Manifestations and Underlying Drivers of Agricultural Land Use Change in Europe[1]

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[1] This text is a preprint. Please cite as: van Vliet J., H.L.F. de Groot, P. Rietveld, P.H. Verburg (2014): Manifestations and underlying drivers of agricultural land use change. Landscape and Urban Planning 133: 24–36. The original publication is available at: http://dx.doi.org/10.1016/j.landurbplan.2014.09.001.

Abstract

Agricultural land use in Europe has changed considerably in the last decades. However, our understanding of agricultural land use changes, especially changes in land use intensity, is limited because the evidence is fragmented. This paper presents a systematic review of case study evidence on manifestations and underlying drivers for agricultural land use change in Europe. We analyzed 137 studies that together report on 76 cases of intensification and 143 cases of disintensification. Observed changes were manifested as expansion or contraction of agricultural land as well as in changes of land management intensity, landscape elements, agricultural land use activity, and specialization/diversification. Economic, technological, institutional and location factors were frequently identified as underlying drivers, while demographic drivers and sociocultural drivers were mentioned less often. In addition, we found that farmers were very important as moderators between underlying drivers and manifestations of agricultural land use change. Farmer decisions differed between different farmer types, and according to their characteristics and attitudes. We found major land use change trajectories in relation to globalization of agricultural markets, the transition from a rural to an urban society, and the shift to post-socialism in central and eastern Europe.

Introduction

In spite of rapidly urbanizing societies, a large part of the European land is used for agricultural activities. This agricultural land is constantly changing, following different development trajectories: some mountain areas have faced land abandonment (MacDonald et al., 2000), peri-urban areas are affected by changing societal demands (Zasada, 2011), and yields have increased considerably due to technological developments (Olesen et al., 2011). These agricultural land changes have important consequences as agricultural areas provide a wide range of goods and services, including the provision of food, feed, and fiber, but also biodiversity preservation (Young et al., 2007), climate change mitigation (Freibauer, Rounsevell, Smith, & Verhagen, 2004), and landscape esthetics (Van Zanten et al., 2014). Policy measures and regulations at the European level directly influence agricultural land use and its impacts. Consequently, understanding agricultural land use change pro- cesses and their drivers is important to anticipate future development trajectories and assess the influence of land related policies. Land use change and its causes are typically investigated in local case studies. Biophysical as well as socioeconomic conditions differ considerably from one location to another. Therefore case study findings cannot be generalized easily. In order to aggregate case study findings, meta studies have been presented that synthesize land change case study evidence (Magliocca et al., 2014). Examples include studies on the drivers of desertification (Geist & Lambin, 2004), agricultural intensification in the tropics (Keys & McConnell, 2005), wetland conversion (Van Asselen, Verburg, Vermaat, & Janse, 2013) and changes in shifting cultivation in tropical forests (Van Vliet et al., 2012).

Land use change meta-studies distinguish between proximate causes of land use change, and underlying driving forces, where proximate causes are the human activities or immediate actions that take place at a location, while underlying driving forces denote the fundamental societal processes that drive these proximate causes (Geist & Lambin, 2002). However, changes in agricultural land are themselves typically identified as proximate causes, for example as cultivation of new fields can cause wetland conversion (Van Asselen et al., 2013) or deforestation in tropical forests (Geist & Lambin, 2002). Therefore, the conceptualization of proximate causes and underlying drivers requires adjustment for studying agricultural land use changes. Instead of addressing proximate causes, agricultural land use change can be characterized by the manifestations of these changes. Moreover, many meta-studies synthesize the relationship between underlying drivers and proximate causes of land changes, but in doing this they ignore the diversity in actors and their decisions (Hersperger, Gennaio, Verburg, & Bürgi, 2010). Case studies often provide information on actors and actor characteristics, and meta-studies should address this explicitly to assess their influence.

This paper presents a systematic review of the manifestations and underlying drivers of agricultural land change in Europe. For this purpose we systematically searched for case studies that report on agricultural land use change on a sub-national scale. We distinguished two major types of change: intensification and disintensification of agricultural land use. Intensification includes both changes toward more intensive land management and expansion of agricultural land in a region, while disintensification represents both changes to reduce the intensity of land management and contraction of agricultural land, including abandonment. Based on this case study evidence, we categorize manifestations of agricultural land use change and their underlying drivers, and identify major land change trajectories based on typical combinations of manifestations and related underlying drivers.

Materials and methods

Case study evidence

This systematic review of drivers for agricultural land change is based on cases that have been reported in peer-reviewed publications in English. A systematic search in Web of Science (Topic = (agricultural + intensification) OR Topic = (land + abandonment) OR Topic = (land + use + change + agricultur*); Timespan = 1945– 2013; Search language = English) yielded 3201 potentially relevant publications. From these potential publications, 52 were selected for inclusion in this study after screening the title and abstract first, and subsequently reading the full paper. We included all publications that reported on observed agricultural land use change in Europe, on a sub-national level, starting after 1945. Accordingly, publications that describe the state of agricultural land at one particular moment in time were excluded. Subsequently, we applied a snowball search procedure in which publications referenced from and referencing to eligible studies were considered iteratively. This snowball search yielded an additional 85 publications, resulting in a total of 137 publications. We did not consider gray literature such as conference proceedings, because these documents typically refer to work in progress, while finished work is generally published in peer reviewed journals or book chapters in geography. Designing and conducting a systematic review benefits greatly from the application of well-defined guidelines, in order to increase its credibility and reproducibility (CEE, 2013). This study was designed and reported according to the PRISMA statement (Moher, Liberati, Tetzlaff, & Altman, 2009), which is provided in the Supplementary material S1. The complete list of cases is included in the Supplementary material (S2).

From the selected studies we identified 218 cases of agricultural land change. A case is a unique combination of an agricultural change type, a location that was analyzed separately, and a publication. The agricultural land use change types that were identified for this review are intensification and disintensification. Both types of change were taken broadly, hence intensification includes all changes that increase the agricultural land use intensity on the scale of the case study region, ranging from hedgerow removal to expansion of the total area of agricultural land, and disintensification represents the opposite, including conversion to organic farming to complete abandonment of agricultural areas. When a publication describes and analyzes changes in different case study areas separately, these were considered as separate cases in this review. When more than one paper describes the same case study areas, these are treated as separate cases and coded accordingly if both papers apply different methodologies or include different datasets.

The location of all cases is shown in Fig. 1. Only those cases were included that reported on areas located in Europe and for which the period of analysis started after 1945, because land use dynamics before and after World War II are very different (Antrop, 2005). When a publication analyzed multiple time periods and some of these periods started before 1945, we excluded those periods from this analysis.

The period for which changes were analyzed ranges from 3 to 61 years with an average of 27 years. The median start year of case study periods is 1975 and the median end year is 2000. However, study periods differed for both types of agricultural land change, as the median start year for intensification cases is 1960, while the median start year for disintensification cases is 1980. The median end year was 2000 for cases of both types of changes. Case study areas ranged from 2 km2 to 449 964 km2, with a median of 385 km2. Cases were coded for their general characteristics of the case study, the main research methods applied, the manifestation of the agricultural land change, and for the underlying drivers. General characteristics include the size and location of the study area, the start year and the end year of the study period. Five different manifestations of change were identified, where intensification and disintensification represent opposite directions of change: expansion or contraction of agricultural land area, changes in the number or density of landscape elements (such as hedgerows or woody patches), change in land management intensity (such as irrigation or fertilizer application), change in agricultural land use activity, and specialization or diversification of farm activities. Underlying drivers were categorized as demographic drivers, economic drivers, technological drivers, institutional drivers, sociocultural drivers and location factors, based on similar classifications applied in Geist, McConnell, and Lambin (2006) and Hersperger and Bürgi (2009). These underlying drivers were complemented with a separate category for farm and farmer characteristics, as shown in Fig. 2. The category farm and farmer characteristics was added to explicitly address the influence of land managers on agricultural land use change. Consequently, since farm and farmer characteristics included as a separate class, sociocultural drivers, economic drivers and demographic drivers refer to external influences on farmers, but not to the sociocultural, economic and demographic characteristics of the farmers themselves. Each category of underlying drivers was further divided in subcategories. For studies that included statistical analyses, drivers that have a statistically significant association (p 0.10) with the observed land use change were included, while we followed the interpretation of the original authors in studies that did not apply statistical analyses. We assumed that each study identified the actual manifestations and underlying drivers for agricultural land use change. Besides coding individual drivers, cases were also interpreted in terms of the major land use change trajectories, based on the narratives of the publication. These trajectories were based on the land use change regimes as identified in Jepsen et al. (2013).

Case study representativeness

In order to meaningfully synthesize the manifestations and underlying drivers of agricultural land use change in Europe, it is important that the case study evidence provides a representative sample of these land use changes. Cases are not evenly distributed over Europe. Some countries, specifically Spain, the United Kingdom, Denmark and Switzerland, contain a large number of cases, while no cases are reported from Iceland, Finland, Lithuania, Moldavia, European Turkey and the countries in former Yugoslavia. In addition, Romania and Austria only have cases for one location, and all but one of the Italian cases are in the Northeastern part of the country. The uneven distribution of cases over countries can be explained by the focus on English language publications in this review (Rudel, 2008): the countries that are well represented have a long tradition of publishing internationally. The concentration of several studies in particular regions can be explained by the long standing interest of a number of important research groups in particular areas, for example Southern England, Denmark and the Swiss Alps. Further geographic bias was found toward marginal areas. Fig. 3 shows the agro-ecological zones within which case study areas are located, as well as the distribution of agro-ecological zones of all agricultural land in Europe. These results show a clear bias in the case study selection: cases are more than can be expected by chance located in areas that have a marginal productivity. While the case study locations might not be representative for all agricultural land in Europe, they may be more representative of changes in agricultural land use. Marginal areas are considered hotspots for change (Verburg & Overmars, 2009). Scientists are primarily interested in change, and not necessarily in regions that maintain a status quo. Therefore we feel comfortable that the included cases still provide a good overview of drivers of agricultural land use change, particularly for disintensification processes.

Land use change has been studied by scientists from a range of disciplinary backgrounds. The disciplinary background is reflected in the data sources used and in the subject categories of journals in which case studies have been published. Out of the 218 cases, 141 applied spatial data including remote sensing imagery, 122 were based on interviews or questionnaires, 81 analyzed non-spatial data sources such as censuses or other statistical data, and 21 adopted a fieldwork or participatory approach. Since these different data sources are complementary, many studies applied two or more sources in one study. Table 1 shows the subject categories of journals in which case studies have been published according to web of science. This table shows that cases are more or less evenly divided over the sciences and social sciences journals, and that there is little difference between case studies reporting intensification or disintensification. Relatively many studies have been published in the science category ecology and the social science categories environmental sciences and geography, while relatively few studies have been published in the field of sociology, economics and planning and development studies.

Results

Manifestation and underlying drivers of agricultural land use change

Of the 218 cases included, 76 report on drivers for intensification and 143 report on drivers for disintensification. Notably, 65 cases describing intensification note disintensification happening in the same study area as well. Most underlying drivers, with the exception of sociocultural drivers, are associated with intensification as well as disintensification depending on the specific case. The relative importance of underlying drivers for both types of agricultural land use changes is shown in Fig. 4. Demographic drivers and economic drivers are primarily mentioned in the context of disintensification, as they contribute to 28% and 62% of the disintensifications cases, while they are only reported in relation to 7% and 37% of the intensification cases. Technological drivers, on the other hand, are identified in relation to 59% of the intensification cases, but only in 16% of the disintensification cases. Institutional drivers, location factors and farm(er) characteristics are important for both intensification and disintensification, as they relate to 59%, 41%, and 53% of the intensification cases and 69%, 58%, and 67% of the disintensifications, respectively. Sociocultural drivers are not frequently mentioned and only in relation to disintensification (27% of the cases).

Intensification of agricultural land primarily manifests itself as an increase in land management intensity, for example through increase in livestock density or mechanization. In addition, intensification was observed as an expansion of agricultural land, a decrease in landscape elements, changes toward more intensive agricultural activities and specialization of land use activities. 37 cases (or 49%) report only one manifestation of intensification, mainly increases in land management intensity, while 39 cases (or 51%) reported various combinations of manifestations. Increases in land management intensity and increases in agricultural area are most frequently observed jointly. Fig. 5 presents an overview of the reported manifestations of agricultural intensification and their underlying drivers.

Intensification is typically caused by a combination of underlying drivers, of which technological drivers and institutional drivers are the most frequently reported. At the same time, there is little or no evidence for the influence of demographic and sociocul-importance. Farm(er) characteristics, in particular the productivist attitude of farmers and the household economic conditions of the farming family, were occasionally reported as the sole driver for intensification. 67 cases of intensification (or 88%) were caused by two or more underlying drivers, 15 of which (20%) even reported four or more underlying drivers. A number of typical relations are found between manifestations of intensification and underlying drivers. Economic drivers and location factors primarily influence expansion and increases in management intensity. Technological drivers, institutional drivers, and farm(er) characteristics are related to all observed manifestations. Farm(er) characteristics are particularly important drivers for specialization of agricultural activities. A complete overview of underlying drivers and their sub- categories is provided in Table 2, while the coding of individual cases is available in Supplementary material (S2).

Disintensification of agricultural land is primarily manifested as contraction, partly caused by farmers abandoning their land, but also partly caused by conversion to urban land and natural areas. To a lesser extent, disintensification is manifested as a decrease in land management intensity, as a change to a less intensive agricultural activity, as on-farm diversification and as an increase in landscape elements. In almost half of the cases that observe con- traction of agricultural land, contraction is the only manifestation reported. Contraction has also been reported in combination with decreasing land management intensity and changes in agricultural land use activities. Increase in landscape elements, decrease in management intensity and on-farm diversification were reported as the only manifestation of disintensification in 2, 11, and 8 cases, respectively, (or 1%, 8% and 6% of all cases of disintensification). Fig. 6 presents an overview of the manifestations and underlying drivers of disintensification as found in the case study evidence.

Almost all cases that report on disintensification mention a combination of underlying drivers as causes of observed land use change processes, and 55 cases (or 38%) are even influenced by four or more underlying drivers. Economic drivers, institutional drivers and location factors are the most frequently identified causes of disintensification, and they often occur together. Farm(er) characteristics are also frequently identified as underlying drivers for disintensification. However, these factors are less often related to contraction of agricultural land and more often to the other manifestations of disintensification. This is mainly due to the farmer attitudes toward the environment and their motivation for farming. Farmer characteristics influence the way the land is managed, but not the decision to quit farming activities. Demographic drivers, technological drivers and sociocultural drivers are mentioned as drivers of disintensification much less frequently. Table 2 provides a complete overview of underlying drivers and their subcategories as reported in case study evidence.

Besides the drivers indicated in Table 2, a few cases identified events as causes of disintensification, including swine fever (Schröder, 2011), bovine diseases (Chételat et al., 2013), the Chernobyl nuclear disaster (Hostert et al., 2011), and the construction of a new dam (Pinto-Correia & Godinho, 2013). Despite the importance of these causes for land use change, they are not further analyzed here as they represent one-off events instead of underlying trends or processes.

Common land use change trajectories

The underlying drivers that are identified and their relation with manifestations of agricultural change provide insights in the main processes and their relative importance. However, most drivers do not act independently; instead there are typical combinations underlying drivers that together explain changes. Based on the case study evidence we identified three common land use change trajectories that are observed throughout Europe or in large regions of Europe. These are (1) the joint occurrence of intensification on productive agricultural land and disintensification of more marginal locations as result of globalization of agricultural markets, (2) changes in land management and on farm diversification related to societal change and the shift from rural to urban societies in large parts of Europe, and (3) land abandonment or decrease in land management intensity following the shift to post-socialism in Central and Eastern Europe.

Globalization of agricultural markets caused intensification and disintensification to occur in parallel in many locations in Europe. Increased market competition pushes farmers to increase the profitability of their farm, manifested by upscaling, rationalization, or increasing land management intensity (Cocca, Sturaro, Gallo, & Ramanzin, 2012; Reger, Otte, & Waldhardt, 2007; Zomeni, Tzanopoulos, & Pantis, 2008). If they fail to do so, farmers often leave their land abandoned or continue managing their land in a more extensive way next to another job (Cialdella, Dobremez, & Madelrieux, 2009; García-Ruiz et al., 1996). Within a region this typically leads to an intensification of fertile soils and abandonment of more marginal land (Jones, de Graaff, Rodrigo, & Duarte, 2011; Mallinis, Emmanoloudis, Giannakopoulos, Maris, & Koutsias, 2011; Nainggolan et al., 2012). In other cases these processes lead to land transfers between farmers, so that large farms survive and increase in number, while the smaller farms are disappearing (Dannenberg and Kuemmerle, 2010; Moreno-Perez & Ortiz-Miranda, 2008). Technological drivers add to this development as mechanization requires large and relatively even plots that are well accessible, leaving smaller fields, remote areas and steeper slopes aside for abandonment (Corbelle-Rico, Crecente-Maseda, & Santé-Riveira, 2012; Garcia-Ruiz & Lasanta-Martinez, 1990; Sklenicka et al., 2009). These parallel processes are also observed at larger scales. For example fodder for livestock was originally grown on many live- stock farms, or in their direct vicinity, while globalization and decreased transport costs reduced that need as it could be imported from other regions or countries (Ales, Martin, Ortega, & Ales, 1992; Marini, Klimek, & Battisti, 2011; Morán-Ordóñez, Bugter, Suárez- Seoane, Luis, & Calvo, 2013).

Large parts of Europe have faced a gradual shift from a rural society to an urban society. As a direct consequence, agricultural land converted into urban areas (Parcerisas et al., 2012; Straume, 2013) or peri-urban areas (Primdahl & Kristensen, 2011; Zasada, Fertner, Piorr, & Nielsen, 2011). In addition, the rural land around urban areas is no longer exclusively utilized for the production of agricultural goods. Instead, a larger number of other services are provided such as attractive landscapes and recreation activities such as horse-riding (Bomans, Steenberghen, Dewaelheyns, Leinfelder, & Gulinck, 2010; Giupponi, Ramanzin, Sturaro, & Fuser, 2006; Pfeifer, Jongeneel, Sonneveld, & Stoorvogel, 2009), especially in the wealthier regions in Northwestern Europe. In addition, a growing number of lifestyle farmers owns agricultural land to enjoy a rural lifestyle, and not necessarily to generate income (Busck, 2002; Primdahl, 1999; Sutherland, 2012). On the other hand, areas that are to far from cities to benefit, face a rural exodus (Baumann et al., 2011; Lasanta & Vicente-Serrano, 2012; Nikodemus, Bell, Grı¯ne, & Liepinš, 2005; Petanidou, Kizos, & Soulakellis, 2008). Another aspect related to this societal change is an increasing awareness of environmental issues by society at large (Battershill & Gilg, 1997; Plieninger, Schleyer, Mantel, & Hostert, 2012). This environmental awareness is also reflected in land use policies and subsidies, which increasingly focus on environmental management, nature preservation and landscape restoration rather than agricultural production (Hersperger & Bürgi, 2009; Walford, 2002).

A number of countries in Central and Eastern Europe have experienced a shift from socialist to post-socialist politics toward the end of the 20th century, which had significant consequences for agricultural land use. Under socialist regimes, a large share of the agricultural land was collectivized, aggregated into very large farms, and the production of these lands was optimized to increase yields (Mander, 1994). In addition, new land was cultivated, including marginal land. As a consequence of the shift to the post-socialist system, the collective farms were dismantled and land was de-collectivized, i.e. returned to private ownership (Gross, 1996; Nikodemus et al., 2005). This process of land restitution resulted in agricultural land abandonment in many cases, especially in more remote or isolated patches of agricultural land (Lakes, Müller, & Krüger, 2009; Vanwambeke, Meyfroidt, & Nikodemus, 2012), and in the more marginal areas (Müller, Kuemmerle, Rusu, & Griffiths, 2009; Sikor, Müller, & Stahl, 2009). This land abandonment was further reinforced by ownership insecurity as a consequence of land return policies (Kuemmerle, Müller, Griffiths, & Rusu, 2009), a lack of affiliation, interest or knowledge of agriculture of the new landowners (Feranec et al., 2009; Lieskovsky´ et al., 2013) and the loss of production subsidies that were avail- able under the socialist regimes (Prishchepov, Müller, Dubinin, Baumann, & Radeloff, 2013). In other cases these developments even led to a conversion back to subsistence farming (Kuemmerle et al., 2008). Outmigration of potential farmers to find better paying employment in the urban areas only reinforced these dynamics as it created a rural exodus in some post-socialist areas (Kuemmerle et al., 2009; Müller & Sikor, 2006; Nikodemus et al., 2005).

Farmer decisions and diverging land trajectories

Although this analysis focuses on land use change processes, all case study regions also include farms or locations that do not change, even though these farms or locations are influenced by the same underlying drivers. A large number of case studies even find parallel agricultural land use change processes in opposite directions: 65 cases of intensification have also observed disintensification in the same area. In most of these cases, different farmer characteristics cause these different land trajectories resulting from different decisions under otherwise comparable circumstances. Three different but related farmer characteristics were mentioned frequently in the case study evidence: the motivation for farming, the farmer's attitude toward agricultural production and the environment, and the retirement-succession cycle that relates to the farm as a family-run business causing these diverging land trajectories.

The motivation for farming is the most important farmer characteristic explaining why agricultural land use changes. Case studies identify five types of farmers, based on their motivation for farming: full-time commercial farmers, part-time commercial farmers lifestyle farmers, retired farmers and subsistence farmers (Table 3). For commercial farmers, the farm is frequently the main source of income. However, whether it is their only source of income or not matters as full-time farmers sometimes select different development trajectories than part-time farmers. For instance, Walford (2003) observed both specialization of farming activities and upscaling of farm enterprises as strategies to increase or secure income for full time farmers. On the other hand, other farmers have adopted a combination of part-time farming with off-farm employment to be able to continue their farm (Lobley & Potter, 2004). In both cases farmer behavior was driven by the desire to maintain or increase their farm income, but with different land use changes as a result. Lifestyle farmers represent an increasing number of farmers that do not farm for income, but primarily aim at enjoying a rural lifestyle (Busck, Kristensen, Praestholm, Reenberg, & Primdahl, 2006; Busck, 2002; Orsini, 2013). Frequently, their sentiments and attitudes toward rural areas and the environment guide their land management decisions (Praestholm & Kristensen, 2007; Primdahl, 1999). Retired farmers still keep their farms for a variety of reasons, for example to maintain the family property (Kizos, Vasdeki, Chatzikiriakou, & Dimitriou, 2011), or to supplement their pension (Bohnet, Potter, & Simmons, 2003). Typically they try to minimize the amount of work that is required (Meert, Van Huylenbroeck, Vernimmen, Bourgeois, & van Hecke, 2005). Subsistence farmers are not frequently discussed, and form a relatively small group in Europe. They farm to grow their own food to survive, possibly selling some products as an extra source of income. However, in some cases the shift from self-sufficiency to market oriented farming is precisely what drives land use changes (Calvo-Iglesias, Crecente-Maseda, & Fra-Paleo, 2006; Cialdella et al., 2009). These different motivations explain why farmers that otherwise face similar conditions make different land management decisions in several cases. As Table 3 indicates, full-time commercial farmers are more frequently related to intensification, while the other farmer types are generally associated with disintensification. For example, in Danish cases, lifestyle farmers are most active in planting hedgerows, while commercial farmers have removed the largest amount of hedgerows (Kristensen & Caspersen, 2002; Primdahl & Kristensen, 2011).

Farmers' attitudes explain whether or not land use changes are made in response to certain drivers. Case study evidence identifies two types of attitudes: productivist attitudes and environmentalist attitudes. Productivist farmers argue that the role of a farm is to produce agricultural products, and consequently, a farm is managed to increase or optimize production (Walford, 2003), which precludes alternative strategies like on farm diversification and farm tourism (Meert et al., 2005; Serra, Pons, & Saurí, 2008). This productivist attitude typically leads to intensification (Schneeberger, Bürgi, Hersperger, & Ewald, 2007). Cases were productivist farmers are found to extensify, this is typically manifested as a decrease in management, with the aim to maintain the farm and prevent complete abandonment (Kizos, Dalaka, & Petanidou, 2010). Land managers with an environmentalist attitude aim to farm without damaging their environment, or even trying to improve the environment and provide landscape services (Van Zanten et al., 2014). These attitudes generally lead to disintensification. In addition to explaining changes, attitudes also explain why certain changes are not observed. For example, productivist attitudes and farming tra- ditions are reasons to not participate in agri-ecological schemes, while others facing identical economic and institutional conditions do participate (Morris & Potter, 1995; Selfa, Fish, & Winter, 2010; Walford, 2002). Similarly, environmental awareness of farmers can explain why some farmers are much more active in adding landscape elements, such as hedgerows, or woody patches (Busck, 2002), or convert to organic farming (Darnhofer, Schneeberger, & Freyer, 2005) when these changes have little or no economic benefits (Kristensen, Thenail, & Kristensen, 2004). Although attitudes and perceptions are not strictly related to the motivation for farming, there is some overlap. Environmental awareness is particularly apparent among lifestyle farmers (Busck et al., 2006; Madsen, 2003), while productivist attitudes are mostly found among commercial farmers. The retirement and succession cycle of farmers is an important determinant of the timing of agricultural land use changes. Many farms are family farms and they are effectively owned and managed by the head of the family. This ownership is passed through to the next generation upon retirement if a successor is identified. This retirement and succession cycle influences the moment agricultural changes take place, as farmers are less likely to make large changes or investments in the years before retirement as it is not worth the investment of resources (Battershill & Gilg, 1997; Ingram, Gaskell, Mills, & Short, 2013). This will cause a delay in the response of the agricultural land system to changes in underlying drivers, such as subsidies and market changes. Young farmers, on the other hand, are more likely to make considerable changes on the farm as they have a long career to earn back such investments (Moreno-Perez & Ortiz-Miranda, 2008). When no successor is identified, for example because offspring chooses a career outside agriculture, land is frequently rented out or sold to other farmers (Dannenberg & Kuemmerle, 2010; Selfa et al., 2010). On the other hand, farmers that choose to continue farming when approaching retirement or even after retirement typically decrease the land management intensity to limit their workload (Bohnet et al., 2003; Rueff, Choisis, Balent, & Gibon, 2012; Selfa et al., 2010). Eventually, this can lead to abandonment if there are no successors identified (Gellrich, Baur, Robinson, & Bebi, 2008; Kizos et al., 2011), typically because the new generation has no interest in agriculture but instead favors an urban lifestyle and employment in other sectors (Lieskovsky´ et al., 2013).

Discussion

Comparison of findings with other land use change meta-studies

Agricultural land use change differs from land use change processes studied in other meta-studies. First, meta-studies of other land use change processes such as deforestation (Geist & Lambin, 2002) and wetland conversion (Van Asselen et al., 2013) are frequently driven by agricultural land use change. Hence, agricultural land use change is often a proximate cause of other changes, but it is not always possible to identify proximate causes for agricultural change itself, except for urbanization and the development of natural areas. Therefore this study analyses manifestation of agricultural change itself rather than their proximate causes. Then, meta-studies of other land use change processes, such as urbanization (Seto, Fragkias, Güneralp, & Reilly, 2011), and deforestation and forest regrowth (Rudel, Defries, Asner, & Laurance, 2009) typically focus on changes in one direction, while agricultural land use changes in Europe were observed in two directions here: intensification and distensification, which are often found together in one case study location. Moreover, other meta studies mainly focus on land cover changes, while agricultural land use change is predominantly characterized by changes in land use intensity (Erb et al., 2013). This difference is reflected in the manifestations of agricultural land use change in this study, as well as in meta-studies of agricultural intensification in the tropics (Keys & McConnell, 2005) and changes in swidden cultivation (Van Vliet et al., 2012). In theory this yields four distinct agricultural land use changes: increase and decrease of the area used for agricultural activities and increase and decrease of the intensity of existing agricultural areas. However, in practice the difference between increase in area and increase in intensity is not always clear, and likewise for decrease in intensity and decrease in agricultural land area. For example, Chételat et al. (2013) indicate that woody pastures in the Jura were increasingly less visited, until they, until they are eventually considered abandoned. Similarly, Kizos et al. (2010) indicate that olive orchards on Lesvos, Greece are initially managed less frequently while they are still harvested, until the owners eventually stop managing them altogether. Because the differences between intensity changes and area changes could not be identified clearly we grouped both types of change together in two major land use change types: intensification and disintensification. Underlying drivers for agricultural land use change in Europe can be categorized by the same broad classes as used in other meta-studies. However, some noticeable differences appear in the relative importance of these groups. Demographic drivers play a large role in desertification (Geist & Lambin, 2004), tropical deforestation (Geist & Lambin, 2002) and wetland conversion (Van Asselen et al., 2013), while evidence from case studies of agricultural change in Europe is relatively small. A likely explanation is that urbanization and globalization of agricultural markets caused population growth and agricultural development to become dis- connected (Meyfroidt, Lambin, Erb, & Hertel, 2013). This implies that assessments of future land use changes as well as policies targeting or preventing these changes should acknowledge the increasingly distal connection between agricultural land use and the drivers that influence their changes (Liu et al., 2013).

This study also reveals that land managers and their decision making are very important factors in agricultural land use change in Europe. While individual behavior is included as a sociocultural factor in several studies (Geist & Lambin, 2002; Geist & Lambin, 2004; Van Asselen et al., 2013), case study evidence in this study justified the identification of a separate category. Specifically, several studies identified the land manager characteristics that influenced their decisions, including age (Hansson, Ferguson, & Olofsson, 2010), education level (Chaplin, Davidova, & Gorton, 2004; Defrancesco, Gatto, Runge, & Trestini, 2008), and attitude (Schneeberger et al., 2007). The motivation for farming was especially important as lifestyle, subsistence and commercial farming provide completely different incentives for farming, and thus determine the land manager's reactions in response to financial incentives and other trends (Kizos et al., 2011; Primdahl, 1999). This indicates that future changes are critically depending on the land managers' responses to changing conditions and that these responses can differ widely between different groups of farmers. Moreover, while agent characteristics and motivation for farming are presented as moderating factors in this study, they can also be influenced directly due to changes in societal values.

Conjoint causation

Synthesizing information from case study evidence inevitably involves generalization, and consequently some of the richness in detail of individual cases is lost. This is especially the case for explanations of combinations of underlying drivers, as well as for the role of sequences of land use change processes.

The variation in manifestations of agricultural land use change and their underlying drivers indicate that it is difficult to find one-to-one relations between drivers and agricultural land use change. For some drivers the causality is clear. For example mechanization and land improvement technologies cause intensification, and nature development policies stimulate disintensification. For many other drivers, however, we find that they can yield different types of land use changes depending on their interaction with other drivers, and that sometimes combinations of drivers actually prevent land use to change. This interdependence of different drivers is illustrated by the poor fit of statistical models that ignore such conjoint causation in case studies (Gellrich, Baur, Koch, & Zimmermann, 2007a; Gellrich, Baur, & Zimmermann, 2007). In some locations, off-farm employment causes land abandonment or a decrease in land management intensity, because people leave agriculture for jobs with a higher income (Gellrich et al., 2007a,b). In other regions off-farm employment generates extra income that can be used to continue farming and thus prevent abandonment (Fjellstad & Dramstad, 1999; O'Rourke, 2005). Another example of context dependence is the age of the farmer. Young farmers are likely to intensify their land use, as they adopt new technologies and make the necessary investments (Evans, 2009; Riedel, Casasús, & Bernués, 2007). However, in other cases we find that young farmers are more likely to extensify, for example by diversifying their farm business (Hansson et al., 2010; Lobley & Potter, 2004). They have in common that young farmers are more likely to adjust their farm business strategies. However, in some cases that leads to intensification, and in other cases to disintensification. Therefore, care is required in interpreting the results of this systematic review: while relations between underlying drivers and manifestations of agricultural land use change might hold on a general level, their effect can be different in combination with other underlying drivers, location factors or farm(er) characteristics. Consequently, effects of planning and policy measures need to be considered in their contextual setting, as generic relations might not always hold in particular cases.

Land use changes are path dependent. Consequently, the influence of underlying drivers can only be measured relative to the initial situation, and the influence of drivers can change due to different initial conditions. For example agri-environmental schemes can lead to disintensification in areas that are managed intensively (Morris & Potter, 1995), while it can prevent land abandonment in other regions as it provides the additional income to continue farming (Calvo-Iglesias, Fra-Paleo, & Diaz-Varela, 2009; Schröder, 2011). Path dependency and feedback mechanisms can also lead to unexpected outcomes. For example, the Portuguese montado and Spanish dehesa are originally extensive agrisilvopastoral systems. Over time some of these systems have intensified leading to unsustainable land management. As a consequence, these locations have become overexploited and subsequently abandoned (Pinto-Correia & Godinho, 2013; Schröder, 2011; Van Doorn & Bakker, 2007).

Conclusions

The systematic review of case studies of agricultural land use change in Europe revealed intensification and disintensification of agricultural land manifested itself as expansion or contraction, changes in landscape elements, changes in land management intensity, changes in agricultural land use activity, and specialization or diversification. Demographic, economic, technological, institutional, and sociocultural drivers are all related to the observed changes, in combination with location factors and farm and farmer characteristics. Demographic and sociocultural drivers are less frequently mentioned than other drivers. Farmer characteristics, on the other hand, are identified as key driver of change in many studies, which can especially explain why land use changes take place on one location and not on another under otherwise comparable conditions. Specific combinations of drivers were identified as part of three more general land use change trajectories: disintensification following the shift to post-socialism in central and eastern Europe, intensification as well as disintensification as a consequence of globalization of agricultural markets, and disintensification as a result of the shift from a rural to an urban society. Results of this review need to be interpreted carefully given the bias that is inevitably apparent in case study evidence. While studies in this review typically considered multiple underlying drivers, there are only very few studies that cover a comprehensive set of drivers (Hersperger & Bürgi, 2009). Standardization of experimental setup has been proposed as a way to increase comparability of empirical results (Stanley, 2001; Turner, Meyer, & Skole, 1994), however such standardized case study procedure may not be feasible given the variation in case study objectives, and not desirable either. Nonetheless, there is a need for more case studies that assess a broad range of underlying drivers, rather than a selected subset. The representativeness of this review can be improved by including case studies in regions that are not currently covered. In particular, there is a need for additional case studies that study agricultural land use changes other than disintensification of marginal areas.

Acknowledgements

We would like to thank three anonymous reviewers for their helpful comments. The research reported in this paper was sup- ported by the European Commission, 7th Framework Programme, through the projects GLOLAND (ERC grant agreement no. 311819) and HERCULES (grant agreement no. 603447). This research contributes to the Global Land Project (www.globallandproject.org).

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the published online version, at http://dx.doi.org/10.1016/j.landurbplan. 2014.09.001.

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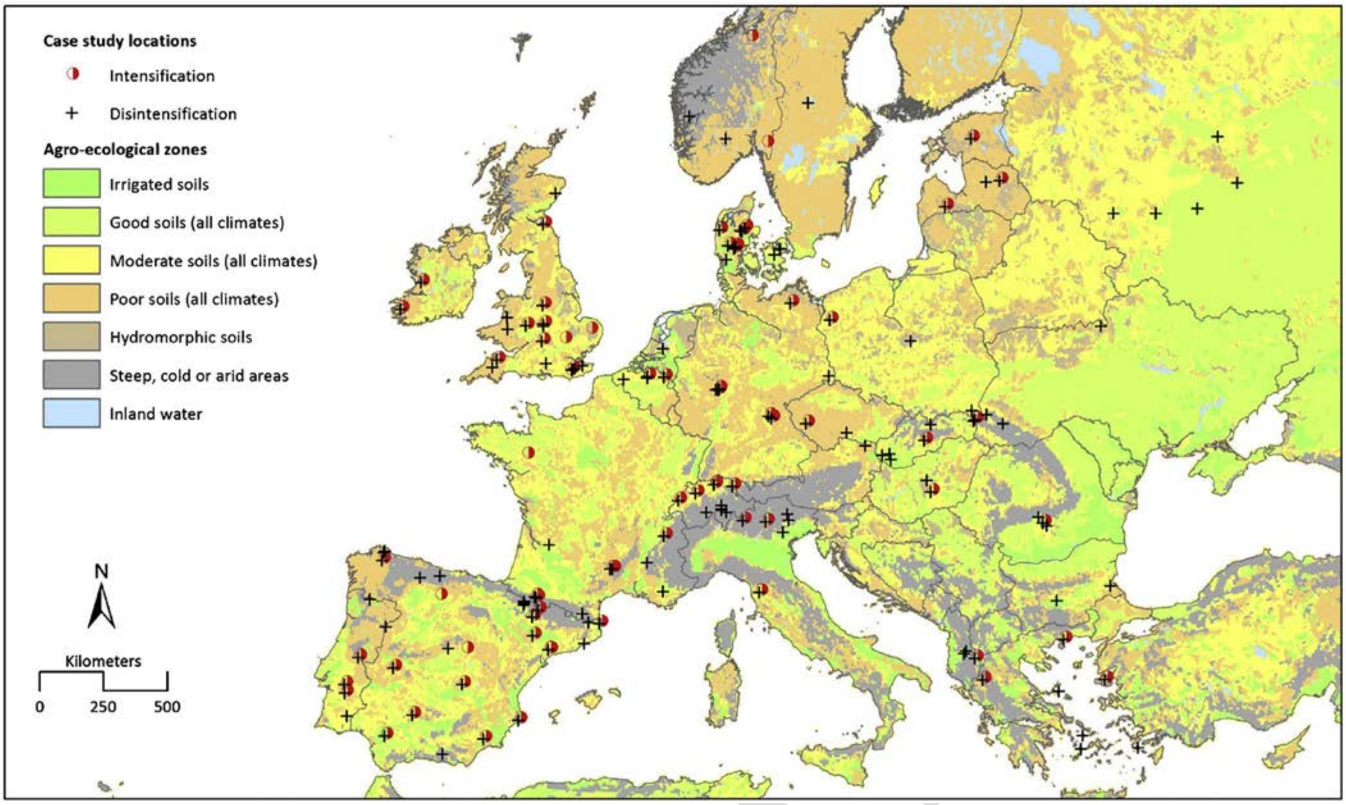

Fig. 1. Location of case study areas included. Cases that report on changes in multiple areas or large areas are indicated in the center of this area.

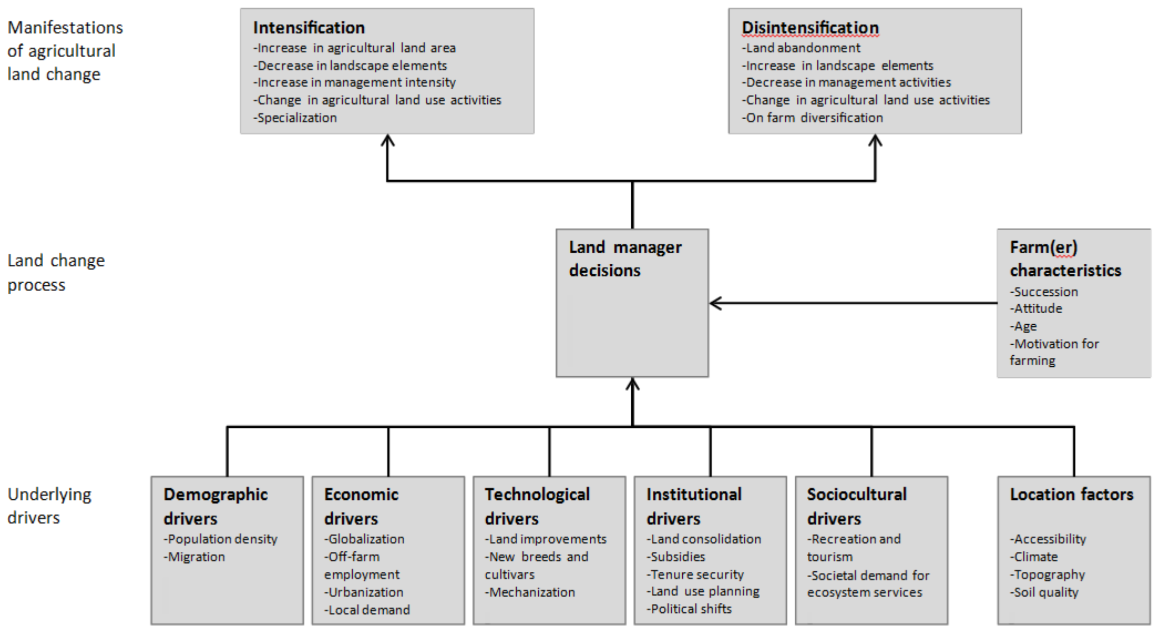

Fig. 2. Conceptual framework of manifestations and underlying drivers for agricultural land change.

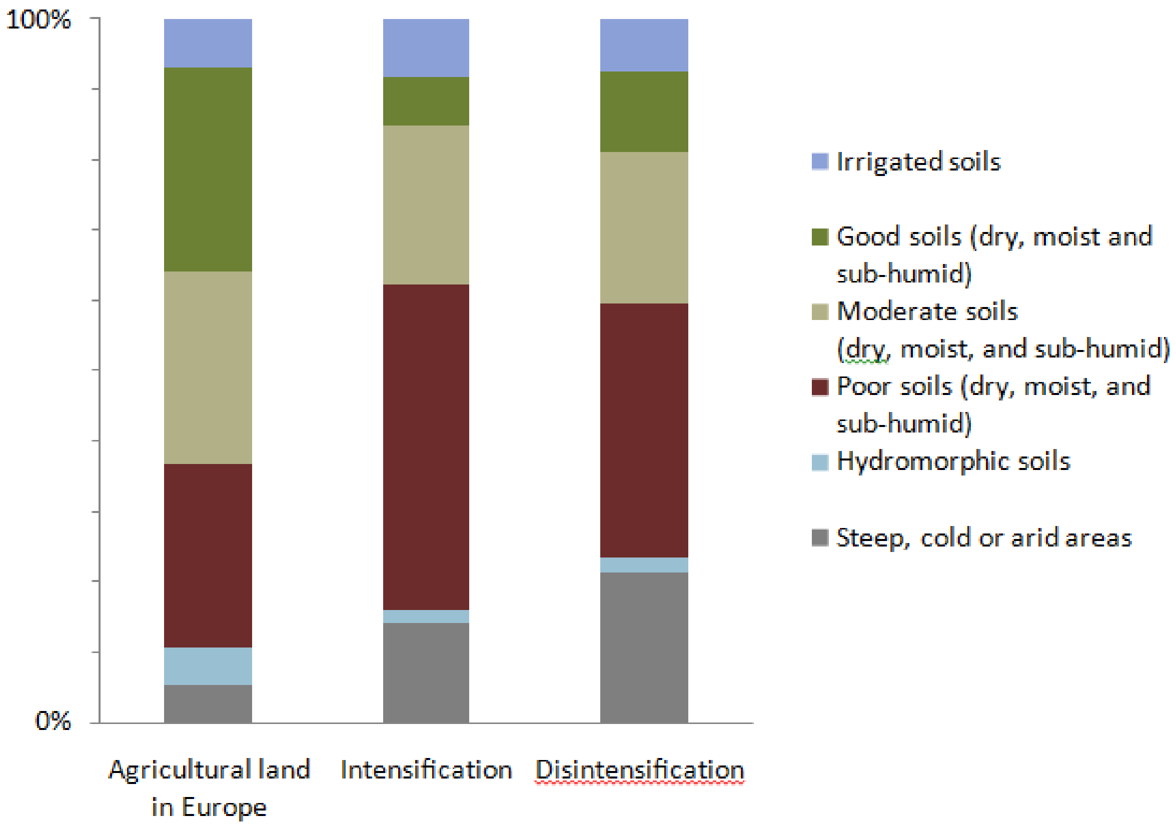

Fig. 3. Distribution of agro-ecological zones of all agricultural land in Europe, compared to the distribution of case study areas (based on IIASA & FAO, 2012).

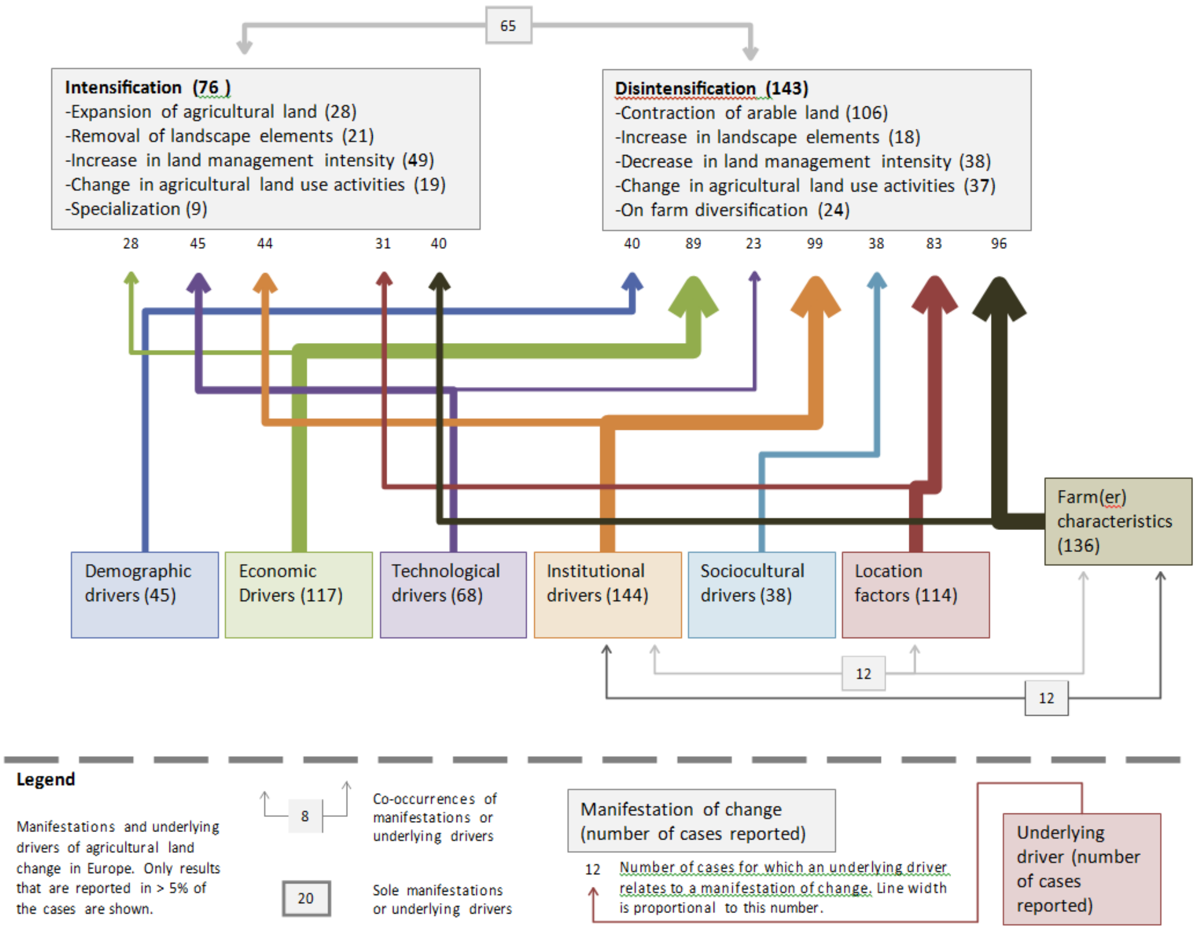

Fig. 4. Relative importance of underlying drivers for intensification and disintensification of agricultural land change in Europe.

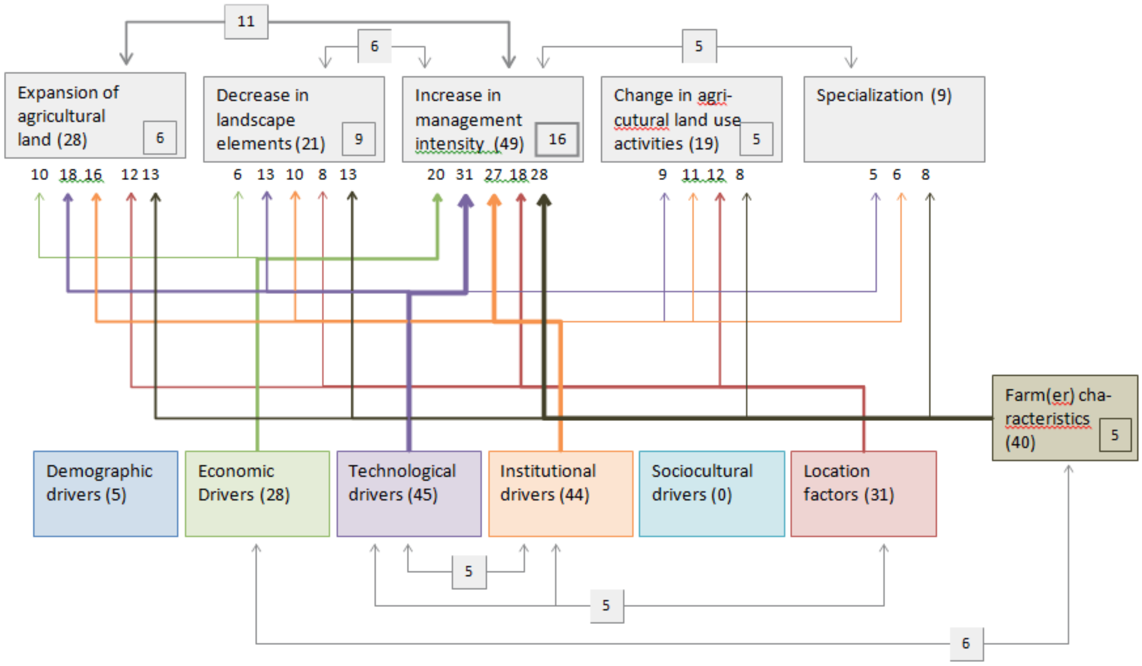

Fig. 5. Manifestations of agricultural land intensification and their underlying drivers (a legend is provided in Fig. 4).

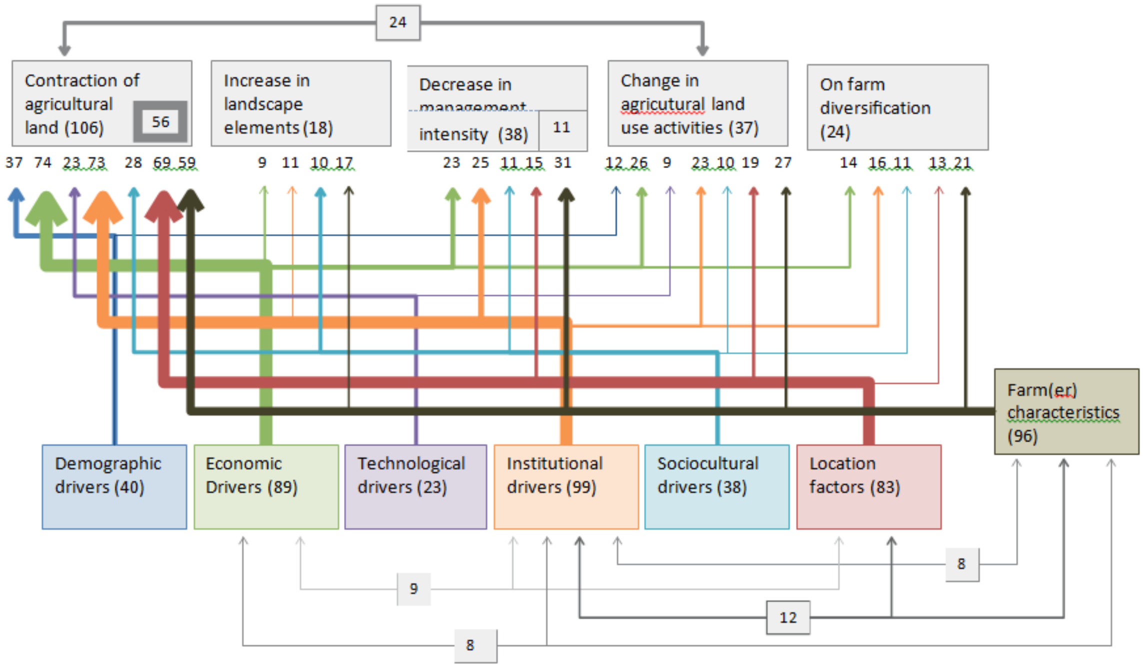

Fig. 6. Manifestations of agricultural land disintensification and their underlying drivers (a legend is provided in Fig. 4).

Table 1. Representation of subject categories of the journals in which case studies have been published, as listed in the web of science. Percentages denote the share of all cases, cases for intensification and cases for disintensification, respectively. Several journals are listed in more than one subject category, therefore totals do not add up to 100%.

Web of Science subject category	All cases (*n* = 219) [%]	Intensification (*n* = 76) [%]	Disintensification (*n* = 143) [%]
Science combined	50	51	50
Agriculture	11	13	9
Ecology	32	32	32
Environmental Science	15	16	15
Physical Geography	24	24	24
Social Science combined	57	53	59
Economics	4	4	3
Environmental Science	38	35	39
Geography	34	35	34
Sociology	2	3	2
Planning and Development	8	8	8
Journal or book not listed	12	12	12

Table 2. Counts and percentage of underlying drivers for agricultural land use changes. Percentages denote the share of all cases, cases for intensification and cases for disintensification, respectively. Several cases report on more than one subcategory, therefore, subcategories do not add up to the category total.

	All cases (*n* = 219)		Intensification (*n* = 76)		Disintensification (*n* = 143)	
Underlying driver	[*n*]	[%]	[*n*]	[%]	[*n*]	[%]
Demographic drivers	45	21	5	7	40	28
Population density	13	6	2	3	11	8
Migration	36	16	3	4	33	23
Economic drivers	117	53	28	37	89	62
Globalization of agricultural markets	29	13	11	14	18	13
Off farm employment	41	19	5	7	36	25
Labor requirements	25	11	6	8	19	13
Urbanization	33	15	0	8	33	23
Local demand	31	14	11	14	20	14
Technological drivers	68	31	45	59	23	16
Land improvements	29	13	19	25	10	7
New breeds and cultivars	5	2	5	7	0	0
Mechanization	53	24	37	49	11	0
Institutional drivers	144	66	45	59	99	69
Land consolidation	16	7	7	9	9	6
Land management subsidies	55	25	9	12	46	32
Production subsidies	40	18	21	28	19	13
Tenure/ownership security	18	9	4	7	14	10
Land use plans	44	20	4	5	40	28
Shift in political systems	43	20	9	12	34	24
Sociocultural drivers	38	17	0	0	38	26
Recreation and tourism	34	16	0	0	34	24
Societal demand for other services	9	4	0	0	9	6
Location factors	114	52	31	41	83	58
Accessibility	66	30	14	18	52	36
Climate	9	4	0	0	9	6
Topography	40	18	9	12	31	22

	All cases (*n* = 219)		Intensification (*n* = 76)		Disintensification (*n* = 143)	
Underlying driver	[*n*]	[%]	[*n*]	[%]	[*n*]	[%]
Soil quality	66	30	18	24	48	34
Farm and farmer characteristics	136	62	40	53	96	67
Farmer's age	33	15	5	7	28	20
Succession	19	9	4	5	15	10
Attitude	51	23	14	18	37	26
Farm size	40	18	14	18	26	18
Farm/household economics	58	26	20	26	38	27
Motivation for farming	87	40	25	33	62	43

Table 3. Farmer characteristics and their relation to observed land use changes. Percent-ages denote the share cases for intensification and disintensification, respectively, that report these farmer characteristics. Farmer characteristics are based on the interpretation of the original authors and do not follow strict definitions.

	Intensification (*n* = 76)		Disintensification (*n* = 143)	
Farmer characteristic	[*n*]	[%]	[*n*]	[%]
Motivation for farming				
Commercial farmer, full-time	17	22	18	13
Commercial farmer, part-time	7	9	24	17
Lifestyle farmer	4	5	26	18
Retired farmer	2	3	13	9
Subsistence farmer	0	0	9	7
Attitude				
Productivist	12	16	16	11
Environmentalist	3	4	24	17
Succession				
No successor identified	0	0	15	10
Successor identified	4	5	1	1
Age				
Farmer is old	0	0	10	7
Farmer is young	5	7	22	15