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# Towards a comprehensive analysis of agricultural land systems: What can we see with publicly available datasets in the EU and US?

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# **Towards a comprehensive analysis of agricultural land systems: What can we see with publicly available datasets in the EU and US?**

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**Agricultural Land Markets – Efficiency and Regulation**

# Towards a comprehensive analysis of agricultural land systems: What can we see with publicly available datasets in the EU and US?

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## Abstract

Understanding agricultural land systems is paramount to preparing for future transitions under climate change. A first step in moving towards a systematic, multi-context comparison of agricultural land systems is an assessment of data availability and commensurability. We compare publicly available and publicly curated data describing agricultural land systems—those devoted to the production of food, fuel, and fiber—to map analytical potential for comparative research in the United States (US) and European Union (EU). We discuss how political priorities shape what we can(not) see in each region and articulate future data needs to support cross-context understanding of agricultural land systems dynamics. This comprehensive understanding of how and why agricultural land systems change is imperative to promoting sustainable, resilient, and just agriculture futures.

## Keywords:

land systems; agricultural land; data comparison; US Farm Bill; EU Common Agricultural Policy

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# 1 INTRODUCTION

Agricultural land systems throughout the world are today more connected than ever through global markets. As a result, events and changes in one place may affect land use outcomes elsewhere. For example, the efforts of the European Union (EU) to tackle climate change through its European Green Deal and the associated Farm to Fork and Biodiversity Strategies are likely to generate secondary effects in other parts of the world via international markets (Wesseler, 2022). The global challenges linked to agricultural land systems thus require global collaboration and learning across distinct cultural, political, and socioeconomic contexts, including systematic comparative analyses.

To provide sound evidence, large-scale analyses of agricultural land systems require a solid theoretical basis, but also comprehensive and comparable data across contexts. However, national data processes and priorities filter the information through which we can track and understand agricultural land use change. These data in turn shape the models that researchers and decision-makers use when working to understand and evaluate agricultural land systems and frame the questions we can(not) ask about agricultural systems. A first step in moving towards a systematic, multi-context comparison of agricultural land systems is therefore an assessment of data availability and comparability. In this publication, we aim to provide such an assessment. We compare publicly available and publicly curated data describing agricultural land systems and map data availability, data gaps, and analytical potential for comparative research in two relatively data-rich regions: the United States (US) and the European Union (EU). We discuss how political priorities shape what we can(not) see in each region and articulate future data needs to support cross-context understanding of agricultural land systems dynamics.

Several publications to date compare EU and US agricultural *policies*. A relatively recent special issue of the European journal EuroChoices (Davis, 2019; see especially Blandford & Matthews, 2019) compares the EU CAP and the US Farm Bill, concluding that both regions prioritize farm income support, but the EU (at least rhetorically) gives greater priority to environmental aspects of farming than the US. An older special issue from the same journal (Blandford & Hill, 2008) provides a comparison of Rural Development Policies more specifically. Baylis et al. (2008) also provide a focused comparison of agri-environmental policies in both contexts and show that these differ in both objectives and implementation. Recognizing that social policy, as well as farm policy, affects agricultural production, Becot and Inwood (2020) provide a foundational framework for comparing social safety net programs' impacts on farm households between countries. Other researchers compare US and EU policy and *production* (see Pawlak et al., 2021), however there has been little research comparing the agricultural data available in both regions which shapes the questions researchers can even ask at certain scales, driving research agendas and shaping the policies that help to transform agricultural land systems.

By presenting an overview and comparison of the data that are publicly available in the EU and the US we provide a reference point for future data users and data providers in several ways. First, our collection and description of the available datasets on agricultural land systems can serve as a starting point for researchers interested in using these data for empirical work in either or both contexts. Second, our comparison of the available data will show where potential for comparative analyses currently does and doesn't exist, and therefore also where additional data should be collected and/or provided publicly to support research. Third, by identifying and analyzing the (implicit) data collection priorities and norms that manifest in data (un-)availability we can caution those working with these data about the view of the world that they imply. With these contributions we support empirical research that enhances our understanding of agricultural land systems and their trajectories. Such a comprehensive

understanding of how and why agricultural land systems change is imperative to promoting sustainable, resilient, and just agriculture futures.

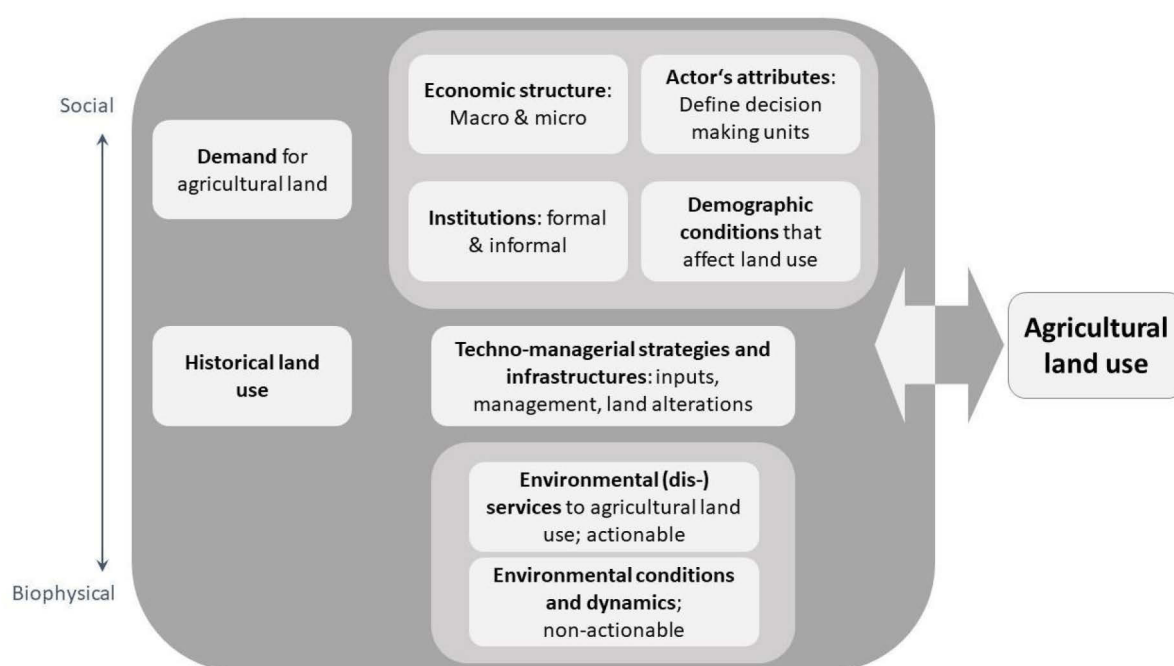
The remainder of the paper is structured as follows. Section 2 presents the framework we use to define and analyze agricultural land systems and provides a description of the data sources we rely on. Section 3 presents the results of our research, i.e., describes the data available in the EU and the US on the elements of agricultural land systems. We discuss the implicit data collection norms underlying these results and their implications and summarize commonalities and differences in the available data in section 4. Section 5 concludes.

## 2 METHODS

We conceptualize *agricultural land systems*—or land systems devoted to the production of food, fuel, and fiber—using the framework proposed by Turner et al. (2020) to “frame the search for a theory of land use.” Figure 1 shows the ten core land use elements that this framework proposes and that we use to structure our analysis and comparison of publicly available agricultural data in the EU and US. The availability of comparable data that correspond with each element shapes the empirical questions of land use drivers and land use change that can be empirically addressed across these two contexts. We define each element in the corresponding results section.

In our data comparison, we focus on data accessible to the general public for direct download without additional requests, payments, or analyses. In the EU, this includes data curated by Eurostat (mostly from the Farm Structure Survey (FSS)), the Farm Accountancy Data Network (FADN) and data from the Integrated Administration and Control System (IACS). In the US, we include the USDA’s QuickStats database and the USDA’s Cropland Data Layer (CDL).

**Figure 1: Agricultural land systems and their elements**



Source: adapted from Turner et al. (2020)

## 2.1 EU Data

The EU's statistical office Eurostat cooperates with member states' statistical offices to provide harmonized datasets describing agricultural land systems across the EU. The most prominent and harmonized agricultural data curated by Eurostat are from the FSS. Additional data originate from administrative registers (e.g., of vineyards, organic farms), the European System of Accounts, the FADN, and more. The data are available for free download at the level of NUTS-1 (e.g., Germany's *Federal states*), NUTS-2 (*Government regions*) or NUTS-3 regions (*Districts*).<sup>1</sup> Eurostat also collects the LUCAS survey, which is an in-situ land cover and land use ground survey extending over the EU. Not curated by Eurostat are the annually available agricultural land system data reported in the representatively sampled FADN (reported at regional level), data from the IACS (reported at field level), and CORINE remotely sensed land use data.

### 2.1.1 Farm Structure Survey (FSS)

The FSS has been conducted across EU member states using a consistent, common methodology since 2000. Each member state conducts a full census every ten years (2000, 2010, and 2020) as well as sample surveys every 2-4 years from individual agricultural holdings above certain thresholds (e.g., 1.7 livestock units or two hectares of arable land, specified in Regulation (EU) 2018/1091, 2018).<sup>2</sup> Approximately 300 variables are collected covering characteristics of the farm and the farmer, land use/land cover, land management (e.g., rotation, intercropping), ownership, livestock, manure management, labor force and organization, and rural development support measures (e.g., agri-environmental schemes). The data can be arranged by geographic levels (NUTS-2 or NUTS-3), area status, farm size class, legal status of the holding, and farm type (Eurostat, 2023a). Microdata at farm level are available for research projects upon application to Eurostat. Due to the irregular intervals of data collection, and changes in legislation and focus of the census in each period, much of the resulting data are only available at single or few points in time.

### 2.1.2 Farm Accountancy Data Network (FADN)

The FADN monitors farm income and business activities and is the only source of annually available microeconomic data based on harmonized bookkeeping principles across all member states. It is based on national surveys of approximately 80,000 'commercial' farms<sup>3</sup>, making up roughly 1% of the total EU farm population. The FADN represents a stratified random sample of 'commercial' farms, with strata based on region, economic size (standard output - SO) and a typology related to the relative economic importance of different on-farm activities (types of farming - TF). Participation in FADN is voluntary and requires participating farms to have suitable farm accounts at hand. FADN data are digitally available from 1989 to present annually<sup>4</sup>, but there was a structural break in the data due to a change in farm type

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<sup>1</sup> NUTS (abbreviated from the French "Nomenclature des Unités territoriales statistiques" for "nomenclature of territorial units for statistics") is the European classification of regions, classifying the whole EU territory into 92 NUTS-1, 242 NUTS-2, and 1166 NUTS-3 regions.

<sup>2</sup> An agricultural holding is defined as "a single unit, both technically and economically, that has a single management and that undertakes economic activities in agriculture..." (Regulation (EU) 2018/1091 2(a), 2018). Member states can vary thresholds slightly if justified, but 98% of a country's utilized agricultural area (UAA) needs to be covered.

<sup>3</sup> The minimum economic size to be considered as a commercial farm and fall into the field of observation for FADN is set on a national level, due to differences in farm structure between member states.

<sup>4</sup> Publicly available FADN data (on FADN region level) are mostly 2-3 years behind, due to time lags in data reporting by member states and data preparation. Currently (February 2023), the most recent available data are from 2020.

definitions and economic size of farm holdings in the mid-2000s.<sup>5</sup> The publicly available FADN database provides aggregated data at the level of FADN regions, which, depending on the size of the member state, range from larger administrative regions to country level. It covers 180 “standard results” indicators which include economic size, farm typology, labor input, land use activities, livestock activities, revenue, differentiated by activities, subsidies, costs, and economic outcomes (profit indicators, cash-flow indicators, capital-related indicators)<sup>6</sup>. Researchers can apply for access to the underlying data at farm level and additional indicators (roughly 2,800 in total).

### 2.1.3 Integrated Administration and Control System (IACS)

To administer subsidies to farmers, EU member states are required to operate an IACS. Through the IACS, subsidy applicants (i.e., the vast majority of farmers in the EU) have to provide georeferenced information on their farmed land and cultivated crops to determine hectare-based subsidy levels and prove compliance with cross compliance and greening requirements.<sup>7</sup> Hence, IACS monitors the location, amount and type of farmland as well as crops grown and landscape elements such as hedgerows at parcel level on a yearly basis. With the entering into force of the 2021 CAP period (Regulation (EU) 2021/2116, 2021), member states are required to publicly share the resulting geospatial datasets containing parcel-level crop information, and some countries have been publishing them since 2015.<sup>8</sup> Although data are collected at the farm level and linked to the farm, the openly available data usually do not identify the farm for data privacy reasons. As IACS is subject to member state subsidiarity, differences in data setup and content exist between member states (or federal states where applicable), e.g., in the level of detail of crop types. Member states (or federal states) provide the IACS data via their own platforms and no single dataset covering the entire EU is currently available. Harmonization of datasets and their provision is therefore a key challenge and is being addressed by different initiatives, e.g., EuroCrops (EuroCrops, 2020).

### 2.1.4 Other EU-wide land use data

The CORINE Land Cover (CLC) inventory and the Land Use/Cover Area frame Survey (LUCAS) are additional land use databases for the EU. The CLC inventory, which began in 1985 with a reference year of 1990, provides information on land cover in 44 classes, utilizing a Minimum Mapping Unit (MMU) of 25 hectares (ha). Additionally, the CLC incorporates change layers that highlight shifts in land cover over time. The LUCAS survey, conducted by

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<sup>5</sup> In the old definitions of TF and economic size of farm holdings, both were calculated based on so-called standard gross margin (SGM). SGM for a farm is according to the Eurostat glossary (Eurostat, 2023c), the difference between the gross production (to which subsidies are added) of all activities of a farm and the variable specific costs of these activities. TF definition was based on the relative shares of SGM of specific activities from total SGM of a farm. Economic size of farms was derived from total SGM of farms, resulting in different economic size groups. Data based on these definitions of economic farm size and TF is available from 1989 until 2009. The new (and current) definition of economic size and TF is based on so-called Standard Output (SO). SO is, according to the Eurostat glossary, “the average monetary value of the agricultural output at farm-gate price, in euro per hectare or per head of livestock” (Eurostat, 2023d). The reason for the change from SGM to SO was that due to changing economic conditions for farms, some activities started getting negative SGMs.

<sup>6</sup> Detailed definitions of Standard Results indicators can be found at <https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/description.html>

<sup>7</sup> Depending on member states’ implementation of the CAP’s second pillar (esp. voluntary agri-environmental schemes), additional information may be collected or merged with IACS (e.g., cover crops, slope gradients and soil erosivity) in individual member states. The availability of this additional information collected in IACS for research varies between member states. IACS also consists of additional systems, e.g., an animal registry, but these data are not publicly available.

<sup>8</sup> Although IACS existed earlier, it has only been geospatially referenced since 2003.

Eurostat every three years since 2006, captures the state and dynamics of land use and cover changes across the EU.<sup>9</sup>

## **2.2 US Data**

### **2.2.1 USDA QuickStats**

The US Department of Agriculture's (USDA) National Agricultural Statistical Service (NASS) is responsible for collecting, reporting, and sharing data describing agricultural land systems in the US. NASS conducts both a quinquennial Census of Agriculture (CoA) and a series of annual surveys on topics including agricultural chemical use, cattle inventory, irrigation on farms and ranches, organic agriculture, and land tenure as well as annual county-level surveys on production and acreage of major crops. The CoA is a complete count of every farm, ranch, and operator grossing at least \$1,000 from agricultural production. Even small plots of land—whether rural or urban—growing fruit, vegetables or livestock are included if the farm operation grossed, or would have normally grossed, \$1,000 in annual sales during the Census year. The CoA is a comprehensive look at US farms—collecting data on agricultural land use, land rents, crop-specific yields and acreage, animal products, on-farm expenses, farm assets, irrigation, participation in federal programs, and farm operator attributes. The highest spatial resolution at which the data is collected is the US county.<sup>10</sup> Most data are available for download on the USDA's QuickStats website<sup>11</sup> where data can be arranged by geographic levels, year, program (CoA or survey), and data category.

### **2.2.2 USDA Cropland Data Layer (CDL)**

The USDA's Cropland Data Layer (CDL) CDL is a geo-referenced, crop-specific land cover data layer created annually for the continental US using moderate resolution satellite imagery and extensive agricultural ground truth data. Unlike the CoA and USDA surveys, which provides county-level estimates of acreage annually for major crops, the CDL provides spatially explicit identification of agricultural land use, making it one of the most widely used tools for understanding agricultural land systems in the US. The CDL has field-level resolution (30-meters) and crop classification accuracies near 90% for major commodities like corn, soy, wheat, and rice from 2008 to present. Non-crop areas and less dominant crops have much lower classification accuracies than top commodities. The CDL is intended for monitoring annual land cover and not changes over time and while researchers have provided recommendations for harmonizing data across years, there remains a high likelihood of error and misanalysis (Lark et al., 2017). While it is not possible to link the CDL land use data to farm-specific attributes with publicly available data, a recent release of farm field boundaries based on the CDL data could support linking CDL data to specific fields and farms (USDA NASS, 2023). All historical CDL products are available for use and free for download through the CropScape web interface.

### **2.2.3 Other US-wide land cover data**

The strength and emphasis of the CDL is crop-specific land cover categories. Because the accuracy of the CDL non-agricultural land cover classes is based upon the National Land Cover Database (NLCD) provided by the US Geological Survey, the USDA recommends using the NLCD for studies involving non-agricultural land cover. In addition to the NLCD, there are several other remote-sensing based land cover products including the suite of LANDFIRE data

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<sup>9</sup> Over 270,000 points have been surveyed in-situ on different land cover and use types (cropland, grassland, forest, built-up areas, transport network, etc.) irrigation management and structural elements in the landscape. The statistics can be analyzed at a more detailed level, providing data for the almost 300 NUTS-2 regions within the EU-28.

<sup>10</sup> There are 3108 counties in the coterminous US. County size varies significantly by state; for example, some western counties are nearly as large as entire states in the northeastern US.

<sup>11</sup> <https://quickstats.nass.usda.gov/>



for tracking wildfire extent and impacts and the Landscape Change Monitoring System (LCMS) data suite.

### 3 RESULTS

In what follows, we discuss data available in each region to operationalize and understand the core elements of agricultural land systems as conceptualized by Turner et al. (2020).

#### 3.1 Economic structure

We define the element “economic structure” as the explicit and implicit economic incentives that govern socio-economic interactions in agricultural land systems<sup>12</sup>. We differentiate macro- and microeconomic structure—with the former relating primarily to the agricultural sector as a whole and the latter being dedicated to economic information about individual (or average) farms.

##### 3.1.1 Macro-economic structure

Eurostat provides macro-economic indicators such as local unemployment rates, GDP, investment and consumption, competitiveness and innovation indicators, poverty index, price indices and deflators, exchange rates, interest rates, trade balance, etc. The Economic Accounts of Agriculture (EAA)<sup>13</sup> provide total monetary values of agricultural outputs and inputs as well as income indicators at national and regional level.<sup>14</sup> Income indicators comprise the total factor income per annual working unit, the net entrepreneurial income per unpaid annual working unit, and the net entrepreneurial income. Highly differentiated data on agricultural production and trade flows both within the EU and beyond are also available.<sup>15</sup> Annual price indices of the main outputs and inputs are available at national level<sup>16</sup>, whereas land prices and land rents are provided at NUTS-2 level.<sup>17</sup> Information on the agricultural workforce is provided through the agricultural labor input statistics, which is part of the EAA, including total labor input by paid and unpaid labor at national level.<sup>18</sup> Detailed labor force statistics are also provided through the FSS, including the total farm labor force at NUTS-2 level by sex, working time, contract type, and labor type (family or external). Data can be broken down by farm types, legal status, and size. Wage data are available at national level as indices for salaried and non-salaried labor. FADN provides additionally the paid and unpaid labor force and the total payroll by farm type and economic size at national and FADN regional level.

The USDA’s Economic Research Service (ERS) provides the bulk of agricultural macro-economic data in the US. Much of this data is provided at a national scale in the form of data reports. Available data include the total monetary value of agricultural inputs and outputs, broken down by commodity class; sector wide estimates of land value, assets, and debt; commodity costs and returns back to the 1970s; farm household income and wealth statistics;

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<sup>12</sup> In the Turner et al. (2020) framework economic structure is defined less explicitly than other elements. One key variable reflecting economic structure mentioned by the authors is the economic rent for land, which is also the most central economic indicator with respect to demand for land (see Section 3.7). Furthermore, the economic structure is closely related to other elements such as institutions or actors’ attributes.

<sup>13</sup> The EAA are a part of the European system of national and regional accounts (ESA).

<sup>14</sup> Data on both outputs and inputs is highly differentiated, providing information on in total around 160 output and input categories.

<sup>15</sup> This is partially listed under agricultural production, but more detailed data under the more general - i.e., comprising all sectors of the EU economy - international trade in goods.

<sup>16</sup> Again, in a highly differentiated manner (around 200 different categories). See [https://ec.europa.eu/eurostat/cache/metadata/en/apri\\_ap\\_esms.htm](https://ec.europa.eu/eurostat/cache/metadata/en/apri_ap_esms.htm)

<sup>17</sup> See [https://ec.europa.eu/eurostat/cache/metadata/en/apri\\_lpr\\_esms.htm](https://ec.europa.eu/eurostat/cache/metadata/en/apri_lpr_esms.htm) and Section 4.7 “Demand” for more details.

<sup>18</sup> While the taxonomy of many of these categories and indicators in the EAA is similar to those in the FADN, the data is compiled by member states through the combination of different data sources, statistical methods and expert assumptions, which raises potential issues with respect to comparability across regions.

national production estimates for major commodities (including animal products); and foreign agricultural trade, including export destinations. Because the US Farm Bill also implements programs providing food benefits to low-income families (notably the Supplemental Nutrition Assistance Program or SNAP), macro-economic data also includes federal expenditures to support food access, nutrition assistance, food availability (including retail prices), and SNAP benefits. The USDA ERS also provides data on farm labor including wages, geographic distribution, H2A temporary agricultural program, legal status of workers, worker demographics. Though the bulk of this data is reported nationally, the USDA NASS has implemented a series of surveys on farm labor that provide a subset of the data at finer spatial scales. At county level, the farm labor force is described through the quinquennial CoA including farm sizes (number of hired workers), the number of migrant workers (hired and contract workers), the unpaid worker share, and labor expenditures.

### 3.1.2 Microeconomic structure

In the EU, farms' microeconomic structure can be described through several databases, the most important one being the FADN public database. For each combination of farm type and farm size category observed in a FADN region, it reports the 180 standard results variables<sup>19</sup> of the average farm. Farm revenues are provided for three main categories (crops and crop production, livestock and livestock products and other gainful activities) and 30 distinct subcategories. Farms' expenditures are similarly available for roughly 30 input categories such as costs for materials, labor, and other costs, including paid interest and taxes. Monetary data on public payments as well as on assets and capital is provided in more than 20 variables each. A range of economic indicators related to income, cash flow and investments completes the economic accounts. FADN also provides physical measures of a few selected variables, such as milk yield, yield of maize and wheat, mineral fertilizer use, the number of livestock units or the composition of the farm labor force. Related input or output price data are mostly missing or provided as aggregates only. Information related to interactions with the land use system are provided in terms of total utilized agricultural area (UAA) by crop category. Farms' acreage of rented land and expenditures for rent (for land and buildings) are also provided.

The triennial FSS provides further information about farm structures at NUTS-2 level, including farms' UAA, livestock units, and annual work units, differentiated by farms' legal forms, economic farm size, and UAA. Additionally, information on tenure status differentiates owned, rented, and shared land at NUTS-2 level by age class, sex, and farm type. Adding to FADN and FSS, IACS provides spatially explicit information on farms' field arrangements, sizes, and cultivation types (e.g., organic and conventional) to describe, for instance, farm structural change and land use concentration (see, e.g., Plogmann et al 2022, Balmann et al. 2022).

The US CoA provides detailed information about farms' economics at county level. This includes data on federal receipts, farm income by commodity, farm size, indicators of the importance of off-farm work, number of operations, farm expenditures (chemical, fertilizer, machinery, labor). Farm expenditures are available for various farm inputs, such as fertilizers, feed, and labor. Much of these data are reported by different farm types including non-family farms and small (GCFI <\$350,000), mid-size (\$350,000 - \$999,999), and large-scale farms (>\$1,000,000). Annual farm structural information at state levels is also provided through the USDA's Agricultural Resource Management Survey (ARMS). Because crop insurance for certain commodities is federally subsidized, the USDA Risk Management Agency (RMA) also provides detailed data on crop insurance coverage and indemnities, including the cause of loss at a county-scale.

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<sup>19</sup> See <https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/description.html> for a list of all SE variables, including descriptions and definitions.

### 3.2 Actors' attributes

Many actors influence agricultural activities. Here, we focus on the attributes of the immediate or proximate decision-maker, in line with the definition by Turner et al. (2020). We refer to these individuals as “farm operators.” The USDA defines a farm operator as a person who makes day-to-day management decisions on-farm. Eurostat and FADN define the “manager of the agricultural holding” as “the person responsible for the normal financial and production routines of running the holding” (Eurostat, 2023b). In both regions, demographic data describing farm operator age and sex (but not gender identity) are reported at subnational scales. The CoA reports years' experience of farm operators while Eurostat reports categorical levels of agricultural training (e.g., practical only, basic training, full agricultural training). The CoA reports operators' race, however, no data on farm operator race or nationality is reported in the EU.

### 3.3 Demographic conditions

The Turner et al. (2020) framework defines demographic conditions as the number, density, and movement of people affecting agricultural land systems. We consider factors related to population composition, farm labor workforce and availability, and pressure generating demand for agricultural products and farmland, e.g., through urbanization (Bren d'Amour et al., 2017; Güneralp et al., 2020).

Through Eurostat, the decennial EU census provides detailed information at national and regional level from 1991 onwards. Population structure by sex, age, and marital status are reported at NUTS-3 level; employment characteristics, occupation and migration characteristics are provided at NUTS-2 level. Annual demographic characteristics (e.g., balance, live births, deaths), and demographic indicators (e.g., crude rates) with various breakdowns (e.g., by sex, age, country of birth, citizenship, educational attainment) are available since 1960 at national level and from 1990 onwards at NUTS-2 level. Demographic projections until 2100 include main indicators under various scenarios concerning life expectancy, mortality, fertility, and migration. Based on the 2011 census, a static measure of urbanization differentiates cities, towns and suburbs, and rural areas based on population densities. Agricultural labor force information is provided through FSS and FADN, however, only at regional levels (see 3.1.2).

For the US, the US Census database provides population statistics and other census products (e.g., American Community Survey, Economic Census). The decennial census data is available online from 2000 onwards; annual estimates are provided after 2011. The database covers a wide area of topics including age and sex distributions, ancestry, citizenship, and household composition at ten spatial breakdowns, from states to census tracts. Data availability decreases with the spatial resolution. Demographic projections under various assumptions concerning life expectancy, mortality, fertility, and migration are provided. Urban and rural areas are differentiated based on population density and non-residential urban land use. Information on the agricultural labor force is provided through the USDA ERS at national scale, including data on workers from the H2A visa program, and through the CoA and NASS surveys at finer regional scales (see 3.1.2).

### 3.4 Institutions

Agriculture is a human endeavor. As such, cultural norms, values, and beliefs together with legal and political frameworks shape farmland use. We follow Turner et al. (2020), who capture these dynamics in the “institutions” element. Information on *informal* institutions such as gender norms, rural social conventions, or familial expectations are completely absent from both US and EU datasets, rendering these vital drivers of agricultural land use invisible from a big-data perspective. Public agricultural databases are themselves products of the broader cultural contexts they seek to systematize. The modern governance priorities of quantification and standardization (Merry 2011) are readily apparent in both US and EU data products and

determine what public data are available for agricultural research. Neither governing entities nor researchers frequently recognize the choices embedded within national datasets (Rissing et al. 2023).

The most prominent formal rules governing agricultural land systems are the US Farm Bill and the EU's Common Agricultural Policy (CAP), respectively. The corresponding regulations are detailed in legal texts at US and EU level; in the EU partly also in national legislations. Both the EU and the US provide information on subsidy receipts per area (and per beneficiary in the EU), insurance payments, and payments for participation in the conservation reserve program (CRP) and rural development measures (RDM; implemented by EU member states), respectively; but no details on payments per particular program or scheme. In the EU, no single dataset lists all RDM measures available and implemented in each member state. EU data can be arranged by farm type and size, and legal form of the holding; in the US this information is not available. In both places it is difficult or impossible to see how subsidies are allocated across operator's race, nationality, gender, age, or education.

Other formal institutions relevant to agricultural land systems include environmental regulations, land market regulations, trade policy, laws on succession and inheritance of farms, agricultural tax and social security laws, and agricultural extension services. In the EU, some of these are regulated at EU level (e.g., Habitats Directive, Birds Directive, trade policies), others by member states (e.g., land market or soil protection regulations) or a combination of EU and national regulations (e.g., farm advisory system). This offers the possibility of comparisons, but at the cost of high complexity in EU-wide analyses or comparisons with non-EU countries. Member state-level regulations are not systematically collected or published in publicly available repositories. Spatial data on environmentally protected areas (in particular the EU-wide network of protected areas Natura 2000) is available in the EU from the European Environment Agency (EAA) and INSPIRE platforms. Eurostat also provides information on compensation payments to farms who farmland in such areas. Similarly, in the US, data on acres enrolled and payments made for the CRP and the Conservation Stewardship Programs (CSP), which aim at conserving environmentally sensitive farmland, are available at the state level through the Farm Services Agency (FSA) and aggregated across conservation programs at a county-level from the CoA. Both the US and the EU (Eurostat, FADN) provide some information on the tenure status of farms' agricultural land, but not information on lease terms (e.g., length, payments, etc.). Neither the EU nor the US publish detailed information on farmers' tax or social security payments.

### 3.5 Techno-managerial strategies and infrastructures

Techno-managerial strategies and infrastructures are the technological inputs, management methods, and permanent landscape alterations that manipulate agricultural land for use. Both the US and the EU report expenditures on and/or amounts of major production inputs used, including labor, machinery, mineral fertilizers, and pesticides (CoA; Eurostat and FADN).<sup>20</sup> Both also report information on irrigated areas (US: also by major commodity crops in dominant regions; EU: also irrigable area), organic farms and acreage (EU: also farms/area under conversion), and the use of reduced tillage and cover cropping practices by farms and area (CoA, Eurostat). In the EU, tillage practices can be arranged by farm types and sizes, but not by operator characteristics; in the US county-level adoption rates of cover cropping and no-till were reported by operator race in 2017, providing a rare glimpse at the intersectionality of management practices implemented on US farms. In both the US and EU, information on the adoption of the more *specific* agricultural practices incentivized and subsidized by the national EQUIP program (US) and RDM, including agri-environmental schemes (EU), are not available. In the US, a recent Freedom of Information Act (FOIA) request by Basche et al. (2020) provided access to county-level EQUIP adoption and spending data through 2018; however, these data

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<sup>20</sup> In the EU, fertilizer use of nitrogen and phosphorus by Eurostat, and for nitrogen, phosphorus and potash in FADN.

are still not publicly available through federally funded databases. Another initiative by the USGS provides gridded 250-m resolution estimates of irrigated agriculture across the coterminous US for 2002, 2007, 2012, and 2017 (USDA CoA year) (Pervez and Brown, 2010).

In the EU, Eurostat additionally provides information on livestock herd sizes, the types and numbers of manure storage facilities, under-glass production in greenhouses, and the numbers of low, medium, and high-input farms at NUTS-2 or NUTS-3 level. Information on pesticide sales and pesticide use by active substances per crop is also provided, but partly incomplete. At a national level, Eurostat collects data on machinery (e.g., numbers of tractors), the structure of orchards and vineyards, gross nutrient balances, holdings with equipment for energy production, and areas farmed with GMOs and energy crops. In the US, the USDA ERS reports *national*-scale estimates of GMO adoption and fertilizer use and prices, as well as county-level estimates of fertilizer expenditures. The USDA QuickStats database provides data on farm buildings (e.g., storage facilities), equipment (e.g., sprayers), and vehicles at a county level from the CoA, as well as data on facilities such as irrigation infrastructure and wells at a state level.

### 3.6 Environmental (dis-)services

Environmental (dis-)services refer to the benefits or harms that the environment provides to agricultural land users. Material benefits include production of fuel, fiber, and food, while non-material benefits encompass pollination, soil fertility, climate regulation, hydrological regulation (including drainage), and habitat provision. Disservices are negative impacts or damages resulting from environmental factors, such as soil erosion.

The European Environment Agency (EEA) offers various environmental datasets available for download at different spatial and temporal resolutions. These include the EEA Conservation Status of Habitat Types and Species, which includes spatial information about habitat and species distribution data with a 10 km grid cell resolution (Council Directive 92/43/EEC, 1992). The dataset covers the period from 2007 to 2018, is publicly available and updated every 6 years. Another data set is the EEA Population Trend of Bird Species, which provides data on a 10 km grid cell resolution. It enables analysis of changes in bird populations across different areas. Additionally, Eurostat offers agri-environmental indicators that provide insights into various aspects of agriculture and the environment. These indicators include soil loss from water erosion, production data for crops, meat, and dairy, soil cover information, such as winter crops and cover crops, and participation in rural development programs (including Agri-Environmental Schemes). Eurostat also provides country-level data on air pollutants and greenhouse gas emissions from agriculture, gross nutrient balance, and a farmland bird index. Furthermore, the FADN dataset includes information on yields of main crops, as well as meat and dairy production. It provides insights into the economic structure of farms, including indicators related to nitrogen and other relevant aspects. Other datasets that can contribute to environmental analysis include citizen science efforts like eBird, which helps fill gaps in publicly curated datasets, and datasets related to small woody features from the Copernicus program. Additionally, the IACS land use dataset provides vector data that allows for accurate determination of ecological indicators such as edge length, field sizes, and geometrical shape of fields.

In the US, very little data is collected systematically on environmental quality in agricultural settings. The USDA CoA reports county-level data on federal payments for the adoption of conservation practices, and work by Basche et al. (2020) released more detailed county-level information on the adoption (acreage) and payments for specific practices sanctioned by the federal Environmental Quality Incentives Program (EQIP) program. Citizen science efforts, such as eBird and Adopt-a-Stream, contribute to data collection, particularly regarding biodiversity. The agriculture sector is explicitly excused from numerous requirements and regulations outlined in the Clean Air Act and Clean Water Act as well as other landmark federal

legislation, severely limiting the power of entities like the Environmental Protection Agency (EPA) to reduce emissions (Clean Air Act of 1970; Clean Water Act of 1972; Kulkarni, 2020).

### 3.7 Environmental conditions and dynamics

Environmental conditions and dynamics refer to the ambient biophysical setting affecting the ecosystem functioning such as climate, soil properties, and topography. The European Soil Data Center (ESDAC) offers 7 soil property maps at 500 m resolution describing soil composition. Moreover, additional raster maps for soil properties at different dept and for more specific attributes are available in the ESDAC portal at 1 km resolution. Eurostat provides data for the estimated soil erosion by water and wind at NUTS-3 level for the entire EU territory. For the topography, data is provided by the European Digital Elevation Model (EU-DEM), which supplies an elevation map at 25 m resolution. The Copernicus Climate Data Store provides temperature and precipitation gridded datasets for global and regional domains, derived from in-situ and satellite observations between 1981 and 2021, with a higher resolution of 0.25 degrees. Direct measures of soil fertility seem not to be available.

The Soil Survey Geographic (SSURGO) and the Gridded Soil Survey Geographic (gSSURGO) database provide vector and raster data on soil properties at 10 and 30 m resolution. In addition, the gSSURGO Database includes a supplementary table with 57 pre-summarized attributes derived from the official SSURGO database. For the topography, the US Geological Survey offers elevation measurements with a higher resolution of 1 m for the whole US. While, for regional weather data, the PRISM Climate Group maintains a dataset covering monthly or daily time steps at 4 km resolution from 1895 to the present. Furthermore, the Daymet dataset includes weather variables at 1 km grid resolution across continental North America, Hawaii, and Puerto Rico. In addition to regional datasets, high-resolution global datasets are readily accessible for soil characteristics and topography, for example SoilGrids—a comprehensive global soil map at 250 m resolution or the Global Land One-kilometer Base Elevation (GLOBE) map which provides elevation information at 1 km resolution.

### 3.8 Demand

Land demand, i.e., agents' desire to own, use and profit from the land use in the future, is linked to drivers for specific land uses, where social and environmental elements feed back into demand. The value of the land is then determined, under functioning land markets, by demand and demanders' willingness to pay, in turn influenced by expected returns from using the land, and supply and sellers' willingness to accept. Higher land values and rental rates reflect stronger demand under limited/decreasing overall supply. Land related policies, e.g., zoning or environmental, and overall economic conditions can impact related values through the expected future returns.

At the EU level, annual agricultural land renting and land prices by NUTS-2 region are available via Eurostat. Data on renting are available from 2012 to 2021, but with completely or partially missing values for many countries. More observations are available for agriculture land prices. The USDA NASS releases annual reports on land values that include national estimates of the average farm real estate value, average cropland value and pasture value, irrigated and non-irrigated cropland value, value of farmlands and buildings, and state-level estimates of cropland value, pasture value, and farm real estate value. NASS also conducts a Cash Rents Survey that provides the basis for annual, county-level estimates of cash rent paid for irrigated cropland, non-irrigated cropland, and pasture.

No data on demand for land driven by investments and only selective information about buyer types are available. Likewise, data availability for any land market competition related information can only be assessed, for instance, by using farm-related land use data would allow land use concentration in a region as a proxy for potential market power in a local land market. Drivers for demand, however, are observable, for instance can urbanization trends,

renewable energy trends, or agricultural soil productivity for certain lands under certain climatic conditions be assessed and used as proxy variables.

### **3.9 Previous and current land use**

Agricultural land use encompasses the utilization of land for the purpose of producing feed, food, and fuel. This involves the processes of planting, growing, cultivating, and harvesting crops for consumption by humans or livestock. The concept of agricultural land use also includes various sub-purposes such as the cultivation of annual crops, permanent crops, or grasslands. In addition to the purpose of the land, attributes like intensity, composition, configuration, and stability play a crucial role in defining agricultural land use.

In Europe, IACS data is a key dataset which provides spatially explicit agricultural land use data at parcel level including field boundaries (however, with nationally and sub-nationally varying categories and different availability and accuracy). Eurostat also provides data on crop acreage on NUTS-2 and -3 level which is, however, not based on or aligned with the above mentioned. This includes fodder crop areas, land use for energy production, other land use shares (e.g., mushrooms/unutilized/short rotation coppice) and energy crop shares. Eurostat offers crop acreage since 1990, with increasing levels of detail (in crop typologies and spatial resolution) over time. However, several legislative changes occurred over time, such that that data are not well harmonized over time. Furthermore, the High-Resolution Layers (HRL) dataset from Copernicus provides detailed information on various land cover types, including grassland, small woody features, forest, imperviousness, water, and wetness. The HRL dataset includes both change and status maps and has a spatial resolution of 30 meters, with a higher resolution of 10 meters available since 2018.

In the United States, there are several datasets available for assessing land use. The CDL provides the best current agricultural data with a spatial resolution of 30 meters and is updated annually. CDL runs from 2008 to present and lets us track land use change (with error and bias towards classifying more common crops better). The National Land Cover Database (NLCD), derived from Landsat imagery, also offers land use information with a resolution of 30 meters. However, the NLCD categories for agriculture are coarser compared to other land cover types. Additionally, the United States Department of Agriculture (USDA) provides acreage data at the county, state, and national levels, specifically focusing on crops planted. These datasets play a crucial role in understanding and analyzing land use patterns and agricultural activities across the United States. There is also county-level acreage data through time going back to the early 1900s, but only for specific crops. CoA provides Acreage for major commodity crops back to the early 1900s.

## **4 DISCUSSION**

What we can see with available data shapes what we can monitor, manage, and transform. Given current data in both the EU and US, what can we learn about agricultural land systems? What remains invisible and which additional data are needed? In what follows, we discuss elements of agricultural land systems we can “see” reasonably well and the elements largely unmonitored in both contexts. We also discuss the implicit priorities and norms that these (in-)visibilities show.

### **4.1 Agricultural land use**

In both regions, the availability of Landsat and other remote sensing satellites has enabled more systematic comparison and tracking of land use and its change over time. Prior to the widespread use of remote sensing and GIS, both the EU and the US relied on reporting land acreage at political boundaries. This approach often limited the granularity of land use change analysis, as the focus was on larger-scale administrative units rather than specific agricultural areas. Today, both regions provide geographically explicit data on land use outcomes

(especially crops) at a high resolution, likely also resulting from an increasing focus on problems related to land use (e.g., biodiversity loss). However, in both places there are gaps in the coverage of less prominent or fringe crops, and in the EU the non-harmonized structure of IACS currently poses problems to continent-wide analyses.

Another shortcoming in both regions is that these detailed land use data lack a link to land users, especially the farm and/or farmer, and hence to decision-making, management, and production. For example, in the US context, there are no formal links between agricultural land use data provided in the CDL and farmer attributes in the CoA. Similarly, in the EU, linking the IACS plot-scale data to FADN or other farm(er) data is extremely challenging. In both contexts, these farm-level data are either behind a paywall, require special permissions, or are simply not available. This is largely to protect the anonymity of producers; however, anonymized databases could be constructed to allow the research community to analyze the interconnections between on-farm economics and decision-making with land use outcomes.

## **4.2 Farm structure and commodity production**

In both contexts, comprehensive data are available on the number of farms and their economic structure, and the amount and value of major agricultural commodities produced. This reflects historical priorities of agricultural policies that aimed at supporting production of commodities and the viability of farming by supporting farm incomes in both the US and the EU (Blandford & Matthews, 2019). However, as we discuss in the following sections, the data on farms and farmers reveals a narrow understanding of and focus on farmers as individual owner-operators and farms as single, independent entities.

## **4.3 Complex modes of production and value chain actors**

In both the US and the EU, available data largely centers individual operations as the de facto unit of analysis. Eurostat reports the legal status of holdings and differentiates between natural persons, legal persons, group holdings, or common land units ([Eurostat, 2023e](#)), which provides some flexibility to capture more complex forms of farm management. Since 2017, the US CoA collects demographic data for up to four operators per farm, which led to a 13.7% rise in the reported number of female operators from 2012 to 2017 (Pilgeram et al., 2020; Burchfield et al., 2022). While some available data describe farm *household* attributes—such as the proportion of farms with off-farm income (Eurostat, nationally available in US) and days worked off the operation (CoA)—intergenerational dynamics such as births and deaths are not prioritized, obscuring the impact of families' life-course stages. Data collection norms also obscure collective or cooperative approaches to farm ownership/management.

Furthermore, the extant data orientations tacitly and structurally reinforce an analytical approach to food systems that is heavily producer-biased. Although many value chain actors and resulting agribusiness corporate interests exert tremendous power over agricultural land use (Clapp 2021; Hendrickson et al. 2020), their mergers, acquisitions, and expansions are not covered in the available agricultural data. Data on the countless and diverse other organizations that support and shape agriculture are also unavailable.

## **4.4 Intersectionality and diversity**

In both regions, available operator demographics and attributes are seldom linked to farm attributes, making it challenging to understand the intersections of operator age, race, experience, or sex with indicators of farm revenue, farm management, or farm location. The US CoA allows a breakdown of population and farm labor statistics, e.g., by race or ethnicity; similar analyses are mostly unavailable via EU data. Understanding how farm livelihoods vary by race, ethnicity, and gender is largely impossible in both regions without special permission to access microdata (Pilgeram et al. 2022). Beyond intersectional analyses of producer populations, historical and current agricultural data priorities of both the EU and US also implicitly elevate a small number of crops grown for processing and export as those most



deserving of research attention. This dynamic reproduces a national agricultural fixation on agro-commodity yield and price, excluding diverse agricultural land uses, effects, and meanings from the realm of legitimate national research.

#### 4.5 Ownership and tenure

Present data collection norms also only partly account for the fact that in both the EU and US, many farm operators do not own (all of) the land they manage but rent from non-operator landlords. Regional data are available on acres rented, partially owned, or fully owned by operators (CoA; Eurostat & FADN, which also break down rental attributes by operator sex, age, and farm-type; FADN also provides amount of rent paid). However, little (US; some state- or national-level data are provided in the Tenure, Ownership, and Transition of Agricultural Land (TOTAL) Survey 2014) or no (EU) information is available on the attributes or identities of the farmland owners themselves in both contexts.<sup>21</sup> This lack of information about the land's owners is striking, as research has shown that renting may impact land use and agricultural practices, depending on the attributes of renting (Leonhardt et al. 2019, 2021, Varble et al. 2016). The absence of information on landowners prohibits analyses of relevant drivers of land use such as land ownership modes, land ownership concentration or fragmentation, and owner-operator relationships.

#### 4.6 Inputs to production

While coarse information about inputs to agricultural production is provided in both regions, data on environmentally relevant inputs as well as on labor inputs are limited. The EU provides some more detailed data on environmentally relevant inputs (e.g., pesticide and fertilizer types) and infrastructures (e.g., manure storage) than the US, but often at a spatially coarse scale. In both regions, more detailed data on the technology and input use of farmers are therefore needed to better understand the link between agricultural land use and environmental pressures. In the EU, there is an ongoing initiative of transforming the FADN into a Farm Sustainability Data Network (FSDN)<sup>22</sup> that collects farm level data on environmental and social farming practices, but this has yet to be implemented. Some information is instead collected on the environmental *impacts* of chemicals through water quality sampling by other authorities (e.g., USGS and EPA in the US; EEA in the EU). Data on water withdrawals from groundwater or surface water and the amount of water used are also not reported and data on the adoption of new “smart agriculture” technologies are lacking in each region. Both would be especially relevant for understanding climate change impacts on agriculture and land use.

In addition, data on *labor*, particularly the attributes describing farm workers who are working on agricultural land, are limited in availability. For both the EU and the US, tracking farm workers is not possible and informal labor markets and illegal/irregular farm labor remains unobserved. Notable differences concern the high spatial resolution for the US, whereas finer scales for EU data are only available through the statistical offices of the member states. The US CoA further allows a stronger breakdown of population and farm labor statistics, e.g., by race or ethnicity, mostly not available for the EU.

#### 4.7 Capital and debt

In both regions, data on farm capital, debt and loans are also limited. For example, US CoA data reports net farm income (revenue minus expenditures), but the bulk of data on farm assets, debt, and wealth are shared in reports provided by the USDA ERS at the national scale ([USDA, 2023](#)). In the EU, information on debts and loans, paid interest rates or sources of

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<sup>21</sup> Eurostat reports some information on farm (not land) holder-operator relationships, where the “holder” is the one who “takes the economic risks of the holding” and in whose name the holding is operated (Eurostat, 2019b). This includes, for example, the number of farms where the manager is the spouse, a family member, or has no family ties to the holder.

<sup>22</sup> See [https://agriculture.ec.europa.eu/data-and-analysis/farm-structures-and-economics/fadn\\_en#conversiontofsdn](https://agriculture.ec.europa.eu/data-and-analysis/farm-structures-and-economics/fadn_en#conversiontofsdn) for more detailed information on the roadmap to FSDN.

loans and access to capital is mainly unobserved or not reported. Price information is scarce and, e.g., farm-gate prices, differentiation by product qualities or production systems (organic/conventional) is missing.

#### **4.8 Policy implementation**

Subsidy programs and agricultural policy drive many of the differences in what aspects of agricultural systems are monitored in both regions; however, while both regions provide coarse information on subsidy receipts on-farm, no details on payments per specific program or scheme are provided. This prohibits analyses of how policies shape land use outcomes, hindering policy evaluation and learning from examples in both the US and the EU. For example, in the US, data is reported at a county-scale on “government receipts” – but accessing data on *receipts from specific programs* at this scale has remained challenging. The same is true for the EU, where RDM measures are designed and implemented at member state level and there is (currently) not even a comprehensive overview of the measures available in each country through the new CAP, and also no data on participation or payments per measure for previous CAP periods. We are aware that detailed impact analyses of RDM's are carried out regularly on a national/regional level, however, the underlying national and farm-level data are not openly available. Thus, while the variation in RDM measures across EU member states theoretically allows for interesting comparisons and impact analyses between countries, the lack of publicly available information makes such research practically impossible at larger scales. Overall, the low level of detail of the openly available information of subsidy allocation hampers analyses of how farm subsidies move through the food system and how they interact with actors' attributes to bring about land use outcomes.

#### **4.9 Environmental services**

There are several similarities between the US and the EU when it comes to capturing and assessing environmental value. First, what we perceive as environmental value is often influenced by political considerations of what is deemed environmentally beneficial. Additionally, tracking environmental services over time relies on “snapshot” estimates to understand the state of the environment. The data are particularly effective in revealing the ecosystem services (ESS) provided by agricultural production, especially for important crops and their yields. However, it is generally challenging to capture and model ecosystem services accurately. Factors such as intra-seasonal variation pose difficulties in accurately quantifying and predicting these services. Furthermore, publicly available data on farm-land birds and biodiversity are often limited, and assessments are commonly conducted on a coarser spatial level basis.

In contrast to the US, the EU provides data on greenhouse gas emissions from agriculture, although partly limited to selected countries and only available at the national level. This may change as the US pivots to investing in “climate-smart” agricultural futures. The EU has a more comprehensive regulatory framework, including directives such as the Water Framework Directive, Flora Fauna Habitat Directive, and Nitrogen Directive, which contribute to better regulation and monitoring of environmental factors. The United States lack such federal initiatives comparable to those in the EU, which may be one reason for differences in data availability and regulatory measures.

#### **4.10 Comparability, definitions, thresholds, and scale**

A generally consistent national agricultural data framework in the US facilitates more comprehensive and longitudinal studies. In contrast, the more recent formation of the EU resulted in varying levels of standardization and data availability across member countries. The EU's formation also created new opportunities for tracking land use change at a super-national scale but changes in EU country boundaries over time pose challenges to accessing data prior to the availability of Landsat satellite imagery. In the US, state and county boundaries have remained relatively static, providing more stability in historical land use data.

Though the content of macro and microeconomic data is comparable across these two regions, data sampling, definitions and thresholds differ notably. For instance, the US CoA reports small sample statistics including partial data from single farms, whereas FADN and Eurostat publish data only if a minimum regional farm quota is met due to privacy concerns. Overall, US data are governed by more uniform requirements and reporting. In contrast, EU data reporting varies between both data sources and member states. FADN and FSS sampling, for example, use different farm size thresholds, and IACS has yet another (implicit) farm size threshold for data collection due to minimum subsidy eligibility requirements. Likewise, farm typologies vary between EU databases with a larger number of type classes in the FSS compared to the FADN. Further, in terms of financial indicator data, ARMS data from the US provides data on whole farm households, while FADN data from the EU only addresses data for farms, and the EU lacks the kind of insurance data tracked by the US.

The scale at which decisions are being made (e.g., farm or landscape level) is often not the scale at which data are provided. In both areas, data describing climatic conditions relevant to agricultural systems are rarely reported at a socially relevant spatial scale. For instance, data on seasonal weather are available only at several kilometer resolution, and consequently they are not suitable to inform on-farm decisions making (e.g., irrigation timing). Furthermore, for most soil properties datasets temporal resolution and alignment are also a concern. In fact, they mostly refer to a specific year leading to difficulties in tracking temporal changes. For example, intra-annual variations in production, such as crop rotations and cover cropping, are difficult to observe with currently available data.

## 5 CONCLUSIONS

The on-going and emergent challenges facing global agricultural systems require re-thinking data needs and data reporting as well as intentional work to identify and develop a shared language describing agricultural land systems. Our review of agricultural land system data that is publicly available in two relatively data rich regions—the US and EU—reveals both priorities and “blind spots” in current monitoring efforts. What and who we see reflects federal and regional policy priorities and bounds research possibilities for comprehensive (cross-context) analyses of agricultural land use change.

In both regions, it is fairly easy to locate data describing the production and revenue associated with cultivation of major agricultural commodities. Our comparative analysis suggests, however, that both regions struggle to “see” complexity and diversity—from alternative forms of management and ownership, to diverse land use systems, to the diversity of the humans engaged in the agricultural sector, to genetic diversity on-farm, to emergent modes of management. EU policies prioritizing conservation and payments for environmental services have led to relatively more developed data on environmental health and land use, however progress is still needed. The planned Farm Sustainability Data Network FSDN will provide information on environmentally relevant inputs to production, but depicting farms’ uptake of management practices supported by the Rural Development Measures will remain difficult, since each member state designed their own scheme ‘menu’ and setup. In both regions, there is very little data on the humans that *own* agricultural land as well as the humans that *labor* on agricultural land. Data on farm debt, farm lending, and farm capital are also limited.

While in both regions, agricultural land use can be seen at a very detailed level, most of the drivers of land use change are reported at much coarser spatial or temporal scales. This makes it difficult to understand how current land system configurations emerged. Current data makes comparative research focused on land use, productivity, and profitability possible, but even in these relatively data-rich regions, analyses of many core components of agricultural land systems remains difficult or impossible. This is a significant barrier to identifying and understanding the leverage points that could help to steer agricultural land systems in both regions towards more sustainable futures.

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