Uptake of Ecological Farming Practices by EU Farms: A Pan-European Typology

L'adoption de pratiques agricoles écologiques dans les exploitations de l'Union européenne : une typologie paneuropéenne

Die Anwendung ökologischer Anbaumethoden in EU-Betrieben: Eine pan-europäische Typologie

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Introduction

Food systems are one of the main drivers of environmental degradation, biodiversity loss and climate change. In Europe and other industrialised countries, high yields of food and feed production have been accompanied by significant ecological harm, such as greenhouse gas (GHG) emissions, loss of biodiversity on farmland, and loss of air and water quality through use of nitrates and pesticide. The agricultural sector in Europe is responsible for an estimated 10.3 per cent of total GHG emissions, most of which (70 per cent) is due to livestock production.

In response to this, the European Commission launched, in the framework of the Green Deal, the *Biodiversity Strategy towards 2030* and the *Farm-to-Fork Strategy (F2F)*. These include targets aiming to reduce the impacts of the food system on the environment, within the context of fostering the transition to healthier, more sustainable and fairer food systems. Targets include significant reductions in the use of mineral fertilisers and pesticides, as well as an increased uptake of more environmentally sustainable farming practices and farm management systems. Though not legally binding, these strategies will need to be linked and accommodated within the forthcoming Common Agricultural Policy (CAP) 2023–2027, which will manage a budget of 270 billion euros to support European farmers whilst pursuing ambitious environmental objectives.

> "Les ambitions environnementales de la PAC et du Pacte vert devraient s'accompagner d'une ambition similaire dans la collecte d'informations pour évaluer efficacement les progrès vers ces objectifs."

In this context, it is essential to be able to assess the environmental performance of farming across a variety of levels: individual farms, groups of farms and territories. To this end, a Farm Typology was devised in the LIFT project as a tool to categorise farms according to their management approach and to evaluate them from an environmental perspective. In this article, we first briefly describe farm typologies and how they can be used to inform policy. We then present the method adopted to develop the LIFT farm typology and illustrate an example of application using individual farm data from the EU-wide Farm Accountancy Data Network (FADN). We show and discuss results from this application and identify knowledge gaps and provide suggestions for the FADN's envisaged transformation into the Farm Sustainability Data Network (FSDN).

Farm typologies and sustainable agriculture

The use of farm typologies has multiple applications in policy evaluation and monitoring, such as for better targeting of policy measures or for investigating trends across farming cohorts over a number of years. Farms belonging to the same group can be considered relatively homogeneous with respect to their characteristics, and typologies allow us to summarise the complexity of farming approaches into a manageable number of units.

Farm typologies centred on ecological criteria can be a useful tool to inform and monitor EU policies, considering the increased environmental ambition of the agricultural sector in the new Common Agricultural Policy (CAP), and the above-mentioned Green Deal, the Farm-to-Fork and the Biodiversity Strategy for 2030. To this end, the LIFT Farm Typology was

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developed with the aim of classifying EU farms and covering the entire spectrum of environmental management, from the most agroecological to the least environmentally friendly.

Method for building the farm typology

The LIFT typology builds on the concept of agroecological farming (Gliessmann, 2015), which is considered in this article as the archetypical description of a fully sustainable farming system able to preserve natural resources in the long run. Building on the key principles of agroecology as defined in the report of the High-Level Panel of Experts for Food Security and Nutrition (HLPE, 2019), five key farm management principles were identified.

These can be summarised as:

- Maintenance of soil health;
- Decrease of total input intensity;
- Increased reliance on self-produced inputs;
- Avoidance of most harmful inputs; and
- Presence of seminatural elements on farm.

The first four principles were associated with archetypical farm types named 'farming approaches': *conservation agriculture, low-input farming, integrated/circular farming* and *organic farming*. A fifth archetype – *agroecological farming* is associated with farms that perform well with regard to all the five principles, as detailed below.

Farming practices contributing to each principle were identified during the LIFT project, and quantified on the basis of associated farm-level variables, i.e. data collected for individual holdings such as cost of purchased fertiliser as a proxy for total fertiliser use. These principles, the farming approaches and corresponding farming practices are listed in Table 1. It should be noted that these categories are not mutually exclusive, as explained below in more detail.

A scoring system was developed (Rega *et al.,* 2021), so that each farm receives a score for each individual variable/indicator associated with the farming practices listed in the right-hand column of Table 1. Specifically, each variable value is converted into a value from 0 (not contributing at all to the criteria) to 4 (maximum contribution to the criteria). Individual scores are then aggregated through a weighted average to derive an overall score relative to each of the main farming approaches listed in the central column of Table 1. Weights were defined by a panel of experts (including some of the authors) taking into account the relative importance of each input for the production specialisation of the farm considered (for instance, feed input would receive the highest weight for livestock specialist farms, and a low weight for crop specialist farms). The allocation of an individual farm to a farming approach is defined by setting thresholds to the scoring: if the farm reaches a certain threshold, it is ascribed to the corresponding farming approach. Farms which do not reach a minimum threshold in any of the four key management principles are grouped into a separate class named *Standard Farming*.

The score-based approach is similar to other available frameworks of farm-level sustainability performance, such as the Tool for Agroecology Performance Evaluation (TAPE) developed by the FAO (Mottet *et al.*, 2020). The resulting typology is made of all the possible combinations of the five sets as shown in Figure 1. A farm is assigned to the agroecological farming approach if it achieves a pre-determined threshold for each of the five key management principles.

Table 1: Key agroecological principles, corresponding farming approaches and farming practices

Agroecological principle	Farming approach	Farming practices
Soil health. Secure and enhance soil health and functioning for improved plant growth, particularly by managing organic matter and by enhancing soil biological activity.	**Conservation Agriculture**	Reduced/no tillage; crop rotation, crop diversification, maintenance of soil coverage through cover crops and other techniques.
Reduced input intensity. Reduce total input use per ha of utilised agricultural area, or per standard livestock unit for livestock-related inputs.	**Low-Input farming**	Reduced use of mineral fertilisers, plant protection products, water for irrigation, fuel/energy; low stocking density.
Recycling. Preferentially use local renewable resources and close as far as possible resource cycles of nutrients and biomass.	**Integrated/Circular farming**	Crop/livestock integration, use of own produced manure as fertiliser, use of own produced forage as feed, own production of seeds; on-farm energy production.
Non-use of specific inputs of concern for consumers	**Organic farming**	Ban on the use of GMO, synthetic pesticides and mineral fertilisers; adoption of animal welfare practices.
Biodiversity. Maintain and enhance diversity of species, functional diversity and genetic resources and maintain biodiversity in the agroecosystem over time and space at field, farm and landscape scales.	**Agroecological farming** (together with the other principles)	Creation and maintenance of landscape features on farm, such as hedgerows, tree lines, herbaceous strips, ponds, fallow land.

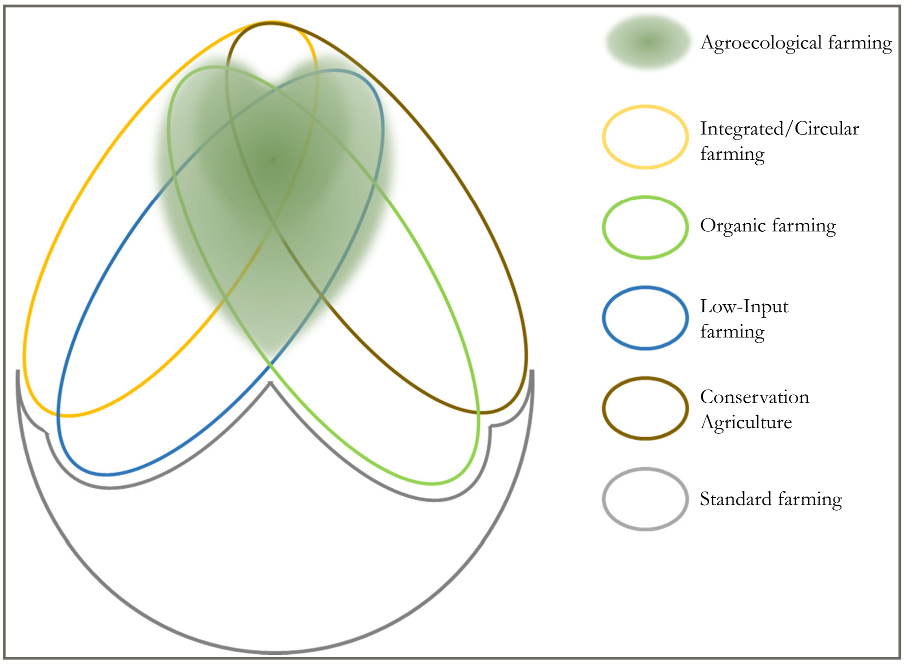
Application of the typology using FADN data

Here we show an example of the application of the typology using micro-data collected through the Farm Accountancy Data Network (FADN). The European FADN is a pan-European statistical survey conducted each year on a sample of around 80,000 farms. It is the only survey that uses homogeneous and harmonised bookkeeping principles across the entire EU. It allows comparisons of farms across Member States, and over time (years). The FADN was designed primarily to be an accounting data source, thus the variables mainly refer to economic and structural aspects like production costs, output, assets and subsidies. Accordingly, only a few variables offer direct information for identifying environmental aspects, among them stocking density or whether the farm is certified organic.

> "Die umweltpolitischen Ambitionen der GAP und des Green Deal sollten mit einem ähnlichen Ehrgeiz bei der Sammlung von Informationen einhergehen, um die Fortschritte bei der Erreichung dieser Ziele effektiv bewerten zu können."

Our approach is to use costs incurred by farms to purchase production inputs (fertilisers, plant protection products, seeds, water for irrigation, fuel, forage), and for the use or maintenance of certain assets (like machinery and buildings) as proxies for the overall intensity of use of such inputs. To convert original values into intensity indicators, they are normalised per ha of utilised agricultural area or per livestock standard unit for livestock-related inputs.

Figure 1: Graphical representation of the LIFT farm typology



Source: Rega *et al.* (2021).

Subsequently, the values from the FADN were processed to account for inflation and price differences between Member States using official Eurostat data to homogenise the whole dataset and allow comparison across time and countries (Rega *et al.*, 2021). For a subset of variables – feed, seeds, electricity, energy – the share of on-farm production is reported, which is used to measure the integration/circularity dimension described above. For each variable, the percentiles of the value distribution across the entire set of available observations (individual farms from the years 2011 to 2015) were calculated.

Five quintiles were determined for each variable. Then, for each farm, a score was associated to each variable, so that values belonging to the first quintile obtain a score of 4, values belonging to the second quintile are allocated a score of 3 and so on. A weighted average of the individual scores is then computed, using a

Crop residues left on soil, Po Plain, Italy © Ernesto Tabacco

pre-defined set of weights defined as part of the typology. Table 2 provides an illustration of the methodology for the *Low-Input farming* approach and scores used for farms specialised in cereals, oilseed and protein crops production.

Due to the limitations of FADN data, which do not collect enough information on both soil conservation practices or the presence of seminatural habitats, these dimensions could not be evaluated with the current FADN.

An illustration of the results of this exercise is shown in Figure 2, showing the classification of all EU farms surveyed by FADN in 2015 in the different farming approaches defined by the typology.

Potential application of the LIFT farm typology

The use of FADN data to apply the typology guarantees that its application is not dependent on *ad-hoc* data collection efforts, but on a survey that is regularly carried out at the EU level, following a standardised approach. One potential application of the typology is the identification and evaluation of spatial and temporal trends in overall input intensity of farms. This could be done, for example, by either looking at the share of farms that are categorised as *Low-Input* compared to other farming approaches, or in a more detailed way by examining how the average intensity scores evolve over time. This follows the same approach already adopted by the European Commission for the development of the CAP context indicator C.33 'Farming intensity', which is part of the official set of indicators under the Performance and Monitoring evaluation framework of the CAP (EC, 2021). The proposed

Table 2: Example of FADN-based scoring system for the evaluation of the Low-Input farming approach for Specialist COP (cereals, oilseed and protein crops) farms

Low-Input farming – Specialist COP (cereals, oilseed and protein crops)

Farming aspect	Variable Formula	Value Ranges	Score	Weight
Fertilisation	Total fertilisation costs per ha of UAA	48	4	2
	SE295*/SE025	92	3	
		147	2	
		240	1	
		> 240	0	
Pest control	Total expenditure for pest control products per ha of UAA	25	4	2
	SE300*/SE025	66	3	
		125	2	
		245	1	
		> 245	0	
Water use	Total expenditure on water per ha of UAA	0	4	1
	IWATR_V*/SE025	2	3	
		5	2	
		14	1	
		>14	0	
Energy use – fuels and lubricants	Total expenditure on fuels per ha of UAA	54	4	1.5
	(IHFULS_V*+IFULS_V*)/SE025	94	3	
		143	2	
		252	1	
		> 252	0	
Seeds	Total expenditure on seeds and plantlets for ha of UAA	28	4	1.5
	SE285*/SE025	56	3	
		94	2	
		196	1	
		> 196	0	
Energy use – electricity	Total expenditure on electricity per ha of UAA	0.0	4	1
	IELE_V*/SE025	8.6	3	
		24	2	
		71	1	
		> 71	0	
Machinery & building (maintenance costs)	Costs of current upkeep of equipment and purchase of minor equipment per ha of UAA	17	4	1
	SE340*/SE025	45	3	
		92	2	
		198	1	
		> 198	0	
Total physical assets (depreciation)	Depreciation of capital assets over the accounting year per ha of UAA	68	4	1.5
	SE360*/SE025	192	3	
		359	2	
		688	1	
		> 688	0	

Note: Variables denoted with an asterisk (*) have been corrected for inflation and price differences between Member States using official Eurostat data.
Source: Rega *et al.* (2021).

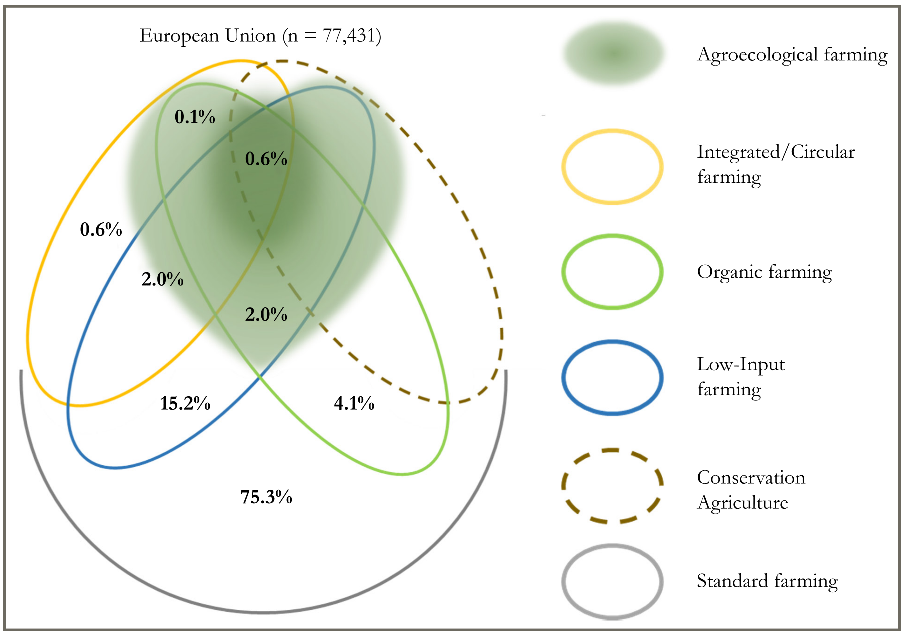
method for the evaluation of the Low-Input type can be considered an advance on current approaches as it considers a wider array of production inputs relevant for determining overall farming intensity (e.g. fuel, energy, machinery), as well as allowing for comparisons among countries.

Reducing the input intensity of EU farming and enhancing the circularity of a bio-based economy are key objectives of the Farm-to-Fork and the Biodiversity Strategies for 2030. These set a reduction target of 20 per cent in the use of mineral fertilisers and 50 per cent in the use of pesticides. These Strategies also seek to reduce the environmental and climate footprint of EU agriculture, which is directly linked to the total amount of resources needed for production. The typology presented here can thus be used as a monitoring tool to assess to what extent these goals are being achieved.

> "The environmental ambitions of the CAP and the Green Deal should be accompanied by a similar ambition in collecting information to effectively assess the progress towards these goals."

The proposed method is also very flexible and allows calculation of the share of farms per farming approach at different levels (EU, national, biogeographic region, and farm type). This enables comparisons across countries and/or accounting years, and provides a suitable tool for policy evaluation. The application of the typology at different points in time can provide information on the extent to which established policy objectives have been achieved. As the ambitions of the F2F strategy, namely to reduce the use of mineral fertilisers and pesticides, are achieved, an increase in the share of low-input and integrated/circular farms would be captured by the LIFT typology.

Figure 2: Distribution of FADN farms (whole sample, year 2015) in relation to the degree of uptake of ecological practices, as described by the LIFT typology



Note: The dotted line for the Conservation Agriculture set indicates that this dimension could not be evaluated with available data. Numbers in bold are the percentage of farms in each class of the typology.

From FADN to FSDN: identification of data gaps and possible solutions

Establishing a protocol to quantitatively assign farms to farming approaches has highlighted the identification of information and data gaps. In the future, these could be partly filled by adding variables in the FSDN questionnaire, and partly by deriving them from existing agricultural databases. In addition, the FADN itself already includes some additional variables like the physical quantity of nutrients in fertilisers. This is certainly an improvement compared to using expenditures as a proxy as it could eliminate possible inaccuracies when accounting for price differences between fertiliser types and countries. Missing information mostly concerns the adoption of farming practices not directly linked to purchased inputs, such as those aiming at enhancing soil health (no-tillage, reduced tillage, crop rotation, and use of cover crops). As for farm-level circularity, information on the share of own produced feed is present in FADN whilst no information on the share of own-produced manure used as fertiliser is available. Another relevant gap is lack of data on the presence and maintenance of seminatural vegetation on farms.

Different strategies and actions can be put in place to fill these gaps, building on already existing information. Many Member States already collect data on the application of measures associated with conservation agriculture (e.g. no-tillage, crop rotation) financed by their rural development programmes and will continue to do so under the new CAP Strategic Plans. Including such information in the FSDN could build on this base of knowledge, though it would require an EU-wide harmonised data collection process. The same is true for other environmentally friendly farming practices that would reduce total input intensity, like the use of biological pest control techniques, or a decreased reliance on external purchased inputs, such as green manuring or crop rotation with legumes as alternative fertilisation options. Again, a harmonisation effort will be required to maintain the standardised bookkeeping principles of the FADN being used in the FSDN. However, the advantage is that this type of information, to a large extent, is already collected within the CAP framework and collected in Member States as part of their monitoring and reporting obligations. Therefore, we consider that the additional effort would be more than compensated by the added value that this would bring to policy monitoring and evaluation.

A further possibility for filling the information gap would be linking FADN/FSDN data with the Integrated Administration and Control System (IACS) of Member States, the main system for the management and control of payments to farmers under the CAP. As the great majority of the farming practices of relevance for the LIFT Typology are adopted by farmers under support schemes financed by the CAP, they are recorded in IACS. Therefore, establishing a link with these two datasets would be a cost-effective approach to augmenting our typology. Despite some limitations due to differences in definitions and technical specifications adopted by Member States, information on the presence of on-farm seminatural vegetation, as well as other soil management practices can be obtained from the Land Parcel Identification System (LPIS), the geographic information system of the IACS (Czuc *et al.*, 2022). Establishing such a link would require additional efforts in terms of homogenisation, but it is an option worth considering in the absence of more reliable data sources.

Significant improvements in knowledge are possible

The typology described in this article was developed with the aim of assessing the progress of EU agriculture towards less harmful and more sustainable courses of action. This is in line with the new ambitious environmental objectives defined by the forthcoming CAP and the Green Deal. Agriculture is a multifaceted activity embedded in complex socio-ecological systems, and there is no straightforward metric that encompasses the three pillars of farming sustainability. The presented typology aims to strike a balance between the need to take into account the different aspects of environmental sustainability whilst reducing complexity in a way that is manageable for policymakers. Other potential users include farmers, advisory services and other actors in the agri-food chain, like retailers or NGOs. Importantly, this typology focuses on only the environmental pillar of sustainability. The economic and social viability of more ecological farming systems are considered elsewhere within the LIFT project but our approach allows us to identify trade-offs and possible synergies across the three pillars.

Good policymaking requires a robust information base. The environmental ambition shown by the new objectives of the CAP and the Green Deal should therefore be accompanied by a similar ambition in collecting information to effectively assess the progress towards these goals. A wealth of information is already

Heterogeneous Mediterranean agricultural landscape, Tuscany, Italy © Maria Luisa Paracchini

Manure spreading in Baden-Württemberg, Germany © CC BY-SA 3.0

collected at the EU level, but data gaps still exist and need to be filled to improve assessment of progress towards sustainability goals. Echoing results from previous research projects, such as the EU Farm-Level Indicators for New Topics in policy evaluation (FLINT) project (Latruffe *et al*., 2016), we consider that significant improvements in our knowledge of the ecological performance of EU agriculture can be achieved with a relatively limited effort, in many cases by exploiting synergies with already existing collection efforts.

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Summary

Uptake of Ecological Farming Practices by EU Farms: A Pan-European Typology

L'adoption de pratiques agricoles écologiques dans les exploitations de l'Union européenne : une typologie paneuropéenne

Die Anwendung ökologischer Anbaumethoden in EU-Betrieben: Eine pan-europäische Typologie

Understanding and measuring the sustainability of farms is key to evaluating progress towards policy goals for a more sustainable agriculture. In the LIFT project, a farm typology was developed to classify farms according to their ecological performance, based on farm-level variables from the Farm Accountancy Data Network (FADN). Selected variables are used to assess three key ecological dimensions of farming: total input intensity; degree of circularity (reliance on own-produced versus external inputs); and avoidance of the use of specific inputs of concern for the environment and consumers. The combination of these aspects is considered as a measure of the farm proximity to a full agroecological approach. The typology allows comparison of farms across farm types, countries and years. We briefly present the method and discuss two key aspects: 1) how the proposed farm typology can inform policymaking in the context of a new EU policy framework; 2) how it can inform the foreseen transformation of the FADN into a Farm Sustainability Data Network (FSDN). We suggest that the use of a typology approach under the new FSDN provides useful information on the impacts of the implementation of agroecological practices with an acceptable additional effort in terms of data collection.

Pour évaluer les progrès vers les objectifs de politique d'une agriculture plus durable, il est essentiel de comprendre et de mesurer la durabilité des exploitations agricoles. Dans le projet LIFT, une typologie a été développée pour classer les exploitations en fonction de leur performance écologique, sur la base des variables disponibles au niveau individuel dans le Réseau d'information comptable agricole (RICA). Des variables choisies sont utilisées pour évaluer trois dimensions écologiques clés de l'agriculture : l'intensité totale des intrants ; le degré de circularité (dépendance vis-à-vis des intrants produits sur la ferme par rapport aux intrants externes) ; et éviter l'utilisation d'intrants spécifiques préoccupants pour l'environnement et les consommateurs. La combinaison de ces aspects est considérée comme une mesure de la proximité de l'exploitation avec une approche agroécologique complète. La typologie permet de comparer les exploitations selon le type, le pays et les années. Nous présentons brièvement la méthode et examinons deux aspects clés : 1) comment la typologie agricole proposée peut éclairer l'élaboration des politiques dans le contexte d'un nouveau cadre pour la politique de l'Union européenne ; et 2) comment elle peut éclairer la transformation prévue du RICA en un réseau de données sur la durabilité agricole (FSDN). Nous suggérons que l'utilisation d'une approche typologique dans le cadre du nouveau FSDN fournit des informations utiles sur les impacts de la mise en œuvre des pratiques agroécologiques demandant un effort supplémentaire acceptable en termes de collecte de données.

Das Verständnis und die Erfassung der Nachhaltigkeit von landwirtschaftlichen Betrieben ist der Schlüssel zur Bewertung von Fortschritten bei der Verwirklichung der politischen Ziele für eine nachhaltigere Landwirtschaft. Im Rahmen des LIFT-Projekts wurde eine Betriebstypologie entwickelt, um Betriebe nach ihrer ökologischen Leistung zu klassifizieren, basierend auf Variablen auf Betriebsebene aus dem Informationsnetz landwirtschaftlicher Buchführungen (INLB). Anhand ausgewählter Variablen werden drei wichtige ökologische Dimensionen der Landwirtschaft bewertet: die Gesamtintensität des Inputs, der Grad der Kreislaufwirtschaft (Abhängigkeit von selbst erzeugten gegenüber externen Inputs) und die Vermeidung des Einsatzes bestimmter Inputs, die für die Umwelt und die Verbraucher von Bedeutung sind. Die Kombination dieser Dimensionen wird als Maß für die Nähe des Betriebs zu einem vollständig agrarökologischen Ansatz betrachtet. Die Typologie ermöglicht den Vergleich von Betrieben zwischen verschiedenen Betriebstypen, Ländern und Jahren. Wir stellen die Methode kurz vor und erörtern zwei wichtige Aspekte: 1) wie die vorgeschlagene Betriebstypologie die politische Entscheidungsfindung im Kontext eines neuen politischen Rahmens der EU unterstützen kann; 2) wie sie die geplante Umwandlung des INLB in ein Informationsnetz für Nachhaltigkeitsdaten landwirtschaftlicher Betriebe (INNLB) unterstützen kann. Wir weisen darauf hin, dass die Anwendung eines Typologieansatzes im Rahmen des neuen INNLB nützliche Informationen über die Auswirkungen der Umsetzung agrarökologischer Praktiken mit einem vertretbaren Mehraufwand bei der Datenerhebung liefert.