effects on landowners. Those ethnographers who have made reference to land fragmentation consider it neither a problem nor an adaptation.

These contrary views are not unreasonable since numerous studies showed contrary results. For instance, Karouzis [9] and Blaikie and Sadeque [10] argue that land fragmentation is a serious constraint preventing productivity whilst other authors [11–14] support the view that land fragmentation has not had negative effects on productivity. However, these studies focused on certain regions. Therefore, Van Dijk [5, 6] and Bentley [1] provide a balanced view by pointing out that land fragmentation has advantages and disadvantages with consequent favoured and adverse effects for different contexts. Thus, these effects should be evaluated separately for each community by considering the local economic, social and environmental conditions before decisions for relevant policies are undertaken.

2.2.2 Problems Associated with Fragmentation

The main problems associated with land fragmentation can be outlined as follows: distance between parcels and the farmstead; many boundary lines; small size and irregular shape of parcels; and lack of access. In particular, when parcels are spatially dispersed, travel time and hence costs in moving labour, machines etc. from one parcel to another, are increased [1, 9, 15, 16]. A consequent drawback is that parcels at a greater distance are cultivated less intensively [5]. Many case studies have proven the consequences of this problem in practice: for instance, Thompson [17] for Greek farms, Karouzis [18] for Cypriot landholdings, DeLisle [19], who demonstrated that distance has a relationship to intra-farm cropping patterns in Manitoba (Canada), and Blaikie [20, 21] for four Indian villages.

In addition, land fragmentation involves a complicated boundary network among parcels (hedges, stone walls, ditches, etc.) which cause land wastage [1, 9, 15] because a part of a holding (especially in small parcels) remains uncultivated at the margins of the parcels. Moreover, the cost of fencing and neighbouring conflicts between landowners increases due to this problem. Furthermore, the small size and irregular shape of parcels is another dominant problem associated with land fragmentation [22]. The use of modern machinery is difficult or may be impossible in tiny parcels and may require an excessive amount of manual work in the corners and along the boundaries [1, 9, 15, 23]. Specifically, irregular parcel shape prevents the proper cultivation of land, especially for some crops (e.g. vines, olives) which need to be cultivated in series. Also, the implementation of soil conservation work is harder, the construction costs are higher, more fencing is needed and roads, which are usually adjusted to the shape of parcels, have low geometrical standards.

As a result of these problems, productivity decreases and hence the income of farmers also declines. Thus, this situation emphasises the need for agricultural commercialization via large farm sizes to attain economies of scale. However, although these arguments may seem logical, and many authors have revealed the positive relationship between farm size, productivity and net income [24, 25], other authors [26] have supported an inverse relationship between farm size and productivity. Niroula and Thapa [16], for example, argue that this situation was a reality in the past but not at the present time.

In addition to the classical land fragmentation problems, the lack of a road network providing access to a parcel is a primary factor favouring abandonment or for parcels to remained uncultivated [9]. Small fields often have no road access [17, 20–22, 27]. Furthermore, the lack of a road network to access the land parcels prevents the introduction of other agricultural infrastructure such as irrigation and drainage systems. Moreover, this problem causes conflicts among neighbouring landowners which may clog up the local courts because a part of a ‘front’ parcel may be used as a road access or a path to the ‘back’ parcel.

It is generally accepted that all the above problems associated with land fragmentation usually act as an obstacle to rational agricultural development. At present, this situation, which is even more intense because of the high

agricultural market competition and the high industrialization of the agricultural sector, reduces farmers' net income considerably.

2.2.3 Causes

Even though causes of land fragmentation may vary from country to country and from region to region, authors [1, 3, 16, 28, 29] tend to agree that the four main factors triggering this situation are inheritance; population growth; land markets; and historical/cultural perspectives. These are briefly described below.

It is accepted that inheritance is the primary cause of land fragmentation. Inheritance laws applied in most countries facilitate or demand the subdivision of holdings into equal parts among all heirs or in some countries among only sons. This tradition has deep historical roots in old world countries' laws (e.g. the Napoleonic and Islamic inheritance laws) where the equal distribution of patrimony among heirs was a requirement [3]. As a result, land fragmentation has become a continuous process with land holdings and land parcels getting smaller and smaller as they have been dispersed to successive generations [30]. There is empirical evidence that inheritance is the prominent factor for land fragmentation in many places such as in medieval England [31], in the Netherlands [32] and in Cyprus [33]. This strong relationship between inheritance and land fragmentation has also been demonstrated in a Portuguese study (Silva 1983; cited in [1]).

Population growth, which is linked with inheritance [2, 8, 34–36], involves increasing demand for land acquisition. However, there are some contradictory views about this issue. In particular, [37–39] claim that population increase is a contributing factor towards better land management and increasing agricultural production. Similar views have been expressed also by Homans [40]. These views contest those of the majority of other scholars causing some confusion.

Since land is a multi-purpose resource, land markets play an important role in the whole process of ownership restructuring, because people wish to acquire a piece of land not only for agricultural activities, but also for other reasons such as investments, enhancing personal prestige and status, and having secure current and future living conditions for the family. Grigg [41] notes that acquiring land is among the most important aims of many people in different societies all over the world. In principle, land markets contribute to further fragmentation of the existing holdings since, in most cases, farmers purchase land which is not continuous to their existing holdings or they (or other people) may purchase pieces of land as shares in other parcels. However, in some cases, land purchase may reduce land fragmentation when farmers acquire neighbourhood pieces of land to expand their holdings.

Historical and cultural perspectives, which prevailed in old communities (such as in Europe), were inevitably the cause of land fragmentation. Some authors consider that the current problem of land fragmentation is a result of the historical legacy of an ancient field structure [1]. In those times, land fragmentation was

adaptive to the prevailing conditions, i.e. small fields for acquiring a family's subsistence, manual or animal cultivation, cheap labour, small production, etc. However, these conditions are not well suited to current modern agricultural mechanization demands.

2.2.4 Disadvantages and Advantages

Although land fragmentation is generally considered as a fundamental rural spatial problem due to many disadvantages and its impacts, it is not a problem by definition in all cases because it can also be beneficial. In particular, the most prominent disadvantage is the increase of economic costs because it hinders mechanisation, causes inefficiencies in production and involves large costs to alleviate its effects. As a result, agricultural productivity and hence income are reduced. Namely, Karouzis [42] found that farmers (in a region in Cyprus with an average of 22 parcels per holding) needed to travel almost 4,000 km annually to visit their scattered parcels. Another economic drawback is that fragmentation limits the desire of a farmer to modernize or rationalise his/her holding by introducing new agricultural techniques such as machinery, irrigation systems and fencing while also preventing the introduction of new crops, disease controls, etc. This is due to small parcel size; a remarkable statistic is that a tractor may spend up to one third of its time turning round on a one hectare parcel [43].

In addition to the economic impacts, King and Burton [44] support the view that fragmentation may have social and psychological impacts with consequently wider repercussions across the agricultural sector or within a certain community as a whole. More specifically, an organised land tenure structure in a rural community may raise the status of certain farmers and improve communication and cooperation among them. Also, it may reduce inequalities among farmers which have less agricultural problems due to fragmentation. King and Burton [3] also emphasise the social tension caused by disputes over ownership, especially in the case of shared and multiple ownerships. As a result, litigation sometimes leads to serious conflicts and court settlement.

While most studies tend to focus on the negative impacts of land fragmentation in agriculture, sometimes land fragmentation offers benefits and sometimes may be desirable or even necessary [3]. Namely, literature concentrates on three main benefits: risk management; crop scheduling; and ecological variety. In particular, risk management may minimise the potential risk due to climatic and natural disasters (e.g. storms, frosts, fire, floods, etc.) because risk is spread spatially [1, 3, 28, 45, 29]. Also, risk management involves the logical reduction of risk by giving a farmer a variety of soils, crops and growing conditions, by virtue of the spatial dispersion of parcels [29]. This situation is especially a reality in Alpine and monsoon areas.

In addition, crop scheduling may be favoured when parcels are scattered between various locations at different altitudes because crops ripen at different

times. Thus, a farmer may adjust his labour force according to a schedule so as to avoid labour bottlenecks. For example, crop scheduling through altitude zones was very important in some villages in the Swiss Alps, for the mowing of hay. Also, crop scheduling is possible on the island of Pantelleria (Italy) since grapes ripen at different times; a household with scattered parcels may harvest all of its grapes without extra labour [46]. The advantages of crop scheduling is not limited to mountainous areas; [47], for example, indicates that crop scheduling has allowed farmers in England to maximise their self-employment and minimise the amount of hired labour needed.

Furthermore, fragmentation may also offer ecological benefits by formulating a natural mosaic of parcel shapes and crops. In contrast, regular parcel shapes, especially in semi-mountainous and mountainous areas are not so harmonious with the landscape and they may create a ‘foreign’ aesthetic value. In addition, small parcels are less exposed to winds and hence to crop diseases and to soil erosion. Moreover, some non-economic and social benefits of fragmentation are offered by the fact that scattered parcels will be distributed more easily to the heirs of a holding. Also, in some communities in which cultivation is still subsistence based, then fragmentation really offers the advantages mentioned above.

2.2.5 Indicators

Land fragmentation is a spatial problem which depends on many parameters. King and Burton [3] cite the following six relevant factors: holding size; number of parcels belonging to the holding; size of each parcel; shape of each parcel; the spatial distribution of parcels; and the size distribution of parcels. In Cyprus, land fragmentation has additional complexities including the lack of road access to land parcels and problematic ownership rights [48]. For example, a parcel may be owned in undivided shares, i.e. it may belong to more than one landowner; or a parcel may have dual or multiple ownership, i.e. the land is owned by one person whilst the trees growing on the land are owned by someone else and a third party has ownership rights to the water. In addition, a land parcel may not have a title deed. The existence of all these different factors highlights the complexity of representing and measuring land fragmentation.

There appears to be no standard measurement of land fragmentation [1, 29] and no index takes into account all of the above mentioned factors [49]. Shuhao [50] distinguished single indicators of land fragmentation from indices based on integrated indicators that utilise more than one variable. Most authors who tried to measure fragmentation have used a simple average of the number of parcels per holding (either regional or national), an average of holding size and an average of parcel size. Some others developed more complicated descriptors. In particular, Edwards [51] calculated a fragmentation index as the percentage of a holding’s land which is not adjacent to the farmstead. In addition, Simmons [52] proposed a land fragmentation index which took into account the number of parcels in a

holding and the relative size of each parcel. The formula for Simmons's land fragmentation index is as follows:

$$FI = \frac{\sum_{i=1}^n a_i^2}{A^2} \quad (2.1)$$

where FI is the fragmentation index, n is the number of parcels belong to a holding, a is the size of a parcel and A is the total holding size. An FI value of 1 means that a holding consists of only one parcel and values closer to zero mean higher fragmentation. The Simmons index becomes the Simpson index if it is subtracted from 1 [50].

Furthermore, Dovring [53] computed fragmentation by measuring the distance which a farmer would have to travel to reach each of his parcels, returning back to his farmstead after each visit although it ignores the number of actual visits per year and the potential that any parcel could be visited without returning back to the farmstead. Moreover, Januszewski [54] developed a similar fragmentation index to Simmons, combining the number of parcels per holding and their size distribution into a K index as follows:

$$K = \frac{\sqrt{\sum_{i=1}^n a_i}}{\sum_{i=1}^n \sqrt{a_i}} \quad (2.2)$$

where n is the number of parcels and a is the parcel size. The K values range from 0 to 1. As values tend to zero, K indicates a high degree of fragmentation. This index has three main properties: the degree of fragmentation increases proportionally with the number of parcels; fragmentation increases when the range of parcel sizes is small and fragmentation decreases as the area of large parcels increases and that of small parcels decreases. Blarel et al. [55] note that Januszewski and Simmons indices are the most popular.

Igozurike [56] suggested a 'relative index of land parcellization'. In contrast to the above indexes, this measure is based on the average size of the parcels and the distance travelled by a farmer to visit all his parcels sequentially (i.e. in one round trip). This index is given by the following equation:

$$P_i = \frac{1}{\frac{\bar{S}_i}{100}} Dt \quad (2.3)$$

where P_i is the fragmentation (or parcellization) index of holding i , \bar{S}_i is the size of each parcel and Dt is the total round-trip distance covering all parcels. King and Burton [3] criticized this index because distance has not been clearly defined by the researcher and is overemphasized, without taking into account the number of parcels. An example is quoted based on a holding with two parcels with size \bar{S}_i and

a distance of 10 km apart, which would give a P_i twice as high as a holding with 10 parcels of size S , each 1 km from its neighbours.

Schmook [57] defined a fragmentation index called P_o , which is the ratio between the area of a polygon which circumscribes all the parcels of a holding, to the area of that holding. Values of this index are always above 1; a high P_o value indicates intense fragmentation. Schmook also suggested another fragmentation coefficient which is calculated by dividing the average distance to parcels by the mean parcel size.

The above presentation of current indices indicates that all have three significant disadvantages [58, 59]. First, they are not comprehensive since, at best, they take into account three factors which can be correlated (i.e. the number of parcels, the size of each parcel and the size of the whole ownership); hence they ignore significant spatial factors such as the dispersion of parcels per ownership and the shape of parcels and also non-spatial factors such as the type of ownership and the existence of accessibility of a parcel to a road. Second, they are not flexible because they are represented by standard mathematical equations and hence therefore a planner is not able to select which factors should be accounted for in a particular project. Third, they are not problem specific since the factors are equally weighted, which may not be true for all cases. As a result of these deficiencies, the existing land fragmentation indices cannot adequately represent the land fragmentation problem; hence their outcome can be misleading and may lead to wrong decisions. Therefore, it is clear that there is a need for a new methodology for measuring land fragmentation that will be able to overcome the noted deficiencies and hence be more reliable and accurate. This demand is addressed by objective 3 of this research which is elaborated in [Chap. 7](#).

2.3 Policies to Control Land Fragmentation

Once a Government assesses that land fragmentation constitutes a problem for rational agricultural development, there are three strategies to be followed. The first strategy is to promote legislation regarding aspects that affect land fragmentation so as to prevent a worsening of the problem. In particular, legal provisions, most of which are restrictions, involve changing legislation regarding inheritance, minimum size of parcel division, absentee landowners, prevention of transfer to non-farmers, leasing, imposing a maximum limit on the size of a holding etc. Some of these legal restrictions that have been applied in EU countries in the past, or they are currently applied in non-European countries such as India and Nepal, could be considered as non-democratic and unconstitutional according to the current institutional framework of the EU.

The second strategy is to apply specific land management approaches to tackle certain problems in particular agricultural areas. The main land management approaches used to battle land fragmentation in agriculture are: land consolidation; land funds and land banking; voluntary parcel exchange; and cooperative farming.

Namely, land consolidation is the prominent land management measure applied as a solution to land fragmentation that involves the reorganisation of space by reconfiguring the land tenure structure in terms of parcels and landowners and the provision of appropriate infrastructure according to the aims of a scheme. As a result, production and hence the income of farmers are increased. Extensive analysis of land consolidation follows in the next chapter.

Land funds and land banking is the process when a landowner is not interested in extending his landholding but in distributing it to other established farms. Thus, in such a case, his land may be used as a land buffer. More specifically, a land buffer is available for the improvement of other farms and the construction of agricultural infrastructure such as roads, irrigation and drainage systems. The land buffer itself is a land fund which can be used as an agricultural policy tool, and its use is referred to as land banking [5]. Land funds and land banking have mainly been used in Western Central European countries such as Germany and the Netherlands.

Voluntary parcel exchange involves the exchange of parcels among three or more landowners resulting in a more efficient spatial layout since the aim is to group adjacent parcels of each landowner. Some Western European countries such as Germany and the Netherlands have used this measure for a long time. Cooperative farming involves the joint cultivation of land by a group of households. It was considered by some Asian countries such as India and Nepal until 1970 as an effective solution to land fragmentation, through the creation of economically operational farm units. However, according to Niroula and Thapa [16], the practical experience has shown negative results, mainly because of the reluctance of landowners to participate in these programmes. Reluctance is due to conflicting interests and perceptions among landowners and the fear of losing their rights. As a result, the whole attempt has collapsed.

The third strategy is to apply specific land protection policies/programmes to prevent agricultural land from being developed for housing or commercial use. This strategy has been applied in the United States in regions/zones where there is a mixed land use, i.e. agricultural and housing [60]. In particular, these policies, i.e. a purchase of development rights (PDR) programme; a clustering programme; and a transfer of development rights (TDR) programme, aim to prevent agricultural land fragmentation because of urban sprawl. The PDR programme involves the use of public funds for purchasing and funding to eliminate the development rights on agricultural land. It is a farmland conservation tool which is considered very effective, is fair to landowners and provides a permanent solution. The most common disadvantage is its high cost of implementation.

A TDR programme, which is applied at a regional scale, concerns a specific area to be protected from development (i.e. the sending area) and an area where development will be allowed to occur (i.e. the receiving area). The programme involves the transfer of the development rights of a parcel located in the sending area to another parcel of the receiving area. This program, which is mandatory, is considered to be the most aggressive in terms of preserving farmland. In contrast to the PDR and TDR policies, which refer to a regional scale, cluster development

programmes focus on development on a site by site basis. Cluster programmes work with the zoning density, reducing minimum parcel sizes and ensuring that a part of the site remains as open space. Despite this strategy being popular among various communities, it is not regarded as a very effective tool to protect agricultural land bases.

A study carried out by Brabec and Smith [60] showed that TDR and PDR programmes are the most successful in terms of the total area of land protected. The clustering program proved unable to achieve the protection of a large amount of land. On the other hand, TDR and PDR programmes have achieved better results regarding an increase in the size and the continuity of parcels than the clustering programme.

A very important point emphasised by Van Dijk [5] is the fact that any land policy applied in one country may not be able to be applied in the same way in another country. Thus, a Government, before considering the adoption of a land policy, should be aware of the prevailing conditions and circumstances of its country; otherwise many problems can arise and failure will be inevitable.

2.4 The Extent of the Problem at the Global and EU Level

Land fragmentation is evident in many areas throughout the world. The following sections consider the current situation regarding land fragmentation in 113 countries in six continents, followed by a deeper analysis for EU countries. The data have originated from the most recent agricultural censuses published by FAO and the European Commission [61–63], respectively. It should be noted that these figures refer to averages for a country. However, it is known that land fragmentation may differ significantly from these figures from region to region within a country.

2.4.1 Land Fragmentation at a Global Level

Even though land fragmentation has been closely associated with Europe and Mediterranean countries, it has been studied in many other countries and regions all over the world: for example, in South Asia [16]; Bangladesh [64]; Vietnam [29], China [13, 28, 50, 65]; Taiwan [66]; Turkey [67]; USA [60, 68, 69, 70]; Nepal [71]; India [72, 73]; Ethiopia [55, 74]; Ghana and Rwanda [55]; Israel [75]; South Asian countries South Asian countries [76]; Jordan [77]; Peru [78]; and Syria [79].

The FAO publishes National Agricultural Census results referring to the 1980, 1990 and 2000 rounds. Countries are grouped in six continents (Africa, Asia, Europe, North and Central America, South America and Oceania). Table A.1.1 in Appendix A shows by continent, the average holding size and average number of

parcels per holding for 113 countries based on the latest available data provided by FAO from 1986 to 2004. In particular, it is indicated that the smallest average holding size is found in Asian and African countries where in 20 out of 24 and 16 out of 20 countries, respectively, it is less than 5 ha. In almost half of the Central American and Oceania countries, the average holding size is less than 5 ha. In contrast, the situation is completely different in South American and European countries where 10 out of 10 and 23 out of 28 countries respectively have an average holding size higher than 5 ha. In the case of European countries, this figure is due to the extensive adoption of appropriate policies to control land fragmentation and particularly the implementation of land consolidation schemes in all European countries (at least in some period). As a result, the average size of holdings in Europe presents an almost normal distribution since 10 countries have more than 40 ha, 10 countries have between 10–40 ha and 8 countries have less than 10 ha.

It is also remarkable that some countries have an even smaller average land holding size which indicates serious land fragmentation; six Asian and four African countries have an average land holding size of less than 1 ha. The Asian countries and the corresponding values are: Bangladesh (0.35 ha), Sri Lanka (0.5 ha), China (0.67 ha), Vietnam (0.71 ha), Nepal (0.79 ha) and Indonesia (0.79 ha). Not only are these land holdings extremely small, but each land holding consists of about 1.8 parcels, a fact that exaggerates the problem. The African countries are: Congo (0.5 ha), Comoros (0.6 ha), Malawi (0.7 ha) and Egypt (0.82 ha). Some of these countries are among the most densely populated countries of the world, which is a factor strongly related to land fragmentation; Bangladesh is ranked 9th, China 14th, Comoros 27th, Sri Lanka 38th, Vietnam 48th and Nepal 59th among the 238 countries of the world.

At the other end of the scale, five countries have much higher average land holding size. Australia has a figure of 3,243.21 ha, which is the highest of all countries. Other countries with high figures are: Brazil (582.45 ha), Uruguay (287.40 ha), Canada (273.38 ha) and the USA (178.35 ha). According to the data provided by the European Commission which are more recent than FAO data, the highest figure for EU countries is for Slovakia (172.1 ha). Undoubtedly, the data in Table A.1.1 have a strong relation with the size of each country since Canada (2nd), USA (4th), Brazil (5th) and Australia (6th) are among the six largest countries in the world. Population density is also another factor justifying the figures. In particular, Australia (232nd), Canada (227th), Brazil (189th) and the USA (177th) are among the least densely populated countries in the world. On the other hand, all EU countries (except Finland, 198th, Sweden, 192nd and Estonia, 179th) are more densely populated than the last ranked country (i.e. USA) of the previous group.

2.4.2 Land Fragmentation in the European Union

The problem of land fragmentation in Europe and particularly in Mediterranean countries has been identified a long time ago [45, 66]. Further to these general studies about land fragmentation in Europe, other studies focused on particular EU countries such as Cyprus [18, 33]; Portugal [80]; Greece [81]; Czech Republic [82]; Romania [83]; Bulgaria, Germany, Hungary, Romania and Slovenia [84, 85].

The European Commission carries out statistical agricultural analyses and prepares relevant reports about farm structure in EU countries. These reports, which are based on the national agricultural censuses of each member state, include some specific sections about land fragmentation. There are three dominant reports which cover farm structure statistics for the period 1966–2003. The first was published in 2000 for the period from 1966/1967 to 1997; the second one was published in 2003 covering the period 1999/2000 and the last one was published in 2005 and refers to a survey of 2003 about the EU-27 countries. Data were extracted from these reports and (after some processing) are presented as basic land fragmentation statistics as described below.

Table 2.1 shows the average agricultural area per holding (in hectares) in EU countries for the decade 1993–2003. It shows a linear rising trend in the average agricultural area per holding for all the countries during the whole period of the study. This finding is also revealed in the results for EU-12 and EU-15. It is remarkable that a significant rise in this measure has been observed in some countries such as Portugal (67.90 %), Germany (54.09 %), Italy (50.85 %), Luxemburg (48.13 %), Sweden (47.96 %), Denmark (47.43 %), the Netherlands (39.88 %), France (39.32 %) and Finland (39.17 %). Smaller increases are evident in other countries.

In terms of numbers, the reason for this increase over time is the general decline in the number of holdings and the rather stable level in the total agricultural area. In reality, this increase is the result of the agricultural policies adopted by the EU for improving farm structure conditions for more effective and productive agriculture. While before 1999/2000 the UK had the highest average agricultural area per holding since its accession to the European Community in 1975, Slovakia, which joined the EU on 1 May 2004, has now gained this position based on the 2003 agricultural census with 172.1 ha. The Czech Republic follows with 143.8 ha and then the UK with 85.2. The phenomenon in Slovakia and the Czech Republic is due to the fact that, although after the collapse of communism 70 % of the agricultural land (in Czech Republic) passed to private landowners, the former have united their land in bigger enterprises. A similar situation exists in Slovenia [5]. Other countries with relatively high figures are Luxembourg (55.4 ha), Denmark (54.7 ha), Sweden (50.9 ha), France (48.9 ha) and Germany (43.3 ha). In contrast, the average area per holding is less than 10 ha in Malta (1.3 ha), Cyprus (5.2 ha), Greece (5.9 ha), Slovenia (7.3 ha) and Italy (8.9 ha). Figures for the other countries range in the middle, i.e. between 12 and 34 ha.

Table 2.1 Average agricultural area per holding in EU countries, 1993–2003

	1993	1995	1997	1999/2000	2003
EU-25	–	–	–	–	22.6
NMS-10	–	–	–	–	17.9
EU-15		17.4	18.4	22.2	24
EU-12	16.4	17.2	18.2	18.4	–
Belgium	17.6	19.1	20.6	23.7	26.4
Czech Republic	–	–	–	–	143.8
Denmark	37.1	39.6	42.6	45.8	54.7
Germany	28.1	30.3	32.1	37.6	43.3
Estonia	–	–	–	–	48.3
Greece	4.3	4.5	4.3	5.3	5.9
Spain	17.9	19.7	21.2	21.7	23.2
France	35.1	38.5	41.7	45.8	48.9
Ireland	26.8	28.2	29.4	32.9	33.8
Italy	5.9	5.9	6.4	8.2	8.9
Cyprus	–	–	–	–	5.2
Latvia	–	–	–	20.5	22.8
Lithuania	–	–	–	–	20.4
Luxembourg	37.4	39.9	42.5	48.2	55.4
Hungary	–	–	–	22.7	25.3
Malta	–	–	:	:	1.3
Netherlands	16.8	17.7	18.6	20	23.5
Austria		15.4	16.3	17.1	19.3
Poland	–	–	–	–	12.2
Portugal	8.1	8.7	9.2	11.9	13.6
Slovenia	–	–	–	6.8	7.3
Slovakia	–	–	–	171.4	172.1
Finland	–	21.7	23.7	28.3	30.2
Sweden	–	34.4	34.7	40.5	50.9
United Kingdom	67.3	70.1	69.3	84.6	85.2

Source European Commission [63]

The distribution by size class (Table A.2.1 in Appendix) indicates that the large majority of European holdings are relatively small in size since 75.7 % (EU-27 in 2003) of all holdings use less than 5 ha. It is noticeable that there was a continuous increase in the proportion of small parcels with every EU enlargement. Namely, for EU-15 and EU-25, the percentage of small parcels was 60.4 and 63.1, respectively. It is also remarkable that this percentage increased significantly by 12.6 % in the last EU enlargement (1 January 2007) when only two new state members joined, i.e. Bulgaria and Romania. This is due to the fact that 95.6 % and 98.8 % of their holdings, correspondingly, are less than 5 ha. The highest shares in the number of holdings with a size of less than 5 ha are found in Romania (98.8 %), Malta and Hungary (97 %), Slovakia (96.2 %), Bulgaria (95.62 %), Cyprus (87.6 %), Italy (87.3 %) and Portugal (85 %). Three of these countries, i.e. Malta, Cyprus and Italy are Mediterranean countries, a region for which early

evidence exists for land fragmentation. Shaw [45] and Burton and King [33] note that there is an excessive land fragmentation in the Mediterranean region, mainly because they contain long-settled peasant communities.

The other four countries, i.e. Romania, Hungary, Slovakia and Bulgaria are ex-Communist Central European countries which, after 1989 and the collapse of the iron curtain, passed into a privatisation process (in terms of land as well). By then, agricultural land was under the control of the state in the form of 'state' and 'collective' farms. State farms were owned absolutely by the state. Collective farms involved transferring only part of the rights to land from the landowners to the collective: the right to use and alienate. According to Swinnen et al. (1997), 78.4 and 21.1 % of agricultural land in Bulgaria was in collective and state farms respectively. The figures for Hungary and Romania were: 71.4 and 14.9 %, and 54.7 and 28.9 %, respectively. After the transition of the political systems to a free market, total land tenure restructuring took place. As a result, the figures on the land fragmentation in these countries show quite a varied pattern. In the case of the countries mentioned above, a large number of small farms use a relatively modest share of the total agricultural land [5].

A different situation, i.e. where the proportion of small holdings is limited to around 10 %, occurs in Denmark (3.7 %), Ireland (6.5 %), Sweden (9.3 %) and Finland (10.5 %). Three out of four are Scandinavian countries. This may be due to the fact that these countries have a very long tradition of land consolidation projects (i.e. the first land consolidation act was prepared in Denmark in 1781). At the other end of the spectrum, holdings with more than 50 ha account for some 4.65 % for EU-27. Among the member states, based on the 2003 census, Luxembourg presents the largest proportion of such holdings with 45.9 %, followed by France and Denmark (35.65 %), UK (26.3 %), Sweden (25.4 %) and Germany (21.4 %). Also, these countries (except for the UK which has applied a form of land consolidation since the 15th century and there is no evidence after that) has a long tradition of land consolidation projects.

The above analysis suggests that agricultural land is still fragmented in most EU countries. However as noted, this is not a problem in principle. Thus, every country should be aware of this potential problem and its consequences so as to adopt the proper land policies noted earlier based on its distinct conditions.

2.5 Land Tenure in Cyprus and its Problems

2.5.1 Historical Evolution of the Cypriot Land Tenure System

The land tenure system of a country plays an important role in its socio-economic development since it defines the framework for managing one of the most important resources, i.e. land. Thus, land tenure has always had a dominant and

multi-dimensional role in Cypriot society [86] due to: the importance of the island because of its strategic location i.e. it is among three continents: Europe, Africa and Asia; the small size of the island (its extent is 9,250 km²); and the strong relationship of Cypriots with land that extends beyond its economic value. The present land tenure system is a result of a long historical evolution which started in the Neolithic era around 7000 BC and the numerous conquests of the island [15]. In particular, each of the long list of colonisers, i.e. Greeks, Romans, Byzantines, Lusignans, Venetians, Ottomans and British left a contribution to the evolving agrarian land structure [33].

In particular, the most significant historical periods that influenced the land tenure structure are the following: the Neolithic age (7000–3900 BC), for which there is archaeological evidence that from the 6th millennium B.C. Cypriots practiced agriculture on a communal basis (Land and Surveys Department 2008); the Bronze Age (2500–1050 BC) during which the idea of individual ownership in Cyprus had arisen by the Greek settlers in about 1400 BC [15]; the historical periods (1050 BC–330 AD) when the 'idalio' inscription was excavated (5th century BC) at Dali village, which can be described as a 'title to land', indicating the development of private ownership in ancient Cyprus; and the Hellenistic period (325–58BC) when private ownership, even at a small scale, consisted of houses, vineyards and gardens or else emerged from the hereditary leasing of land to royal peasants.

In addition, during the Ottoman period (1571–1878), all the land belonged to the Sultan, although for practical reasons, the peasants were the owners of the land they cultivated. It was actually a kind of feudalism. As in other parts of the Ottoman Empire, taxes were very heavy and unbearable for most people. Thus, many pious people donated and granted their land to the Church to avoid taxes and the possibility of seizure by officials, while they could cultivate their land and gain the benefits from it. Furthermore, once the property passed to the Church (monasteries), it was safe, since the Church had certain privileges. Feudalism was abolished when the new Ottoman Land Code of 1850 was introduced [33]. The most important provision of the code was that land was grouped into five categories which led to the registration system. Thus, private rights spread, rights of possession were registered and land inheritance and transfer via sale became possible. The aim of all these measures was to increase revenue from taxes. This Ottoman Code was in force until 1946, i.e. far after the termination of the Ottoman Empire in Cyprus. Afterwards, during the British period (1878–1960), a general survey carried out from 1909 to 1929 attempted to put order into the cadastral chaos and the introduction of the Immovable Property Law in 1946 aimed at reducing land fragmentation.

Eventually, Cyprus became an independent country in 1960 and its constitution safeguarded private and ownership rights. Despite the fact that the British left a well-organised cadastral situation in terms of the land administration system and an excellent (for those times) geodetic and cartographic infrastructure, land fragmentation gradually extended to become a serious problem which hampered agricultural development. Therefore, in March 1969, a Land Consolidation Act

was established in Cyprus as a result of a long effort begun before independence aiming at controlling land fragmentation. Thereafter, in December 1970, the first land consolidation project began, in the Kissonerga village in Pafos District.

It is also worthwhile to note that further to the conventional land fragmentation problems in Cyprus there was the physical fragmentation of people from their properties and their places of origin, imposed by Turkey and its troops following the invasion of Cyprus in 1974. As a result, 38 % of the whole island (the northern part) is occupied by Turkey and it is still not under the control of the Republic. Cyprus (as a whole country) joined the EU on 1 May 2004 when many new political, economic, and social prospects appeared. However, heavy competition in the agricultural sector in the EU and the continuous decline of this sector in Cyprus, required integrated rural programmes, a part of which can be land consolidation.

2.5.2 Causes of Land Fragmentation

Generally, causes of land fragmentation in Cyprus follow the common reasons referred to in [Sect. 2.2.3](#). However, every country has its own, distinct circumstances. Thus, a series of reasons are associated with land fragmentation in Cyprus. In particular, according to Inheritance Law, upon the death of an owner, his/her property is divided among his/her heirs unless there is a different agreement among them. In most cases, particularly in the past, all parcels of the deceased were fragmented and divided between all the heirs. However, with the introduction of the Immovable Property Law in 1946 during the British colonisation, parcels cannot be sub-divided among all heirs but only the holding. As a result, parcels are split in undivided shares. Separate entire parcels can be obtained by the heirs only if they have a size beyond a limit defined by the Immovable Property Law.

Furthermore, according to the Immovable property (Tenure, Registration and Valuation) Law, any vineyard, orchard, grove or land irrigated or capable of being irrigated from a seasonal source of water can be divided into holdings of up to one donum (0.13 ha) in extent. Also land used for agricultural purposes which is not irrigated either from a permanent or a seasonal source of water, can be divided into separate holdings of not less than five donums (0.67 ha) in extent. These very low figures, coupled with the Inheritance Law, permit the fragmentation of the property and its subdivision into tiny parcels of land.

In addition, the increase in population is another cause of fragmentation. Namely, the population of the Republic of Cyprus (only the free part) was 789,258 inhabitants in 2008, which has increased by 16.9 % from 1998. Also, the percentage of the most active and largest age group, i.e. those aged 25–49, rose from 35.7 % of the total population in 1997 to 37.4 % in 2008. As a result, the pressure on the land and particularly the need for land ownership rose as well. People living in agricultural areas or employed in towns or abroad, continue to own land and eventually they pass it over to their children.

Another reason for the existence of land fragmentation is the fact that sometimes it is desirable, e.g. to reduce crop risk as noted earlier. In addition, morphological and parcel sub-division may render the creation of small parcels inevitable. Also, the strong relation of Cypriots with land has made land ownership very popular for social, economic, emotional, cultural and other reasons. Furthermore, the fact that a limited housing development (in most cases just the building of one house) is permitted in agricultural land if a parcel fulfils certain criteria (e.g. access to a registered road, etc.) favours investments by non-farmers and hence further fragmentation. Moreover, the fact that land can be easily, quickly and trustworthily transferred from person to person via the Department of Lands and Surveys (one of the oldest and largest departments of the Republic of Cyprus) creates a plethora of owners, a process that automatically leads to fragmentation.

2.5.3 Land Tenure Trends

The major land tenure types encountered in Cyprus based on the last four agricultural censuses carried out in 1977, 1985, 1994 and 2003 are shown in Table 2.2. Private land, i.e. the land that belongs to private individuals or households accounts for about 97–99 % of the total number of holdings and for 85–93 % of the total area enumerated in the censuses. It constitutes the prominent type of land ownership in Cyprus. The total number of agricultural holdings increased from 1977 to 1985 and from 1985 to 1994 (7.71 and 7.11 % respectively) but a considerable decrease has occurred from 1994 to 2003 (11.57 %). On the other hand, the total cultivated area shows a continuous decline for all the censuses; this ranges from 2.75 to 7.48 %. The last result is in accordance with the gradual and continuous drop of the agricultural sector after 1970. In particular, the agricultural sector's share to the GDP has been decreasing: from 18 % in 1970 to 10 % in 1980 to 7.2 % in 1990 to 6.3 % in 1998 to 3.8 % in 2004 and 2.7 % in 2007. This evolution is attributed to the relatively low-income elasticity of demand for agricultural products, the urbanisation trend and the reallocation of productive resources from agriculture to other more profitable economic activities such as light manufacturing and services.

Joint land holders or partnerships refer to land which is held by or rented jointly by two or more individuals. The number of these holdings decreased from 325 in 1977 to 270 in 1985 and significantly increased to 554 in 1994. This constitutes a small portion of the total number of holdings, ranging from 0.56 to 1.06 %. This land category has not been recorded in the 2003 census. The number of holdings possessed by companies presents a stable increase for the first three censuses and a small decrease in 2003. It is remarkable that the number of holdings owned by companies rose significantly from 95 in 1977 to 303 in 1985 and 526 in 1994. This is due to the fact that agriculture began around the 1970s, developing (despite its decline in terms of its contribution to the GDP share) a more organised base, so

Table 2.2 The major land tenure trends in Cyprus, 1977–2003

Year/Land tenure type	Holdings		Area	
	Number	%	Hectares	%
<i>1977</i>				
Private land	43,867	98.53	172,003.73	85.68
Joint holders land	325	0.73	2,905	1.45
Company land	95	0.21	6,617.99	3.30
Co-operatives land	4	0.01	33.18	0.02
State land	24	0.05	1,259.65	0.63
Community land	16	0.04	94.31	0.05
Church land	163	0.37	6,705.35	3.34
Other	28	0.06	11,140.9	5.55
Total	44,522	100.00	200,760	100.00
<i>1985</i>				
Private land	47,251	98.35	159,131.87	88.85
Joint holders land	270	0.56	2,429.14	1.36
Company land	303	0.63	6,693.98	3.74
Co-operatives land	11	0.02	862.6	0.48
State land	15	0.03	632.64	0.35
Community land	16	0.03	1,213.9	0.68
Church land	168	0.35	7,661.6	4.28
Other	12	0.02	473.44	0.26
Total	48,046	100.00	179,099.17	100.00
<i>1994</i>				
Private land	50,610	97.16	154,751.45	87.07
Joint holders land	554	1.06	5,541.75	3.12
Company land	526	1.01	8,950.95	5.04
Co-operatives land	14	0.03	313.98	0.18
State land	145	0.28	1,675.84	0.94
Community land	29	0.06	1,053.5	0.59
Church land	176	0.34	4,988.58	2.81
Other	35	0.07	454.58	0.26
Total	52,089	100.00	177,730.63	100.00
<i>2003</i>				
Private land	44,752	99.01	145,341.7	92.94
Companies	381	0.84	8,719.2	5.58
Public or government	45	0.10	1,866.4	1.19
Other	21	0.05	452.4	0.29
Total	45,199	100.00	156,379.7	100.00

Source Republic of Cyprus, Censuses of Agriculture 1977, 1985, 1994 and 2003

Notes 1 The above figures refer only to the free part of Cyprus which is under the control of the Republic of Cyprus and not to the occupied part

Notes 2 The figures for 2003 are grouped in four land categories instead of eight as in the previous censuses

many companies acquired agricultural land and they began to operate as agricultural units. The Church, for historical reasons mentioned above, has always been a landowner, owning on average 0.35 % of the total number of agricultural holdings, while it actually holds a greater percentage that is not recorded as agricultural land. Also, a noticeable figure in Table 2.2 is the significant increase in the number of state land holdings enumerated in 1994 (145) compared to previous censuses, i.e. in 1977 (24) and in 1985 (15).

2.5.4 Land Tenure Problems

Burton and King [33], Burton [15], Karouzis [86] and Demetriou et al. [48] point out that the land tenure structure in Cyprus is defective. A brief updated analysis of the main land tenure problems met in Cyprus, which comprises land fragmentation, follows. In particular, the average holding size based on the last six agricultural censuses is shown in Table 2.3.

It is obvious that the average holding size steadily diminished from 1946 to 1994 and then it remained stable until 2003. The fall in mean size from 1946 to 1994 is 51.74 %. It is the second smallest figure (2003 census) among the 27 EU countries (just after Malta, 1.3 ha) and the 46th among the 113 countries of the world. However, the figure varies significantly among the various regions of Cyprus and between dry and irrigated parcels [9].

Another useful figure regarding holding size is the distribution of holdings by size of area in fifteen classes, based on the 2003 census (Table 2.4). The direct comparison with the figures of the previous censuses is not possible since the area unit used was a donum (1 donum equals 1,337.78 m² or 0.133778 hectares) and a different class aggregation was used, so a simple conversion is not useful. The distribution by size class indicates that the large majority of holdings are relatively small in size since 87.4 % of all holdings use less than 5 ha and 54.2 % of this proportion refers to holdings with a smaller size than 1 ha. This figure classifies Cyprus as the sixth country among the EU-27 with the highest percentage of holdings with less area than 5 ha. In contrast, at the other end of the spectrum, only

Table 2.3 The average holding size, 1946–2003

Census year	Average holding size (ha)
1946	7.17
1960	6.23
1977	4.59
1985	3.79
1994	3.46
2003	3.50

Source Republic of Cyprus, Census of Agriculture 1946–2003

Table 2.4 Distribution of holdings by size, 2003

Size class (ha)	Number	Percentage	Cumulative percentage
<0.5	15,561	34.88	34.88
0.5–1	8,631	19.35	54.23
1–2	7,544	16.91	71.14
2–3	3,741	8.39	79.53
3–5	3,499	7.84	87.37
5–8	2,156	4.83	92.20
8–10	696	1.56	93.76
10–15	1,011	2.27	96.03
15–20	511	1.15	97.17
20–25	260	0.58	97.76
25–30	213	0.48	98.23
30–40	231	0.52	98.75
40–50	141	0.32	99.07
50–100	256	0.57	99.64
>100	160	0.36	100.00

Source Republic of Cyprus, Census of Agriculture 2003

2.8 % of the holdings have a size larger than 20 ha. Only 9.8 % of the holdings fall in the middle-sized class, i.e. from 5 to 20 ha.

Table 2.5 shows land tenure trends by size of holding from 1946 to 1994 for four classes: small holdings (0–5 donums), medium holdings (5–20 donums), large holdings (20–60) and very large holdings (more than 60 donums). It is apparent that there is a continuous increasing trend in the proportion of small and medium-sized holdings from 5.3 to 29.1 % and 27.1 to 38.7 % respectively, throughout the 8-year period. In contrast, the share of the large-sized holdings presents a continuous decreasing trend from 37.5 to 23.93 % during the study period. The percentage of very large holdings shows a dramatic fall from 30.1 to only 8.26 %. These figures clearly indicate a gradual increase in the problem of land fragmentation.

Table 2.6 presents the mean number of parcels per holding and the mean size per parcel from 1946 to 2003. The mean number of parcels per holding falls over the years from 1946 to 1994 with the exception of a slight increase in 2003. In accordance with this, the mean parcel size gradually increases over the period 1946–1994 and slightly reduces between 1994 and 2003.

Table 2.5 Percentage of holdings by size class, 1946–1994

Size class (in donums)	1946	1960	1977	1985	1994
0–5	5.3	11.7	18.0	24.4	29.07
5–20	27.1	29.3	34.8	37.38	38.74
20–60	37.5	35.3	34.8	28.29	23.93
>60	30.1	23.7	12.4	9.93	8.26

Note 1 donum = 0.133778 ha

Source Republic of Cyprus, Census of Agriculture 1977–1994

Table 2.6 Mean number and mean size of parcels, 1946–2003

Census year	Mean number of Parcels per holding	Mean size per parcel (ha)
1946	12.7	0.56
1960	9.5	0.65
1977	6.4	0.71
1985	5.2	0.73
1994	4.5	0.77
2003	5.0	0.69

Source Republic of Cyprus, Census of Agriculture 1977–2003

Note Censuses of 1946 and 1960 refer to the whole of Cyprus. The other censuses refer only to the free part of Cyprus (and not to the northern part occupied by Turkish troops since 1974,) which is under the control of the Republic of Cyprus

Although land consolidation projects began in 1970 and land fragmentation then reduced significantly, in particular in the consolidated areas (which by 2008 constituted only 8.87 % of the total agricultural area enumerated in the 2003 census), the trend may not represent an actual reduction of fragmentation since it is potentially due to the significant growth of the smaller holding classes (i.e. 0–5 donums), a result that agrees with the findings of Karouzis [86] and Burton [15]. Karouzis [9] points out that the overall figure of the mean parcel size for the whole of Cyprus could be misleading since on a regional basis there are considerable differences. For example, regarding the 1960 census, he shows that the average parcel size for six regions ranges from 0.29 ha (in mountainous regions) to 2.1 ha (in coastal plain regions). It is clear that a large range and the existence of extreme values may give unreliable statistical results. In these cases, the median may provide a better representation of data than the mean.

Table 2.7 shows the percentage of holdings for six classes of number of parcels. It is clear that there is an upward trend in the proportion of holdings consisting of 1–3 parcels, a levelling out of holdings consisting of 4–5 parcels, a slight fall of holdings consisting of 6–9 parcels and a slump of the share of holdings with over 10 parcels. Despite this finding leading to the conclusion that land fragmentation reduced over time, it may be a misleading interpretation since results are in accordance with a continuous reduction of the cultivated area and the mean

Table 2.7 Percentage of holdings and number of parcels, 1977–2003

Number of parcels	1977	1985	1994	2003
1 parcel	20.0	26.5	30.3	34.8
2–3 parcels	23.7	27.5	30.1	31.5
4–5 parcels	16.2	15.3	15.3	13.8
6–9 parcels	18.8	16.1	13.9	10.8
10–15 parcels	21.3	9.2	6.5	5.0 ^a
16 and over	0.0	5.4	3.9	4.1 ^a

Source Republic of Cyprus, Census of Agriculture 1977–2003

Note ^a These figures are based on rough estimations since the aggregation of the number of parcels for the 2003 census was different than the previous ones

holding size (Tables 2.2 and 2.3). Robust results could only be obtained if the cultivated area was stable over time.

Further to the size and number of parcels per ownership, parcels are spatially dispersed all over village areas in neighbouring villages and in distant villages. As a result, a farmer has to travel long distances to carry out agricultural activities, hence the cost of production is increased and the income is decreased. Karouzis [23, 42] carried out a survey about the time wasted and distance travelled by the average Cypriot farmer in order to visit his scattered and fragmented agricultural holdings. He found that, on average, a farmer travels 1,357 km every year which absorbs 337 h or 15 % of the total working time. Burton and King [33] note that although someone may criticise Karouzis' methodology, the results are highly indicative of the irrational effects of land fragmentation.

Another problem is ownership in undivided shares that refers to a parcel which is owned by more than one landowner. Karouzis [9] notes that about 30 % of the agricultural land is owned in undivided shares. Also, Karouzis [23] found that the smaller the size of a plot is, the higher the number of plots held in undivided shares and the smaller the area occupied. He pointed out that the problem is prevalent in parcels with a size below 3 donums (0.4 ha). Some of the problems associated with parcels of this type include landowner disagreements regarding exploitation of a parcel, i.e. the kind of cultivation; execution of development works such as soil conservation, drainage, irrigation, etc. This form of ownership is not preferred by land purchasers, developers, etc. and landowners consider it as an ownership of secondary importance. Nevertheless, peasants very often find ways and means to operate the land and minimise the potential conflicts with their co-landowners.

Similarly to the previous problem are dual or multiple ownerships. Specifically, they refer to ownership for which the piece of land, the trees or even the water contained within it are owned by different landowners. Karouzis [9] and Burton [15] point out that the origin of this kind of ownership is in the Ottoman legislation. It is realised that this is an anachronistic and undesirable system of ownership with very negative effects on agriculture. Data from four land consolidation areas revealed that the portion of dual/multiple ownership ranges from 9.4 to 23.2 %.

Another significant problem is parcels having irregular shape. According to Karouzis [9, 23], regularly-shaped parcels for Cypriot conditions are considered to be the ones that fulfill the following five prerequisites: parcels that have parallel lines; parcels that have a distance between their sides of at least 30 m; parcels with no pointed edges; parcels of odd shape hindering cultivation; and parcels with an area of at least two donums (i.e. 0.27 ha). Parcels with irregular shapes are met in areas with intense relief whilst parcels with regular shapes are found in areas with low relief. This thesis examines this issue in detail and develops a new index for evaluating shapes called the parcel shape index (*PSI*) in Chap. 7.

Furthermore, the lack of road access of parcels also constitutes a prominent problem. Namely, the random lay-out of parcels, their irregular shape, small size and relevant costs make the provision of road access to every parcel an impossible task. Thus, most parcels are 'enclosed' and the only way they can be reached is by

traversing other parcels or by moving along the boundaries of nearby parcels. But such arrangements lead to frequent disputes between the neighbouring owners. In addition, considerable areas of land are left unexploited just because of the lack of a proper road network. Thus, the existence of registered road access for a parcel constitutes a privilege, which considerably increases its value.

All the above land tenure problems are considered in the new methodology for measuring land fragmentation discussed in [Chap. 7](#).

2.6 Conclusions

Although land fragmentation is not a problem by definition, it is considered by most commentators to be a serious obstacle which prevents rational agricultural development and in general rural sustainable development. Its main disadvantages are that it hinders mechanisation, causes inefficiencies in production and hence reduces the income of farmers. Land fragmentation is a universal phenomenon in the EU and other continents. Cyprus has been confronted by this problem for a long time ago and hence it has applied land consolidation measures since 1970 to eliminate land fragmentation. Planners and decision makers need a reliable metric for quantifying land fragmentation on which to base their decisions. However, existing land fragmentation indices presented in the literature suffer from significant weaknesses that may be misleading and support wrong decisions regarding adopting appropriate land management measures. As a result, there is a need for developing a new methodology for quantifying land fragmentation which is addressed by objective 3 of this research that is elaborated in [Chap. 7](#). The next chapter deals with the most effective land management approach for tackling the land fragmentation problem i.e. land consolidation.

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Decision Support System (IPDSS) for Land Consolidation
Demetriou, D.

2014, XX, 340 p. 121 illus., 45 illus. in color., Hardcover
ISBN: 978-3-319-02346-5