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1. Objective

The aim of task 1.2 is **to characterize and assess reference systems from the mainstream organic/sustainable sector**. The main objective of this study is to define a mainstream organic food system. At a later stage in the project, this will serve as a counterpart to compare with the innovative food production systems analysed to highlight advantages and shortcomings of mainstream organic/sustainable systems. Food system is understood here as follows: "Food systems encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded" (FAO 2018[1]).

Basically, this report has been divided into three main sections: (1) overview of organic farming in European Union (EU) and FOODLEVERS' case study countries, (2) literature review on sustainability of organic systems and (3) evaluation of organic farms in EU. The first two sections were prepared using country-specific benchmarking and literature data. Analysis within the third section was fed with FADN (Farm Accountancy Data Network) data, acquired from the European Commission (EC). Analysis of food systems at farm level is considered to be representative for the agricultural sector. At the moment, FADN is the only source of consistent data, that allows the comparison of farms between all the countries. However, FADN provides data mainly on economic aspects and lacks of information, relating to social and environmental performance of farms which makes any sustainability assessment impossible. In the Farm to Fork Strategy, the EC announced its intention to convert the FADN into FSDN (Farm Sustainability Data Network) in order to collect farm level data addressing social-environmental policy targets and other sustainability indicators[2]. As the system assessing farms sustainability is expected in the future, the FOODLEVERS project assumptions requires comprehensive evaluation of food system sustainability based on thorough and transparent analysis using already available and update indicators. That will help to formulate conclusions, useful for further analysis, when new data under new criteria will become available. For the purpose of an holistic assessment of organic food system in the EU, existing quantitative and qualitative information is explored to demonstrate the state of the art on organic farming performance in terms of the mainstream organic sector. The completed diagnosis of the sector provides a general reference model for the sustainability assessment of selected innovative organic case studies (WP2) and business-as-usual scenario for the development of alternative scenarios (WP3).

2. Trend of organic farming in the European Union and in FOODLEVERS' case study countries

At European Union level in 2019, 13.8 million hectares were farmed organically (the sum of the 'area under conversion' and the 'certified area') (EUROSTAT[3]). This value represents 8.5% of the total utilized agricultural area (UAA) of the EU-27. Despite the strong increase in organic area (46%) observed between 2012 and 2019, trends were very different between the countries. For example, while Bulgaria, France, Croatia and Hungary recorded growth in the total organic area of over 100 %, Poland reported reductions in the organic area (-22.6%). It can also be noted, that only around 2% of the EU agricultural holdings are fully organic (where the entire holding area is managed in compliance with the requirements that apply to organic production). This could potentially decrease sustainability of farms. The share of arable land in organic area accounted for 45.8% of the EU total organic agricultural area, while pastures and meadows covered 42.9% and permanent crops 11.3% (EUROSTAT). Arable land grew by 40% in the 2015-2019 period and showed greater increase than the permanent crops (33%) while permanent grassland grew by 23% (FiBL-AMI surveys, in: FiBL, IFOAM, 2021[4]). In 2017, organic pig and poultry production showed annual growth rates (respectively 6% and 10%) (EC 2019[5]). The growth of laying hens, which represent about 40 % of organic poultry, is estimated higher, at around 13 %. Between 2012 and 2017, the size of the organic dairy herd in the EU has increased annually by around 5.7% and the annual milk production by around 6.3%. The number of organic holdings increased over the last years, in contrast to the declining trend in total number of agricultural holdings. Organic farms are on average almost two times larger (30 ha compared to 17 ha for a conventional average farm in 2017). This could be linked to the extensive and grassland-based production systems in the organic sector, but also to the low number of organic farms in Romania. Over 66% of organic holdings (2017) own 10 ha or more (vs. 20% average for all farms) and only 7% less than 2 ha (vs. 43% for all farms) (EC 2019). Although organic farming is considered as creating more added value and higher margins per production unit, research demonstrates that organic farmers' share of value-added in the food chain do not significantly differ from those in conventional supply chains (between 9% and 62% share of retail prices for organic products compared to between 6% and 40% in conventional) (Sanders et al. 2016[6]). In terms of farm income, performance of organic farms within field crop category over conventional varies significantly across different countries (fig. 1).

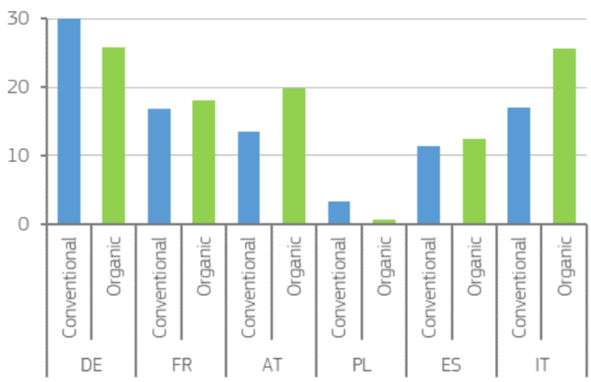
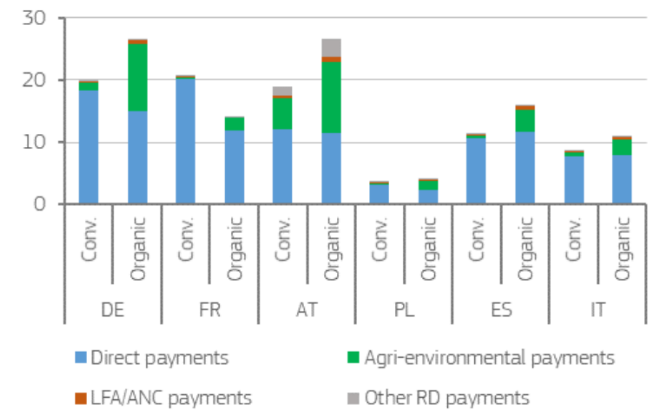


Fig. 1. Net market income per annual work unit (thousand EUR/AWU) for field crop farms. Average 2012-2016 (EC 2019).

Organic farming is recognized as a Common Agricultural Policy (CAP) measure in the European Union, supporting maintenance and conversion to organic farming, providing farmers more profits over conventional farming. Moreover, organic farmers within field crop category receive higher Rural Development subsidies and support for areas with natural constraints and can benefit from support for investments in organic farming practices and aid for marketing and promotion of organic products (fig. 2). Still, the differences in terms of CAP support can be great between EU countries.



Source: EU-FADN, AWU = annual work unit

Fig. 2. Subsidies per AWU (Annual Working Unit) to field crop farms by type, average 2012-2016 (EC 2019). (LFA/ANC = Less Favoured Areas/Areas with Natural Constraints).

In 2019, there were almost 344,000 organic producers in the European Union and over the period 2010-2019 their number increased by 56%. The number of organic processors increased by 9.1% compared to 2018. Nearly 65,600 organic food processors were identified in the EU in 2019. The 3 main categories of processed organic products are fruits & vegetables, cereals and milk. Per capita consumption in 2019 of organic food increased to 84 Euros. However, in Central Eastern European countries, consumer spending is still low. The highly popular purchases among European consumers continue to be organic fruit and vegetables. Retail marketing channels differ between countries – for example in Italy specialized retailers play a significant role, while in Germany they face strong competition from supermarkets. It is estimated, that COVID-19 pandemic has a considerable positive impact on organic food sales[4].

Tab. 1. Key indicators of organic farming for FOODLEVERS case studies countries in 2019 (FiBL, IFOAM 2021).

Country	Organic area [ha]	Organic share [%]	Organic producers [number]	Organic retail sales [million €]
Italy	1 993 225	**15.2**	70 561	3 625
Finland	306 484	**13.5**	5 129	368
Germany	1 613 785	**9.7**	34 136	11 970

Belgium	93 119	**6.9**	2 394	779
Poland	507 637	**3.5**	18 655	314
Romania	395 228	**2.9**	9 277	41
United Kingdom	459 275	**2.6**	3 581	2 679

2.1 Italy

Italy's cultivated organically area reached nearly two million hectares in 2019 (+2% compared to 2018). The organic farm land almost doubled in the last 20 years increasing from 7% to about 15.8% of total Utilized Agricultural Area, more than double the European Union average.

Among the arable land, which increased by just over 12 thousand hectares, organic durum wheat crops were growing (6%); barley (3%) and rice (12%); sunflower (26%) and soy (15%); alfalfa (8%); tomatoes (21%) and legumes (13%). Among the permanent crops, the positive increases of olive groves and vineyards, of the citrus fruit surfaces, which return to increase, after the decrease in 2018, by +3%, should be noted. Finally, the increases recorded by apples and pears are interesting, the extensions of which reach respectively 8,235 and 2,788 hectares. The categories of small fruits and nuts are stable, but there was a significant increase for figs and kiwis, whose areas increased by 102 and 652 hectares (ISNEA-SINAB report for 2019[7]).

Italy represents the second-largest producer of olive oil, with 570,000 tons (about 20% of world production), and the first consumer, with 610,000 tons (19.8% of consumption worldwide). According to the Italian Institute of Statistics (ISTAT), the Italian olive area amounts to 1.17 million hectares and involves 902,075 farms (56% of total Italian farms). Olive farming is mainly concentrated in the Southern regions, Apulia, Calabria, and Sicily. Despite that, in Italy, organic olive growing is the most widespread organic tree cultivation, only 20% of the national olive area is devoted to organic production in 2018.

The organic livestock sector has decreased in last years (2018), except for the consistency of cattle and poultry farms, for which the number of heads reached respectively 375,414 and 3,482,435 units, recording increases of 12% and 15%. The variation compared to 2017 is still contained, although it is decreasing and with negative values for pig (3%), sheep (8%), goat (5%) and equine (15%) farms and for beekeeping, a sector in which the variation in the number of hives is 4%. The absolute value data of sheep heads are less optimistic, which are decreasing even considering the last 3 years.

Organic per capita consumption in Italy increased during the last two decades passing from 18 €/person to 57 €/person. During the same period the export of organic products increased more than 3 times. The average size of organic farms is about 28.3 ha. An analysis of the geographical distribution shows that 51% of the hectares in question are located in four regions (Sicily, Apulia, Calabria, Emilia-Romagna). Organic food consumption increased by 4.4% over the past year[8].

During the year 2020/2021, large retail represented 48% of the Italian organic market, organic shops 22%, out-of-home catering 15% and other channels 15%. Hypermarkets and supermarkets accounted for most organic sales in large retail (63%). The main supermarket chains for organic sales are *Coop*, *Iper* and *Carrefour*. Organic distribution in shops is very fragmented: 23% of shops are totally independent, 42% of shops were part of organic chains. In 2019, 2,857 organic farms practiced direct sales. There were 236 markets with organic products and 797 organic buying groups. 1,466 organic farms practiced agritourism. Italian organic food exports have grown by 156% in ten years and represented around 6% by value of food exports during 2021. Italy exports a lot of organic fruit, vegetables, pasta, flour and wine (Agence BIO 2021[59]).

The main reasons to buy organic food in Italy is health and local origin, in that order. The main categories of organic products purchased by Italians in 2020/2021 were fruits, dairy products, eggs, vegetables and cereal-based products[59].

2.2. Finland

In Finland, around 13.9 percent of the country's agricultural land area was under organic cultivation in 2020. Organic land area has grown steadily in recent years, from roughly 171 ,000 thousand ha (7,5%) in 2010 to over 315,000 hectares in 2020 (13,9%). This was corresponding to an increase of about 84% during the past decade. The land area used for organic cultivation is projected to further increase up to 396,000 hectares by 2027. The largest organic agricultural land areas are located in Northern and Southern Ostrobothnia, as well as in Southwest Finland. There are over 5,000 organic farms in Finland, which accounted for nearly 10% of all farms in the country. The number of farms practicing organic cultivation is expected to increase in the future. By the end of 2022, Finland is predicted to have over 5,900 organic farms. Furthermore, the average size of organic farms has risen, reaching nearly 62.9 hectares per farm as of 2020[9]. The most cultivated organic crop in terms of production volume is oat, accounting for 53% of all organic cereals[10]. The yields of organic wheat, barley, rye, and oats were better than in the previous years. Organic milk production increased 10% from the previous year, but is just under three per cent of total milk production. Organic meat production accounted for around one per cent of total meat production, but more than a quarter of all sheep meat produced was organic. Beef accounts for the majority of organic meat production. Eggs production in organic poultry farms increased by 20%, accounting for 7% of the total volume of eggs[4].

Organic food consumption in Finland has increased in recent years. In 2019, approximately EUR 368 million in organic sales were sold in grocery stores[11]. Sales increased by 9.6% compared to the previous year. Mass retail is by far the main channel for organic sales (particularly S-group, K-group and Lidl). Organic shops and direct sales represent a small share of the organic market. The most committed consumers buy organic products directly from producers through a system called *REKO.* Finnish organic products represented 3,4% by value of Finland's food exports – they were mainly cereal-based products (especially oats), dairy products, berries (cranberries and blueberries), birch sap, potato starch and liquorice[59].

As in recent years, fruit, milk and other liquid dairy products and vegetables were the largest product groups in organic sales[12]. Overall, the consumption of organic food has become more regular in Finland over the recent years. Almost every fourth consumer in Finland buys organic products on a weekly basis. In 2017, organic fruit, berries, vegetables and eggs were the most frequently consumed products[13]. Purity and no pesticides, taste, and health are highlighted as the most important purchasing criteria for organic products. The importance of taste and environmental friendliness has increased[10].

2.3. Germany

In 2019, there were 34,136 organic-production holdings in Germany managing a total area of 1,613,785 hectares (FiBL, IFOAM 2021, p. 232). This corresponds to 12.9 percent of all German holdings or 9.7 percent of the total Utilised Agricultural Area (UAA) (BMEL 2021[14], p. 14-15). According to estimates by the organic industry association BÖLW, the organic agricultural land area slightly increased in 2020 by 5.3 percent to 1,698,764 hectares or 10.2 percent of the country's agricultural area (BÖLW 2021[15], p. 11). Since 2010, the agricultural land under organic cultivation has more than doubled by 62.9 percent (FiBL, IFOAM 2021, p. 260). Within the same time period (2010-2019) the number of organic farms has risen by 12,194 (55.6 percent) (BMEL 2021, p. 16). Organically farmed land is predominantly used as permanent grassland (830,000 hectares) and for arable crops (700,000 hectares), whereas less land is used for permanent crops (23,000 hectares) (FiBL, IFOAM 2021, p. 238).

The average size of a German organic farm reaches 47.3 hectares per farm in 2019 (BMEL 2021, p. 16). According to calculations by the Johann Heinrich von Thünen-Institute (2021[16], p. 3-4), organic test farms achieved an average income (profit plus personnel expenses per worker) of 37,444 euros in the financial year 2019/20, exceeding the earnings of comparable conventional farms by 9,305 euros or 33 percent. On a European scale, Germany shows the largest numbers for organic bovine animals (894,460) and is one of the countries with the highest pig stocks (138,850) in Europe (FiBL, IFOAM 2021, p. 264). For poultry the organic livestock was 10,209,000 in 2019. Additionally, Germany – amongst others – counts to the countries with the largest areas for cereal and dry pulses cultivation in Europe (FiBL, IFOAM 2021, p. 240-241). From a structural point of view, the organic sector in Germany is mostly organised in associations, with "Bioland" and "Demeter" being the largest and oldest ones and "Bund Ökologischer Lebensmittelwirtschaft" (BÖLW, Organic Food Industry Federation) as the umbrella association for the entire organic sector (BMEL 2021, p. 15). In 2020, over 60 percent of the organic agricultural area was managed considering the organic guidelines of these associations which are - in some cases - stricter than those laid down in the EU legislation (BÖLW 2021, p. 11). In addition to producers, organic processors (16,162), importers (1,831) and exporters (1,288) are also important stakeholders along the German organic value chain. Germany is not only the country with the highest number of importers but also 20 percent of the organic processors in Europe are located in Germany (FiBL, IFOAM 2021, p. 246, 265).

Germany represents the largest organic market in Europe, and the second biggest organic market in the world with a retail sale value of 12.0 billion euros and a share of 31 percent of European retail sales in 2019 (FiBL, IFOAM 2021, p. 248-249). The trend of organic and healthy consumption was further reinforced by the pandemic reaching a value of 14.9 billion euros in 2020 (BÖLW 2021, p. 23). By buying 22 percent more organic food and beverages than in the previous year, Germans made the organic share of the food market grow from 5.7 percent in 2019 to 6.4 percent in the 2020 pandemic year (BÖLW 2021, p. 23; FiBL, IFOAM 2021, p. 253). The most consumed goods in 2020 were organic meat, flour, alternatives to milk, fruit, and vegetables (BÖLW 2021, p. 25). In 2019, the German per capita consumption of organic food (144 euros) was the seventh highest in Europe (FiBL, IFOAM 2021, p. 252). The sale of organic products is strongly impacted by decreasing meat consumption in last 20 years (by 8kg/person). Around 9.3 million Germans are vegetarians/vegans. While animal welfare remains the main reason to buy organic food, for younger generation (18-30 year-olds) the main cause is the need to have fun and take care of their body[59].

Supermarkets (60.4 percent) have become the main marketing channel through which organic products are sold, competing more and more with specialised retailers (BÖLW 2021, p. 26). The leading distributors of organic products in Germany in 2020 were *Edeka* and *Aldi*, cooperating with "Bioland" and "Demeter". While in 2014, 33 percent of all organic products were sold in organic food shops, this share decreased to 24.7 percent in 2020 (BÖLW 2021, p. 26; FiBL, IFOAM 2021, p. 255). According to Ekozept, organic shops weaknesses are the following: little differentiation from conventional supermarkets, competition between chains on prices, lack of communication, little products innovation, no strategy to build loyalty customers, staff often insufficiently trained, too weak links with the producers, competition for attractive location between the shops. According to the BÖLW, independent organic shops and organic supermarket chains seem to be doing better than chains of small organic shops. In recent years, most of the newly created shops have a restaurant area[59].

2.4. Belgium

In Belgium, organic farming covers a total area of 99,075 ha in 2020 representing 7.2% of the total UAA. This area is laboured by 2494 farmers. All indicators confirm that the sector continues to grow as it did over the past decade. Between 2010 and 2020 both the organic area and the number of farms more than doubled (+103% and +119% respectively). Within Belgium, the situation of organic agriculture is very different between the regions Flanders and Wallonia. 91% of the agricultural area dedicated to organic agriculture is situated in Wallonia cultivated by 76% of the organic farmers. This reflects the far larger growth rate in Wallonia over the past decade, in which about three times more farmers starting an organic farm or converting an existing farm in Wallonia than in Flanders or 92 farmers/year versus 31 farmers/year respectively. This corresponds[17] with the conversion of 4098 ha/year in Wallonia as opposed to 482 ha/year in Flanders[18]. These differences in development are due to differences in the structure of agriculture in both regions, such as farm typology and average farm size but certainly also to differences in ambitions from a policy perspective between the two regions. At the initiative of Walloon Minister of Agriculture, the Walloon government has adopted a development plan for organic production in Wallonia, aiming to produce organically on 30 percent of the Walloon agricultural area by 2030[19].

In Flanders, the organic agricultural area reached 9,124 hectares in 2020, cultivated by 593 organic farmers. In Wallonia, the organic agricultural area reached 89,951 hectares in 2020, cultivated by 1901 organic farmers. The average agricultural area per organic farm is 39.7 ha in Belgium: 47.3 ha in Wallonia and 15.4 ha in Flanders. This large difference in average farm size between the two regions can be explained by differences in farm typology. The Walloon organic sector is characterized by a large number of cattle farms with large grassland surfaces. Sixty five percent of the Walloon certified organic area consists of permanent grassland[20] compared to only 36% in Flanders. In Flanders 49% of the organic farms (290 farms) cultivate less than 5 hectares. Together, these small farms cultivate only 6% of the total Flemish organic area. The majority of these small organic farms focus on horticultural activities[21]. Many of them do so in Community Supported Agriculture (CSA) (57 farms). Over all farm sizes, outdoor vegetable production is the most important specialisation in the Flemish organic sector, with a share of 27% of the farms. In Flanders 12% of the organic area is used for vegetable production compared to only 2.6 % in Wallonia. Further, the second important farm type in Flanders is arable farming (18%). In both regions, the area of arable crops counts for about 20% of the total organic area. Fourteen percent of the Flemish organic farms are specialised in fruit cultivation. In Wallonia the organic fruit area only counts for less than 1% of the organic area compared to 9% in Flanders.

17% of the Flemish organic farms are specialised in animal production with farms specialised in laying hens or dairy cattle, both counting for 5% of the organic farms, as the most important production sectors. Also in Wallonia the most important animal productions are cattle and poultry. But while the Flemish production is focused on laying hens, Walloon production is mainly focussed on the production of broilers. For dairy cattle Wallonia has about 6 times more dairy cows than Flanders but also significantly more suckler cows (about 10 times more than Flanders). 16% of all organic farms in Flanders combine different types of activities[17].

Since 2011, organic spending in Belgium grew by an average of 11% per year compared to 7% in Flanders. Because of the corona crisis, the confinement and people cooking their own meals, 2020 was an atypical year, with a 14% growth in organic spending both in Belgium and Flanders. This increase was due to both an increase in the number of buyers and a higher buying frequency. Over the past decade, organic spending on fresh produce doubled in Flanders. However, Flanders is lagging behind compared to Wallonia, where households' organic expenditures tripled since 2011. In 2020, the market share of organic in the total spending on fresh products in Flanders increased to 2.6%, in Wallonia a market share of 5.9% was reached[17,18].

In 2019, Wallonia and Brussels represented 61% of the organic market and Flanders 39%[59].

Organic fresh products were on average 45% more expensive than their conventional counterparts in 2020 (in 2019 this was 40%), although differences vary considerably between products[17,18].

Supermarkets are the most important organic sales channel in Belgium with a 38% market share. Specialist shops, e.g. bakeries and butchers, health food shops, organic supermarkets, etc., comes have a 34% share[17,18]. They are mostly independent or members of small chains, however there is a restructuring of the sector in favour of chains[59]. Farm shops and the farmer's market are the channels with the highest percentage of organic products in the assortment, but only reach a 4% market share[17,18]. Only a quarter of the organic products of organic distribution come from Belgium, this seems mainly due to a lack of structuring of the Belgian organic sector. Vegetables (including potatoes) and fruits represented 43% of the Belgian organic market in 2020[59].

Health and quality are the main reasons to buy organic products[59].

2.5. Poland

Poland's organic farms share was 3.5% of farmed land (2019) – 364,721 ha. In 2020, fully organic farms area accounted 400,852 ha (108,439 ha during the conversion period and 509,291 ha in total). In recent years, we can observe steady decline of organic farms in Poland – number of farms decreased by 22% between 2015 and 2020, corresponding to 21,324 and 16,658 farms, respectively (MRiRW - Ministry of Agriculture and Rural Development). This was the effect of introduction of complicated administrative restrictions, due to known cases of misuse among Polish farmers in the first years of EU organic farming support after 2004. It should be mentioned, in 2016 (Eurostat 2021, the latest available reference) the highest number of farms with both organic and non-organic were reported in Poland (17,500) and Ireland. On the other hand, number of organic food preparators increased from 312 in 2019 to 1,022 in 2020 (MRiRW). However the number of organic farms per preparator is quite low (29.3 in 2019) and majority of preparators do not process raw materials, only pack products in retail units for the final consumer.

The average size of a Polish organic farm was 33 ha in 2019 (Statistics Poland), increasing by 31% when compared to 2018 (25.2 ha). Arable crops in 2019 covered the majority of organic farmed land (79%) while permanent organic pasture only 21% (however adding fodder crops, it gives almost half of the organic land covered by feed crops, although only little more than 10% of the farms raised livestock in 2018, see also below). Data of MRiRW (2020) may indicate improving efficiency of organic production. Average cereal yields increased by 0.7 t/ha from 2014 to 2019 while vegetables yields were larger by 1.85 t/ha. Fruits production in 2019 (126 Ktones) was bigger comparing to 2017 (47 Kt). Organic berries (strawberries, raspberries, black and red currants, gooseberries) and rhubarb are Polish top organic products on global market. Organic livestock increased in 2019 by 54% since 2017 due to new EU requirements regarding presence of animals in organic farms, however is still at low level. Particularly organic poultry and aquaculture is growing in importance – the first one in 2019 by 65% compared to 2017. According to Polish FADN data (2018), 30% of farms were arable farms and livestock farms (with ruminants) respectively, while 16% were mixed crop-livestock dairy farms. However, IJHARS Report on Organic Farming in Poland in 2019-2020 states, that organic farms focused solely on plant production represented 78% total organic farms, while those simultaneously cultivating arable crops and breeding animals have 22% share in total number of organic farms.

Control and certification of organic production in Poland is currently carried out by as many as 13 certification bodies – accredited by the PCA (Polish Centre for Accreditation), then authorized to operate by MARD (The Agency for Restructuring and Modernisation of Agriculture) and supervised by AFQI (The Agricultural and Food Quality Inspection). This complex system even increases excessive bureaucracy of organic certification system being the major obstacle to Polish farmers.

Organic food processors mostly process fruits and vegetables (approx. 30%) and cereals (approx. 20%). The majority of them are micro-enterprises (42%), followed by small- (34%) and medium-firms (22%) (based on 11% companies sample survey in 2019[22]). 57.7% companies sell the products on the global market, 40,4% on national market, while only 11.5% and 5.1% of them on regional and local market, respectively. Only 25% companies processed only organic food and they were micro- and small-enterprises. According to the report of Polish Chamber Organic Food[23], compared to other EU countries, organic processing in Poland is underdeveloped, not exploiting raw material potential. The reasons are the uncertainty of sales (still niche market), the lack of organized sales channels, the high price of raw materials, the organizational difficulties associated with the separation of the organic segment from the conventional scheme, the need to undergo certification. Last but not least is the reluctance to submit to further numerous controls (each new certified organic processing plant awaits the inspection of the Voivodeship AFQI, lasting several days, as well as additional sanitary controls).

Most than half of the companies have been supplied by 9 or less producers. 80% processors buy organic commodities directly from organic farms, while 36% of them from distributors[20]. Due to the deficit of organic commodities on the Polish market, 40% processors import them (including 1/3 firms more than 50% commodities they need; imported products are: sesame seeds, soybeans, sunflower seeds, coconut oil, raisins, dates, bananas, tea, cane sugar[21]). About 70% of organic products consumed in the country are imported[59]. The marketing channels for processors are as follows: retail stores – 41.8% companies, wholesalers – 36.4%, big retailers (Lidl, Auchan, Biedronka, Spar, Rossmann) – 25.5%, online shops – 23.6%, distributors – 21.8%, distribution centres – 16.4%, others – 25.5%. 52% processors export organic products while 44% of them (23% in total) export more than a half[22]. The exported products are mainly frozen berries.

Organic e-commerce grows very well, and in the year 2020, due to the Covid-19 pandemic and the accompanying restrictions, there has been a real boom in online sales (well-known Warsaw distributor reports that its 2020 turnover in the online segment has increased by 70%, reaching 250 thousand € in 2020).

The value of organic market in Poland is estimated as much as 314 M€ but it is only 0.5% value of food market[24]. Organic food expenditures per capita accounted for 8€ per year. The yearly sale increased by 23% in the pandemic 2020 year. The most consumed products in Poland were baby foods (13.5% share), yoghurt and plant beverages, followed by milk, bio-vodka, breakfast cereal and muesli. Health and food safety appear to be the main reasons to buy organic products.

The main marketing channel of organic food are supermarkets (we might assume approx. 50% presently) and its role is increasing. Organic food shops sold approx. 20% of all organic products. Recently, some organic items are available in grocery stores, convenience shops and gas stations. Data received from a supermarket belonging to a well-known chain (not a discount) in the city of 60 thousand inhabitants, in the agricultural region, confirm the observations that the Covid-19 pandemic has not stopped the growing demand for organic food: their organic sales in April 2020 were 16% higher than in April 2019[21].

2.6. Romania

In the last 10 years, in Romania the organically cultivated agricultural area has increased by 116.3%. Between 2018 and 2019, in Romania the area occupied by organic agriculture increased by 21.1% from 326,260 ha in 2018, representing 2.4% of the total agricultural area to 468,887 ha in 2020, representing 3.5 % of the total area. The number of operators in this sector increased as well by 13% from 9008 in 2018 to 10,210 in 2019[25].

The structure of organic crops in 2020 showed the highest share of permanent pastures and hayfields (33.1%) and of cereals (28.6%), followed by industrial crops (19.5%), green harvested plants (11.4%), permanent crops (orchards, vines, fruit trees and berry bushes etc.) (5.7%) and dried legumes and protein crops for the production of grain (1.2%). Vegetables occupied in 2019 only 2% of the total organic agricultural area. Regarding livestock sector, cattle raised in organic conditions in 2019 accounted for 19,870 heads, there were 13,189 organic sheep and 171,391 reared birds (mostly laying hens). The important part of Romanian organic sector is apiculture (170,789 bee hives) (2019).

The Romanian organic market was valued at € 137 million in 2019 and the organic market share at 1.2%. The market is growing thanks to a context of economic growth, a development of the organic supply and better consumer awareness. Besides, measures adopted in June 2015 to reduce the value-added tax on food products from 24% to 9% (5% for organic food), as well as other tax policies related to wages and pensions, lowered the costs of food products and have had a positive impact on the demand for consumer products perceived to be healthier. During the pandemic, interest in organic products declined somewhat[59]. In 2020, the Romanian organic market is characterized by: organic retail sales worth € 41 million, exports of € 200 million and imports of € 35 million (FiBL, IFOAM 2022. The World of Organic Agriculture. Statistics and Emerging Trends).

Mass distribution represented more than two-thirds of the Romanian organic market in 2018. Organic shops are not very common, however there are several small chains of organic shops. Online organic sales are growing[59].

Romania imports around 80% of the organic food it consumes, mainly from Western Europe. However the country exports a lot of organic peas and cereals to Germany and to other countries to a lesser extent. Dairy products are the main organic products sold in Romania, ahead of baby food, fruits and vegetables[59].

2.7. United Kingdom

United Kingdom is marked in 2019 by 2.6% of organically farmed area of total farmed area. Its increase has been observed by 2.4% compared to 2018. Since 2008 when the area of land farmed organically peaked, it has declined by 34%. Permanent pasture accounts for the biggest share of the organic area (63%) followed by temporary pasture (20%) and cereals (8%). The three main crop types grown organically are cereals, vegetables including potatoes, and other arable crops. In general, organic livestock sector is decreasing by 5.4%, 9.3% and 7.2% for sheep, pigs and cattle respectively, while it increased by 2.5% for poultry (DEFRA 2020[26]).

The British organic market has more than tripled in twenty years and increased by 55% in ten years, reaching € 2.91 billion in 2020 (+12.6% compared to 2019). However, the organic market share was still below 2%. In 2020, large-scale distribution remained the main channel for organic with a 64.8% market share in the organic food and non-food. The main retail chains for organic distribution are *Sainsbury's*, *Tesco* and *Waitrose*. Home delivery includes both online purchases and subscriptions to box schemes. It represented 17.7% of the organic market in 2020 (excluding online sales by mass distribution). In 2019, the UK was the world's third largest online organic buyer. The two main home delivery companies for organic baskets are *Riverford* and *Abel & Cole*. The independent distributors channel includes organic shops, health food shops, delicatessens, craftsmen, convenience stores and direct sales (farm shops and farmers' markets). It represented 14.6% of the organic market in 2020. The main reason to buy organic is health. The second is the environment, particularly climate change. Reducing packaging has become a priority for British consumers. 82% of organic shops try to have zero waste and unpackaged products are becoming the norm in independent stores. In 2020, dairy products and fruits & vegetables remained the main categories of organic products purchased in the UK, accounting for almost half of the organic market. The United Kingdom exports especially organic milk and salmon[59].

Since January 1st, 2021, the UK has its own laws for the production, processing, labelling and trade of organic food and feed. The new standards are recognized by EU as equivalent for organic products until December 31, 2023.

3. Literature review on organic food production systems' sustainability

Sustainable food systems must meet the needs of present and future generations. FAO concept distinguish four key principles of sustainability for food and agriculture: (1) increase productivity, employment and value addition in food systems, (2) protect and enhance natural resources, (3) improve livelihood and foster inclusive economic growth, (4) enhance the resilience of people, communities and ecosystems, (5) adapt governance to new challenges.

FAO defined sustainable agriculture as "the management and conservation of the natural resource base, and the orientation of technological change in such a manner as to ensure the attainment of continued satisfaction of human needs for present and future generations. Sustainable agriculture conserves land, water, and plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable" (FAO, 1988).[27]

National Research Council[28] in United States, identified in 2010 four goals of farming system to be sustainable. The farming must (1) supply abundant, affordable food, feed, fiber, and fuel, (2) be profitable, (3) enhance the natural resource base and environment, and (4) contribute to the well-being of farmers, farm workers, and rural communities (figure 3).

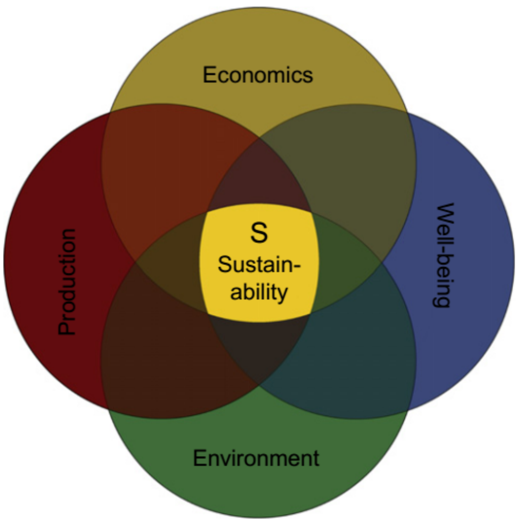


Figure 3. The four components of agricultural sustainability. Source: National Research Council, US.

The organic principles of International Federation of Organic Agriculture Movements (IFOAM) - health, ecology, fairness, and care can be assumed as default sustainability indicators, as they were identified based on the approach of Sustainability Assessment of Farming and the Environment (SAFE) (table 2).

Tab. 2. The principles of organic agriculture. International Federation of Organic Agriculture Movements. Available at: http://www.ifoam.org/en/organic-landmarks/principles-organic-agriculture

IFOAM Principles of Organic Agriculture
Principle of Health
Organic agriculture should sustain and enhance the health of soil, plants, animals, and humans as one and indivisible
Principle of Ecology
Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them, and help sustain them
Principle of Fairness
Organic agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities
Principle of Care
Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment

In general, organic agriculture is subject to strict regulations and controls, imposed by certification bodies to keep allegedly a sustainability standard of agricultural production, however holistic performance of organic farming against conventional systems continues to be debated. Several meta-analysis point out yield averages are 8 to 40% lower in organic systems (Stanhill G. 1990[29], Badgley C et al. 2007[30], Gomiero et al. 2011[31], de Ponti et al. 2012[32], Seufert et al. 2012[33], Fedele et al. 2014[34], Ponisio et al. 2015[35], Meier et al. 2015[36]). On the other hand, yields are considered more stable facing climate change impact e.g. severe drought (Lotter et al. 2003[37]) or in terms of improvement in management techniques and crop varieties (Seufert et al. 2012[31], Ponisio et al. 2015[33]). Moreover, organic food is significantly less or not contaminated with pesticides and is found more nutritious, in comparison to conventional food (for more details see Gomiero 2018[38], see also figure 6). The impact of organic practices is often reflected in a reduction of greenhouse gas emissions and a better performance regarding carbon accumulation, biodiversity, energy use, water use efficiency, soil, water and air quality, and a variety of ecosystem services (Gomiero et al. 2011[29], Kremen et al. 2012[39], Lorenz and Lal 2016[40]). However, yield reduction compared to conventional systems, usually increases the land area to produce the same amount of food, and in the result, hinders environmental performance per unit of product (see also fig. 5). Nonetheless, environmental impact is not only allocated to the harvested product but to the whole food agricultural system and should be accounted across all ecosystem services provided by agroecosystems. This might result in better environmental benefits of organic agriculture in terms of resource consumption in comparison to conventional farming (Boone et al. 2019[41]).

In terms of financial competitiveness, meta-analysis based on findings from 40 years of studies covering 55 crops grown on five continents showed that actual price premiums (higher prices awarded to organic farming) were on average 29% to 32% while breakeven premiums necessary for organic profits to match conventional profits were 5 to 7 percent, even with organic yields being 10 to 18 percent lower. This means, that that organic agriculture can continue to expand even if premiums decline (Crowder and Reganold 2015[42]).

Social equity and animals welfare are in principle supported by guidelines of the International Federation of Organic Agriculture Movements (IFOAM). Van Wagenbert et al. (2017)[43] based on literature review, compared sustainability performance of conventional and organic livestock production systems. They concluded organic systems had higher income per animal or full time employee, lower impact on biodiversity, lower eutrophication and acidification potential per unit land, equal or lower likelihood of antibiotic resistance in bacteria and higher beneficial fatty acid levels in cow milk.

Research has proven organic farming stimulates community economic development and attributes to resilience in the face of variable market conditions and weather extremes (Macrae et al. 2007[44]), leads to an increase of social interactions between farmers and consumers and due to labour-intensiveness greater employment of farm workers (Prihtanti et al. 2014[45], Mendoza 2004[46]).

Overall, research shows that organic farming systems better balance the four sustainability goals than their conventional counterparts and are more likely to achieve agricultural sustainability (figure 4, taken from Reganold and Wachter 2016[54]; figure 5 of Seufert and Ramankuty 2017[47]). That does not mean organic farming is sustainable per se. In order to achieve a food system transformation towards sustainability, a blend of organic agriculture and other innovative systems (agroforestry, conservation agriculture, grass-fed livestock production, mixed crop-livestock production) are needed (Reganold and Wachter 2016, Rosati et al. 2020[48], EIP-AGRI 2017[49]) as well as different kind of strategies including intensive learning and communication regarding new solutions and innovations (Tsetkov et al. 2018[50]). Because interventions tend to focus on one-sided food system actor approach, often within the farm-gate and overlook dynamic nature of interactive factors, they usually block untapped transformation potential. Therefore, sustainable food production and consumption should combine technical innovations, social innovations and social norms and cultural change (Hoek et al. 2021[51]). This may lead to another type of interventions that strategically rely on intersections with other systems, the interactions within the food system, or the incentives towards stakeholders, in order to identify actions that can improve food systems performance and ultimately support food systems transformation (Ruben et al. 2018[52]).

Against this background and based on the framework of leverage points for sustainability interventions (Meadows 1999[53], Abson et al. 2017[54]) three realms of “deep leverage” are proposed to address in sustainability transitions, such as those required to transition towards resource-efficient, circular and zero-waste food systems: (1) reconnecting people to nature, (2) restructuring institutions and (3) rethinking how knowledge is created and used (the latter referring to both communities of practice co-creation of knowledge, and how knowledge is shared and validated). By focusing on these realms FOODLEVERS aims to identify key leverage points to further develop and scale up existing innovative organic and sustainable food systems. WP3 is of particular importance, since it will develop holistic scenarios in the identification of leverage points, using three interconnected models: Fuzzy Cognitive Maps (to understand if/how innovations are present and absorbed), Agent-Based Modelling (to investigate mechanisms and dynamics leading to a system change) and qualitative scenarios development by performing national scenario workshops.

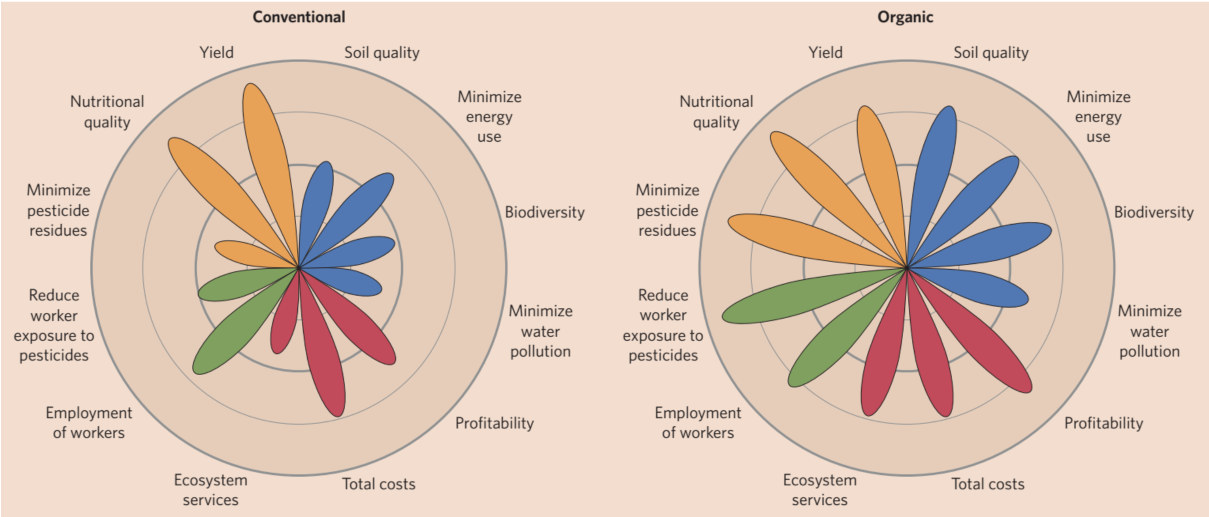


Fig. 4. Assessment of organic farming relative to conventional farming in the four major areas of sustainability (Reganold and Wachter 2016[55]). Lengths of the 12 flower petals are qualitatively based on the studies discussed in the review and indicate the level of performance of specific sustainability metrics relative to the four circles representing 25, 50, 75 and 100%. Orange petals represent areas of production; blue petals represent areas of environmental sustainability; red petals represent areas of economic sustainability; green petals represent areas of wellbeing. The lengths of the petals illustrate that organic farming systems better balance the four areas of sustainability (In: Reganold and Wachter 2016).

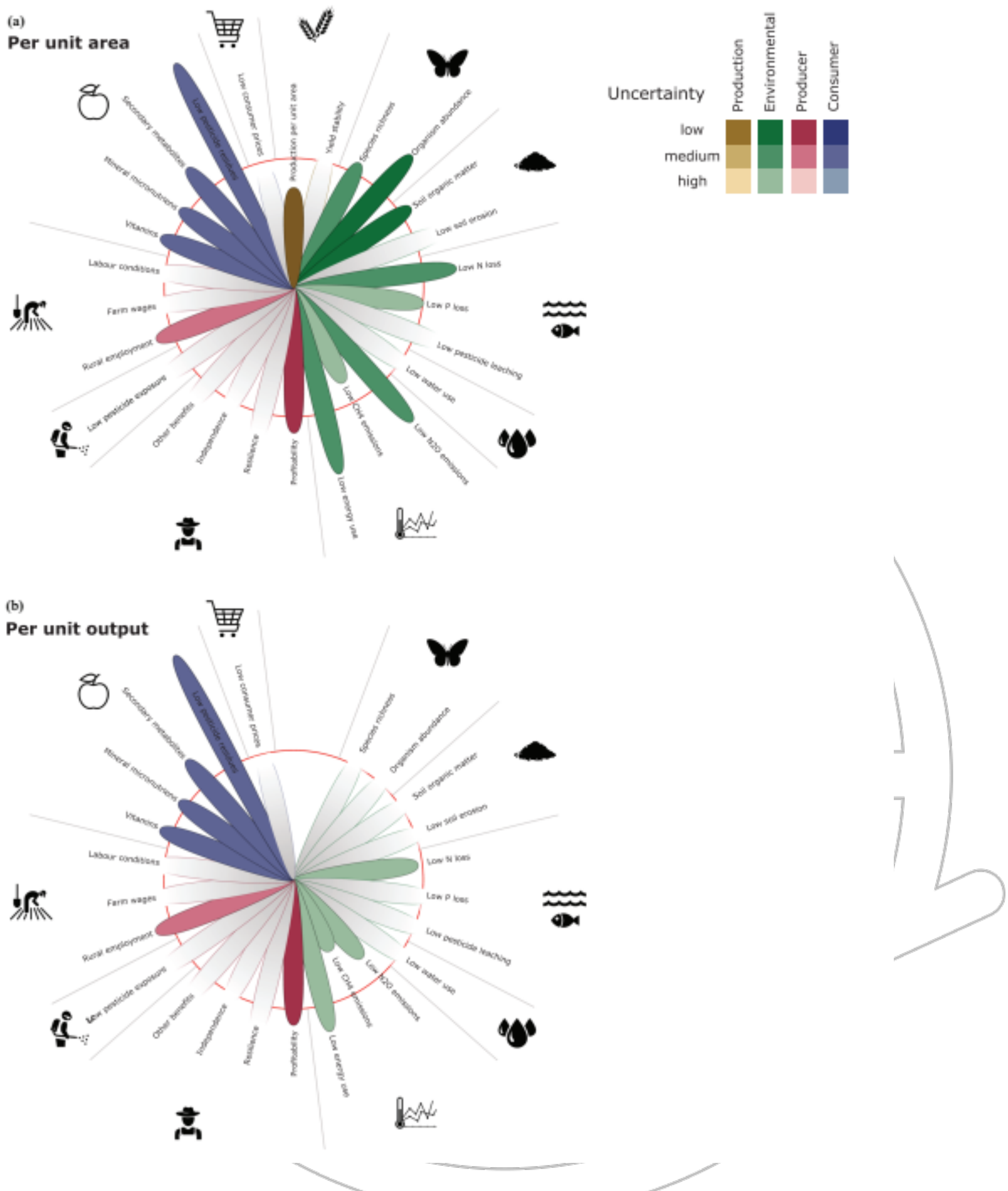


Fig 5. A flower diagram showing the relative performance of organic agriculture (petals) compared to conventional agriculture (red circle). Organic has superior performance when the petals extend outside the circle, and inferior otherwise. Organic agriculture, **compared to the same area** of conventional agriculture, has on average 10% greater species richness, 48% greater species abundance, 11% greater soil organic matter, 24% lower nitrogen loss, 1% lower phosphorus loss, 33% lower nitrous oxide emissions, and 40% lower energy use. The only environmental dimension on which organic performed worse was methane emissions (20% greater emissions). Organic showed worse environmental performance compared to conventional on a **per unit product basis**, with 23% greater nitrous oxide emissions and 49% greater methane emissions; organic continued to have lower energy use (–19%) (Source: Seufert and Ramankuty 2017[31]).

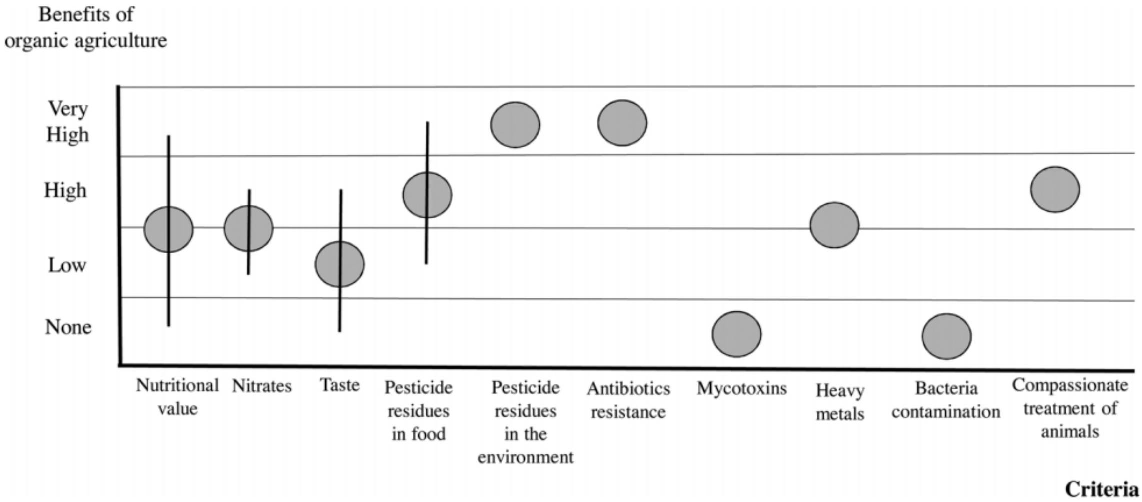


Fig. 6. Benefits of organic food compared to conventional food (taken from Gomiero 2018[36]).

3.1. Environmental footprint of organic food production systems

A carbon footprint (CF) estimates the total balance and sinks of GreenHouse Gas (GHGs) from a products or a system across its life cycle. Recently, accuracy and consistency of the methods of CF calculation for agricultural systems have been doubted (Adewale et al. 2018[56]), particularly with regard to choice of functional units, definition of system boundaries and specificity of emission factors (EF). Therefore, use of consistent broad agricultural system CF boundaries, incorporation of soil emissions and sequestration, and development and use of fine temporal and spatial scale Tier 3 EFs (based on modelling) is recommended. In the context of organic vs. conventional farming, environmental impacts differ, whether they are calculated per unit area (usually beneficial for organic farming) or per unit product (greater emissions than in conventional farming or very variable) (Adewale et al. 2018). There is need to use expanded boundaries to include not only the commonly considered fertilizer, fuel, and electricity, but also farm infrastructure and machinery, pesticides and other chemical inputs, plastics and other materials, land-use change, soil emissions and C sequestration, and livestock enteric fermentation. Moreover, expanding the available Tier 3 EFs simulation for agricultural materials overall and organic inputs in particular will improve accuracy and consistency of GHG emission assessments. Nevertheless, more precise definition of temporal and spatial boundary add complexity to GHG assessments and pose many challenges.

In order to estimate holistic environmental sustainability of food systems, full recognition of agricultural functions behind commodities provision is necessary. Agricultural production delivers to society bundles of ecosystem services, so the impact should be allocated among the whole set of agricultural outputs (Boone et al. 2019[57]). The authors compared the environmental impact of conventional and organic agriculture for the same basket of products based on production data available in Life Cycle Assessment (LCA) Ecoinvent databases and quantified the overall resource consumption by accounting provisional and regulating ecosystem services (ES) for all exergy extracted from nature contained in the natural resources used throughout the supply chain (Cumulative Exergy Extraction from Natural Environment (CEENE (2013) method). Allocation factors were developed for both farming systems types, following their capacity to supply ES. It was concluded that for about half of the studied food products (including maize, potato), organic farming has clear environmental benefits in terms of resource consumption in comparison to conventional cultivation methods.

4. Assessment of reference systems for the mainstream organic sector

In order to put the specific characteristics of the innovative organic/sustainable case studies - farms (WP1) into context of further projects' activities, such as the holistic sustainability assessment (WP2) and the scenario development (WP3), the objective of the assessment of reference systems from the mainstream organic sector has been carried out by an analysis of **FADN (Farm Accountancy Data Network) data.**

The reference system is corresponding to the **country** and **farm type**, due to farm specific features.

Organic production for counterparts of the respective FOODLEVERS innovative farms is described in section 4.4, allowing to build the reference model of specific farm type. Unfortunately, for some countries it was impossible to gather FADN data to characterize mainstream organic model within the subsector which innovative case studies operated in. In those cases, national benchmarking data were reviewed and presented.

4.1. FADN description

FADN is an European system for accountancy data collection from agricultural holdings which has been established in 1965 (Council Regulation EEC/79/65). Currently the FADN system functions in 27 EU Member States and covers over 81,000 of agricultural holdings (approx. 38% of EU farms).

The FADN is the only source of micro-economic data that is harmonised (the bookkeeping principles are the same in all Member States) and is representative of the commercial agricultural holdings in the Union. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the Union. The survey does not, however, cover all the agricultural holdings in the Union (universe defined by Community surveys on the structure of agricultural holdings), but only those what are large enough to be considered as commercial holdings. Hence, **only those farms of a proper economic size are included in FADN** (tab. 3). As the general characteristics of farms differ significantly between countries in terms of size range, number of farms in total pool and within the type of farming group, the comparison between Member States countries is challenging.

Farms participating in FADN are classified according to the Community Typology for Agricultural Holdings. Valid methodological manual on community typology is RI/CC 1750 Typology Handbook[58]. Classification of agricultural holdings is carried out according to three criteria:

- Geographical classification (FADN specific region with similar agricultural characteristics)
- Economic size,
- Type of farming.

Economic size of a holding is expressed in a sum of all Standard Outputs (SO) for all agricultural activities existing in that farm. Type of farming of agricultural holding is based on a share of SO for each group of agricultural activities in the total SO of the farm. Standard Output is the average monetary value of the agricultural output of an agricultural product (crop or livestock) over the reference period of 5 years, per 1 ha or 1 head of livestock per year, in average production conditions in particular geographical units (regions). In the field of European FADN observation there are commercial farms which belong to the group of farms generating, in a given FADN region or a country, about 90% of the value of SO. The minimum economic size class, classifying farm as FADN farm differs between countries greatly (tab. 3).

In order to avoid identification of certain holdings, which participate in the FADN, the **European Commission does not publish averaged results data from the set comprising fewer than 15 farms**. This is however also the next limitation for any kind of comparative analysis of organic farms within a selected group/type.

Tab. 3. Minimum economic size thresholds and FADN sample size in various Member States in 2018

Country	Minimum economic size (EUR)*	Number of holdings in the sample items	Number of organic holdings in the sample	Share of organic holdings in the sample (%)
Belgium	25 000	1 044	58	5.5
Germany	25 000	8 979	601	6.7
United Kingdom	25 000	2 848	172	6.0
Finland	8 000	9 703	86	0.9
Italy	8 000	10 304	1 722	16.7
Poland	4 000	12 272	324	2.6
Romania	4 000	5 100	26	0.5

Source: EU-FADN.

Groupings of **Types of Farming** (TF) based on Regulation (Reg. 2015/220[59]) at the level of the European Union are shown below:

Tab. 4. The grouping of agricultural holdings by type of farming (TF8)

TF8	Description of TF8	Grouping of TF on the basis of principal types of farming
1	Fieldcrops	15. Specialist cereals, oilseeds and protein crops 16. General field cropping 61. Mixed cropping
2	Horticulture	21. Specialist horticulture indoor 22. Specialist horticulture outdoor 23. Other horticulture
3	Wine	35. Specialist vineyards
4	Other permanent crops	36. Specialist fruit and citrus fruit 37. Specialist olives 38. Various permanent crops combined
5	Milk	45. Specialist dairying

6	Other grazing livestock	46. Specialist cattle – rearing and fattening 47. Cattle – dairying, rearing and fattening combined 48. Sheep, goats and other grazing livestock
7	Granivores	51. Specialist pigs 52. Specialist poultry 53. Various granivores combined
8	Mixed	73. Mixed livestock, mainly grazing livestock 74. Mixed livestock, mainly granivores 83. Field crops – grazing livestock combined 84. Various crops and livestock combined

4.2. Organic farming in the FADN

Organic farms of Belgium, Germany, Finland, Italy, Poland, Romania and United Kingdom have been analysed using FADN data from the period 2016-2018, obtained by IUNG-PIB from DG Agriculture and Rural Development of European Commission.

Since the FADN does not specifically take organic farms into account when composing its samples, the scope for using its data to study organic farming is very limited and the data needed for the agreed target were analysed for individual sectors and Member States in order to be meaningful. This approach carries the risk of finding samples with fewer than 15 farms, which is too small number to allow publication of the results. Moreover, even these samples may be strongly influenced by the economic size of the farms. Finally, even if the group of organic farms is large enough and stable in its composition, there is a risk of bias because the FADN focuses on commercial farms and not on the agricultural sector as a whole.

The number of all studied holdings in the FADN sample is varied between countries – the biggest for Poland and the smallest for Belgium (tab.3). The share of organic farms in the total country pool of FADN farms is far more varied – from 0.5% for Poland and 0.9% for Finland to 16,7% for Italy. Hence, representativeness level of organic farms is distinct.

Tab. 5. The structure of organic farms in analysed countries in years 2016-2018 (weighted average).

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Belgium	208	153	56	60	2 110	462	1 192
Germany	1 701	137	74	57	2 104	685	1 481
United Kingdom	479	200	171	24	1 263	292	639
Finland	255	67	72	34	1 090	874	846
Italy	4 628	65	25	119	2 468	514	2 043
Poland	966	15	15	207	646	440	703
Romania	26	29	43	89	874	178	707

Source: EU-FADN.
UAA – Utilised Agricultural Area
Balance current subsidies and taxes - Subsidies and taxes arising from current productive activity in the accounting year. Balance of subsidies and taxes on current operations = farm subsidies + VAT balance on current operations -farm taxes
Gross Farm Income = Output - intermediate consumption + balance current subsidies and taxes.
*Thousands of EURO

The structure of organic farms varies considerably as well between countries (tab.5). The crucial indicator of farm is the physical size, measured by the average amount of agricultural land per farm. Organic farms, represented in the FADN are on average largest in United Kingdom (171 ha), followed by Germany (74 ha) and Finland (72 ha). The smallest farms are in Poland (15 ha) and Italy (25 ha). Poland and Italy are the countries with the greatest labour inputs in organic farming. A clear difference can be observed between Poland/Romania and other countries in terms of total farm output (almost 4 times less in Poland than for Italy where organic farms are most profitable), however gross farm income proved to be the lowest in UK organic farms.

In compliance with the dissemination principle of FADN data, it is advisable to present the result for a group of at least 15 holdings. If the number of farms is smaller than 15, ". " (a dot) is inserted. Since the number of organic farms in FADN database is limited we did not obtain data for each type of farming (see tab. 4). The table below depicts the number of organic farms in grouping by TF8 classification (tab. 6).

Tab. 6. Number of farms grouping by type of farming (TF8) in 2016-2018. Source: EU-FADN

Country	Fieldcrops	Horticulture	Wine	Other permanent crops	Milk	Other grazing livestock	Granivores	Mixed
	1	2	3	4	5	6	7	8
Belgium	.	.	.	.	69	100	.	.
Germany	247		73	.	659	311	56	283
United Kingdom	15	.	.	.	119	229	.	40
Finland	91	.	.	.	53	91	.	.
Italy	997	.	473	1 840	196	720	54	297
Poland	288	.	.	66	139	229	.	221
Romania	.	.	.	.	.	.	.	.

Unfortunately, there was too little information on organic farms in Romania to obtain the data for further analysis. Small number of horticultural organic farms did not allow to gather data as well at level of each of studied country. Only two countries could be assessed in terms of organic wine farms, organic farms with other permanent crops and organic farms with granivores production (for Germany and Italy; Italy and Poland; Germany and Italy, respectively). Farms keeping specialised livestock production are most numerous organic farms, hence we can consider them the most comparable organic farm types.

Figure 7 shows crop structure of organic farms in each analysed country. The largest share of forage crops on average is held by UK (86%), followed by Belgium, Germany and Finland. Romania has the largest share of field crops in farm area (86%). Almost half of average organic Romanian farm is covered by cereals, while in Finland and Poland approx. 1/3 of farm area. Italian organic farming is characterised by significant share of other crops (including olives).

The utilization level of mineral fertilizers, that are allowed in organic farming is highly varied between countries. While Italy and Belgium use relatively high quantities of N, P, K and N respectively, other countries use mostly negligible amounts (fig. 8). It seems related to the costs of their use (costs in Finland are slightly higher). The incurred costs of organic plant protection products is highest in Italy, followed by Belgium (fig. 9).

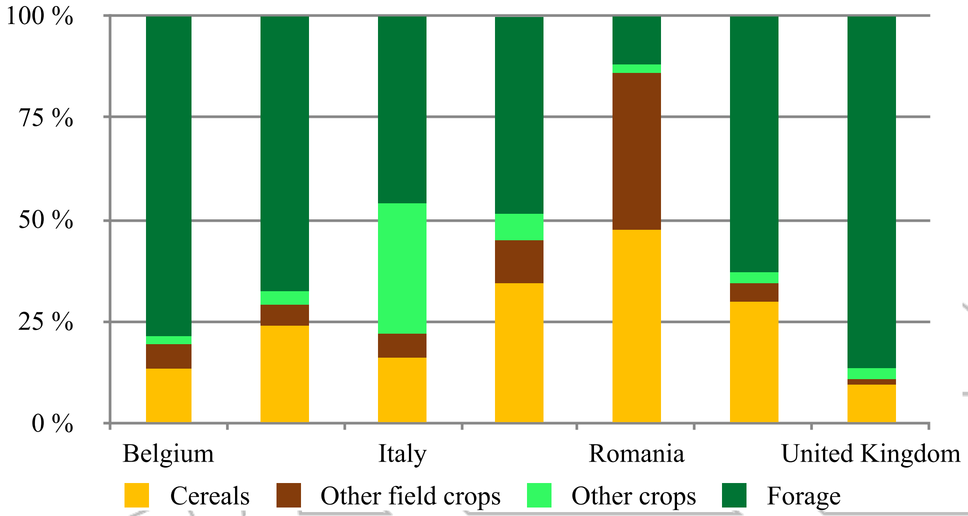


Fig.7. Structure of crops in selected countries (average 2016-2018).
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN.

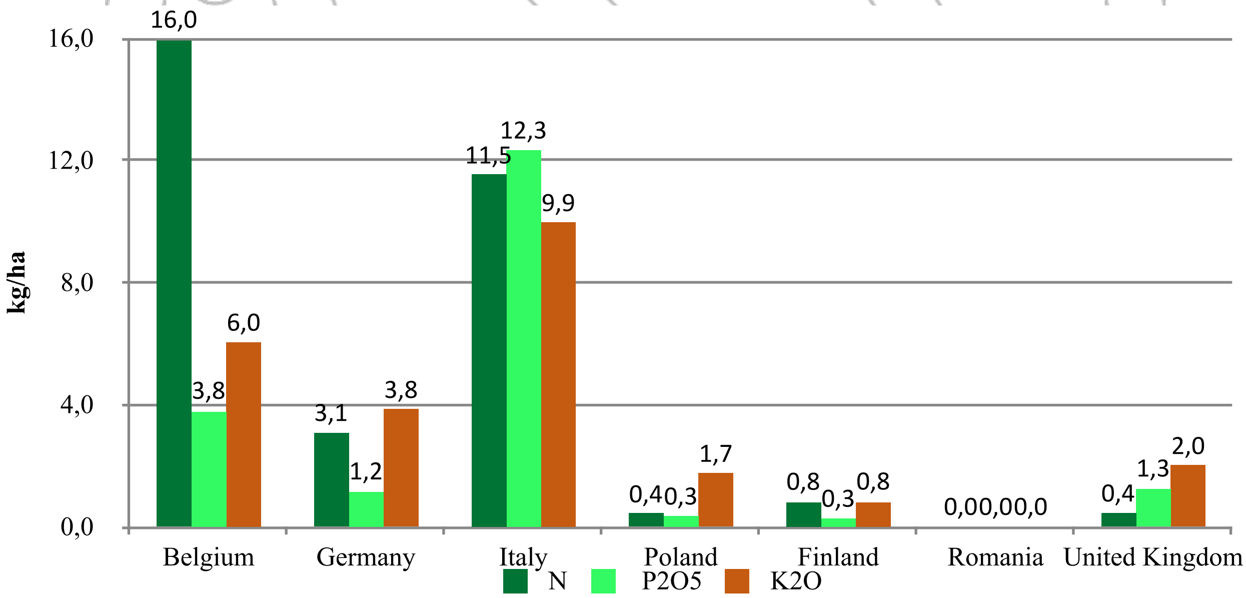


Fig.8. Quantity of N, P2O5 and K2O in mineral fertilisers used per hectare (average 2016-2018). Source: EU-FADN

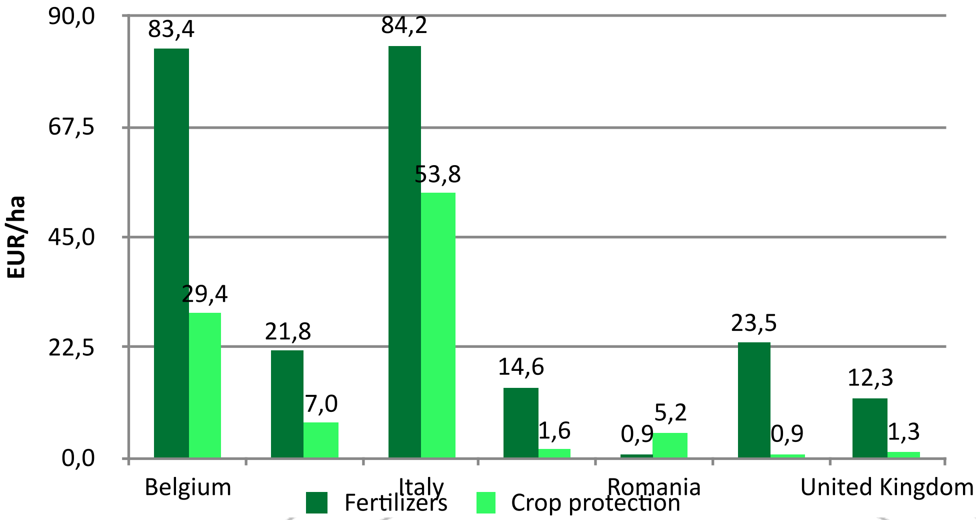


Fig.9. Average costs of fertilisers and crop protection products per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area is varied strongly between countries from only almost 15% in Poland to 67% in Germany, 70% in Belgium and 79% in Romania (fig. 10).

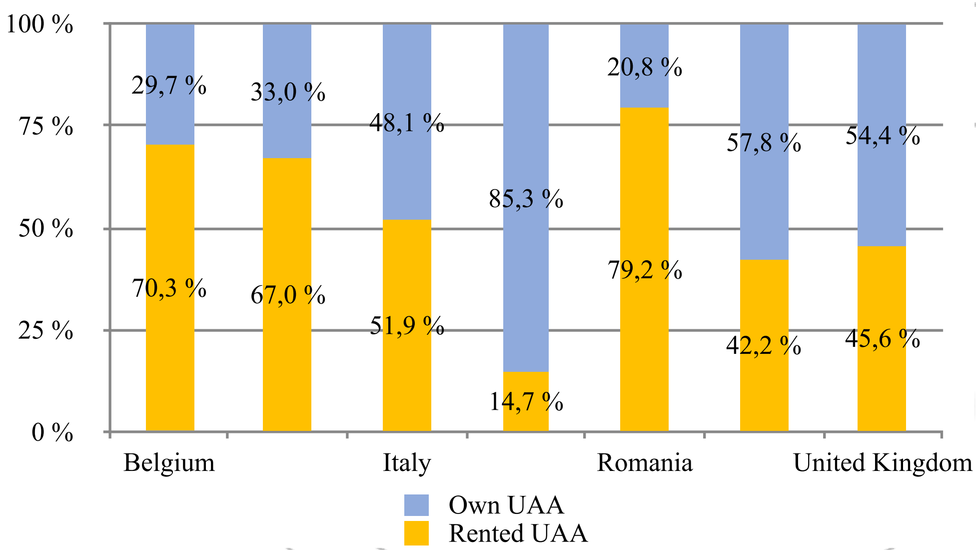


Fig.10. Share of rented organic UAA in selected countries (average 2016-2018). Source: EU-FADN

4.3. Characteristics of organic farms by type of farming

4.3.1. Fieldcrops (TF1)

According to FADN classification (tab. 4), fieldcrops **(TF1)** type include specialist cereal, oilseeds and protein crops (15) and general field cropping (16) i.e. specialist root crops; cereals, oilseeds, protein crops and roots crops combined; specialist field vegetables, specialist tobacco; specialist cotton and various field crops combined. Mixed cropping (61) include: horticultural and permanent crops combined; field crops and horticulture combined; field crops and vineyards combined; field crops and permanent crops combined; mixed cropping, mainly field crops; other mixing cropping. Specialisation is determined on the basis of the contributions of the different lines of production to the total standard output (SO) (see above).

The structure of TF1 organic farms varies between countries (tab. 7). The important indicator of farm is the physical size, measured by the average amount of agricultural land per farm. The TF1 farms, represented in the FADN are on average largest in United Kingdom (216 ha), followed by Germany (111 ha) and Finland (65). The smallest farms are in Poland (14 ha) and Italy (29 ha). Poland has significantly larger labour input in organic fieldcrops farming than other countries (2-8 times larger). A clear difference can be observed between Poland/Italy and other countries both in terms of total farm output as of gross farm income (that is in contradiction to high results of Italy in the entire organic farms pool).

Tab. 7. The structure of TF1 organic farms in analysed countries in years 2016-2018 (weighted average).

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Germany	82	184	111	46	1 858	638	1 480
Italy	332	63	29	95	1 745	464	1 463
Poland	96	12	14	213	593	432	688
Finland	30	35	65	26	746	686	740
United Kingdom	15	217	216	27	1 706	366	1 197

*Thousands of EURO.
Description of columns as in tab. 5.
Source: EU-FADN.

Figure 11 shows crop structure of TF1 organic farms in each analysed country. The largest share of cereals on average is in Poland and Germany (57% and 51%, respectively), and slightly less in the other countries. Finnish and UK TF1 farms are characterized by large share of forage crops (46% and 43%, respectively).

The utilization level of mineral fertilizers, that are allowed in organic farming is highly varied between countries. Italy, Poland and Germany use relatively high quantities of P, K; N, P, K and N, K in TF1 farms respectively, Finland and UK use much smaller amounts (fig.12). It seems related to the costs of their use (except Poland, where costs are the lowest among the countries). The incurred costs of organic plant protection products is highest in Italy (fig. 13).

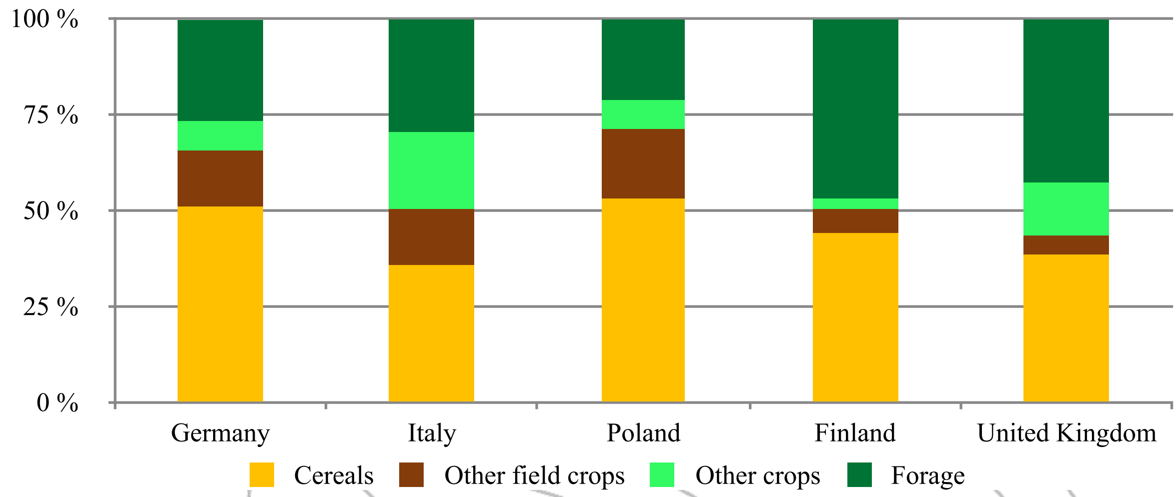


Fig.11. Structure of crops for TF1 organic farms in selected countries (average 2016-2018).
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN.

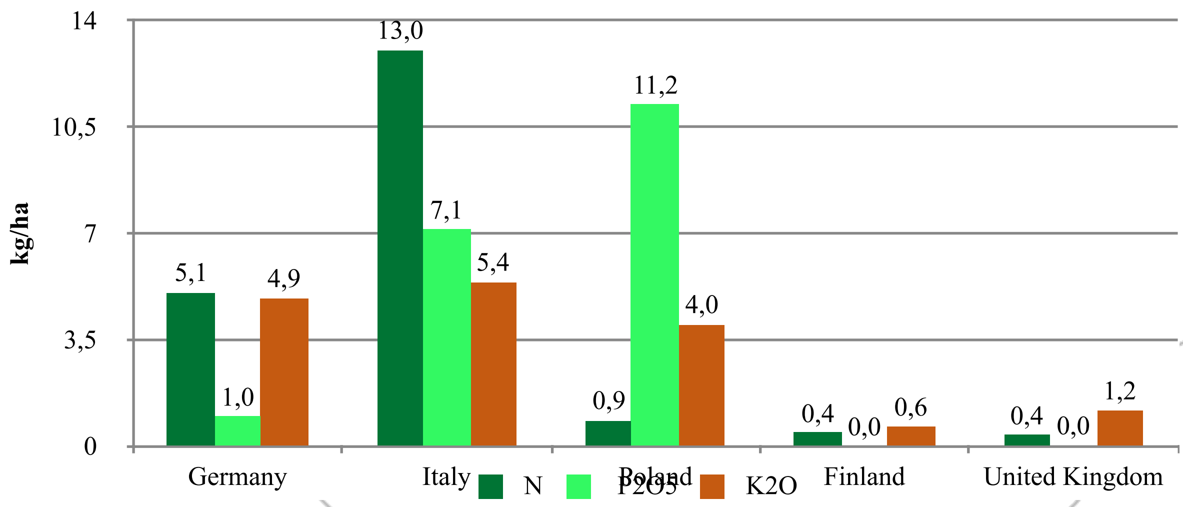


Fig.12. Quantity of N, P2O5 and K2O in mineral fertilisers used for TF1 organic farms per hectare (average 2016-2018). Source: EU-FADN

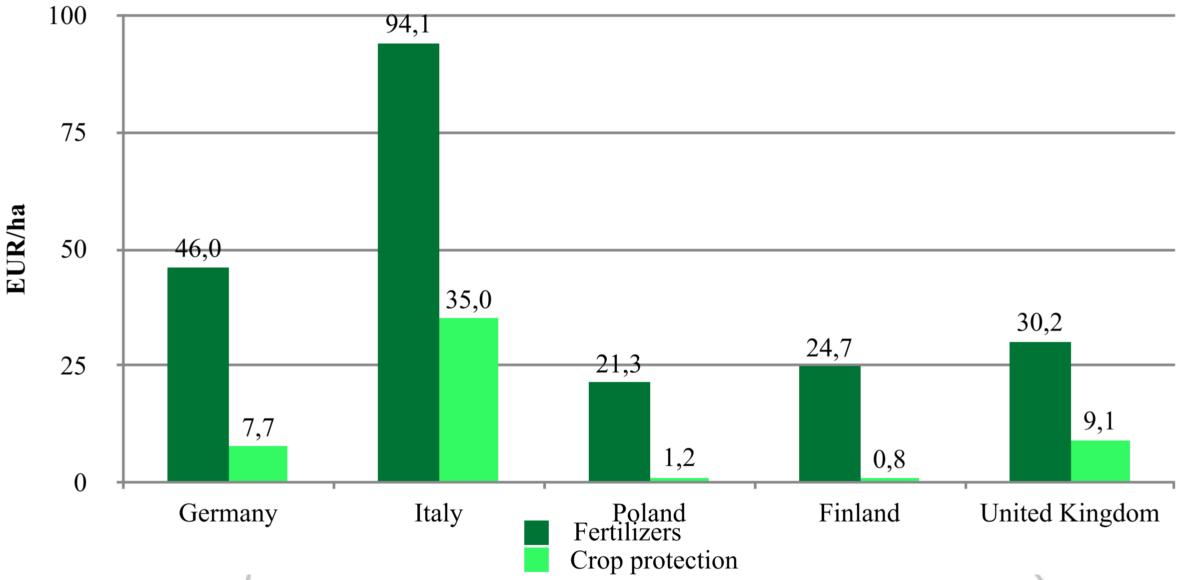


Fig.13. Average costs of fertilisers and crop protection products used for TF1 farms per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area for fieldcrops farms is varied strongly between countries from only almost 14% in Poland to 67% in Germany (fig. 14).

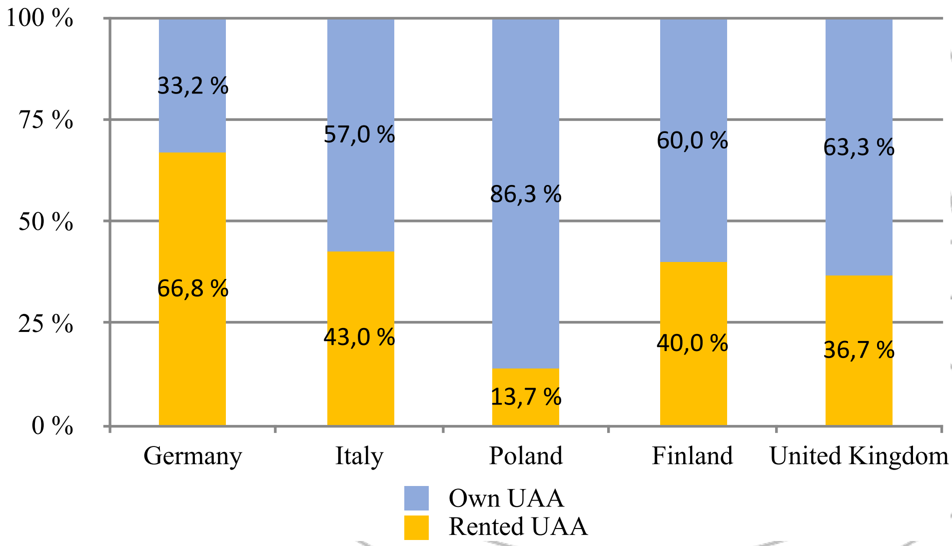


Fig.14. Share of rented organic UAA for TF1 farms in selected countries (average 2016-2018). Source: EU-FADN

4.3.2. Wine (TF3)

Organic farms, specialised in vineyards (wine farms, **TF3**) could be found only for Italy and Germany.

The structure of TF3 organic farms varies significantly between both countries (tab. 8). Although average farm land area is very similar, cash flow seems much higher in German farms, resulting in larger gross farm income. That happens even despite almost tripled labour inputs in Germany when comparing Italian wine farms.

Tab. 8. The structure of TF3 organic farms in analysed countries in years 2016-2018 (weighted average)

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Germany	24	159	13	657	16 120	1 776	10 405
Italy	161	94	15	238	8 314	569	6 162

*Thousands of EURO.
Description of columns as in tab. 5.
Source: EU-FADN.

The above differences may be affected by much more diversified farm structure in the case of Italy (fig. 15). While cereals share has similar level, other land use form (mostly olives[60]) is visible in Italy.

The utilization level of mineral fertilizers, that are allowed in organic farming is highly varied between countries. Italian farmers use much larger amounts of mineral fertilizers in wine farms than German ones (fig. 16). However the costs of fertilizers use for German wine farmers is twofold larger in comparison to Italian colleagues (fig. 17).

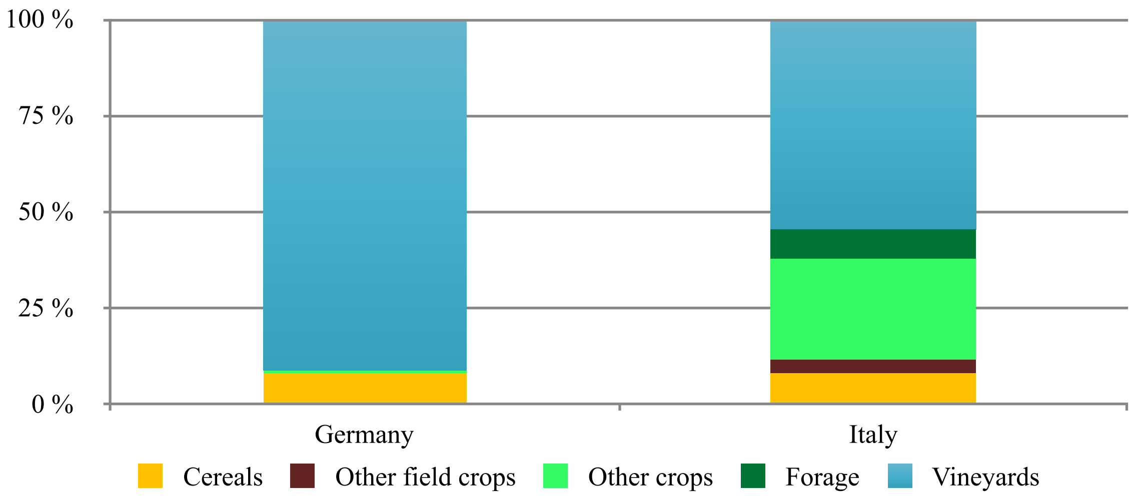


Fig.15. Structure of crops for TF3 organic farms in selected countries (average 2016-2018).
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN

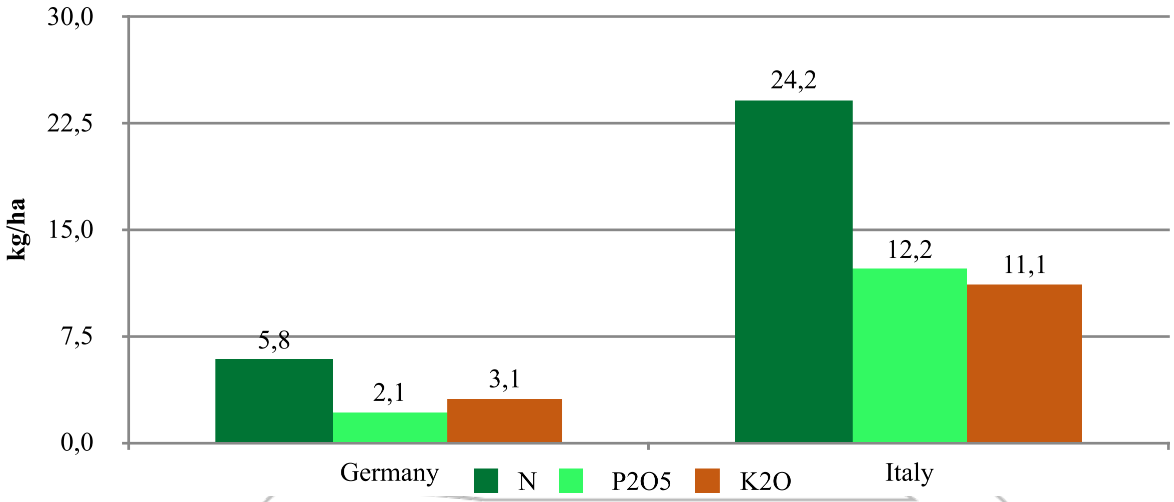


Fig.16. Quantity of N, P2O5 and K2O in mineral fertilisers used for TF3 organic farms per hectare (average 2016-2018). Source: EU-FADN

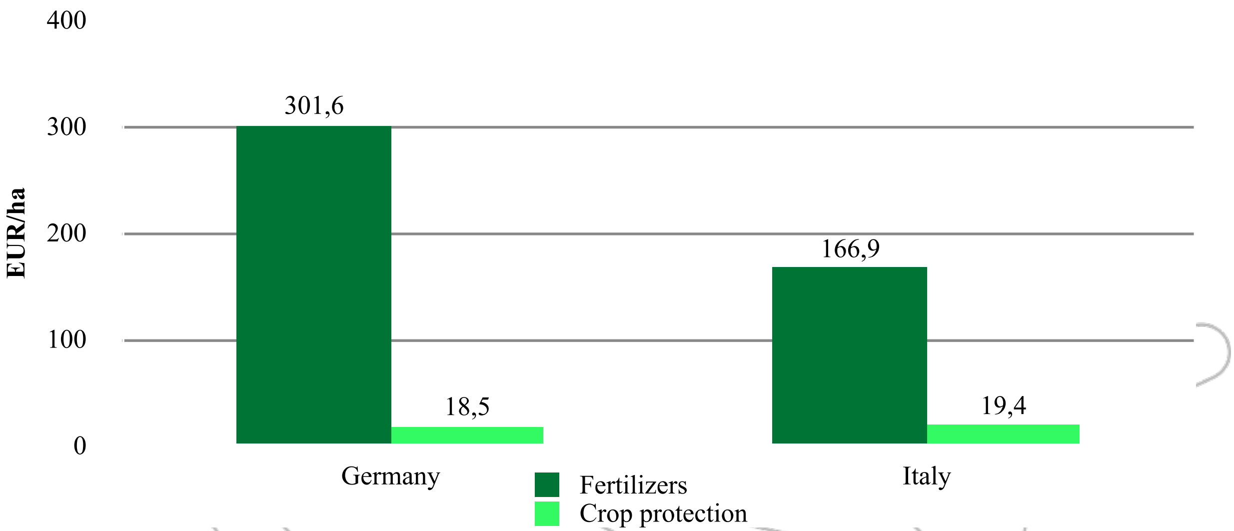


Fig.17. Average costs of fertilisers and crop protection products per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area for wine farms is slightly larger in Germany (14%) (fig. 18).

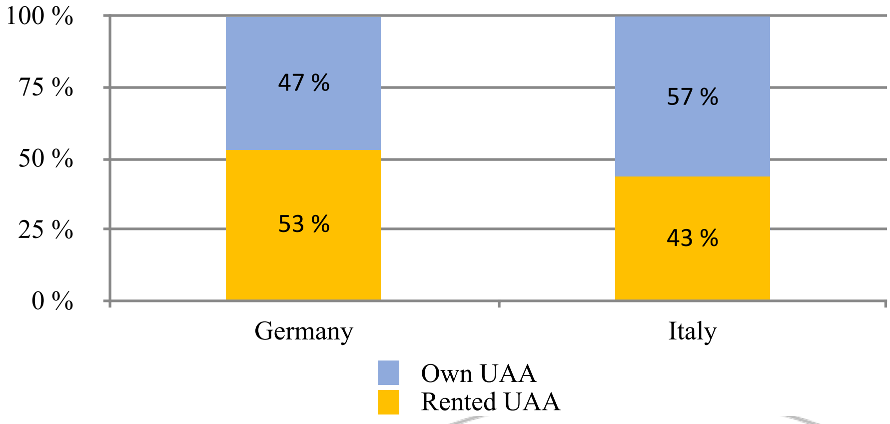


Fig.18. Share of rented organic UAA for TF1 farms in selected countries (average 2016-2018). Source: EU-FADN

4.3.3. Other permanent crops (TF4)

Organic farms, specialised in other permanent crops (**TF4**) could be found only for Italy and Poland. The type include specialist fruits production, olives and various permanent crops combined.

The structure of TF4 organic farms varies greatly between both countries (tab. 9), both in physical (farm area) as well as in financial terms. Average Italian TF4 farm is 33 times spatially larger than Polish one and 49 times economically. Labour inputs per hectare of Italian land is 1717% higher than in Poland. Gross farm income is even 4675% larger in Italy. Those huge differences result from production profile and value added. While in Poland, farms are focused on orchard production, mostly apples (often with traditional varieties) or bush fruits (e.g. northern highbush blueberry) are still unrecognised products or not competitive on the market, Italian farmers produce mostly in TF4 farms a well-recognised brand of high quality olive and to a lesser extent other fruits (oranges, almonds, chestnuts, hazelnuts, lemons) (fig. 19).

Tab. 9. The structure of TF4 organic farms in analysed countries in years 2016-2018 (weighted average).

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Italy	613	1 096	331	6 251	90071	24 353	86 116
Poland	22	22	10	364	1923	508	1 842

*Thousands of EURO. Description of columns as in tab. 5. Source: EU-FADN.

The utilization level of mineral fertilizers, that are allowed in organic farming is much higher in Italy for nitrogen and phosphor (fig. 20), resulting in higher costs of fertilizers than in Poland. Crop protection is quite intensive as well, while Polish farmers producing fruits use very extensive methods in this respect (fig. 21).

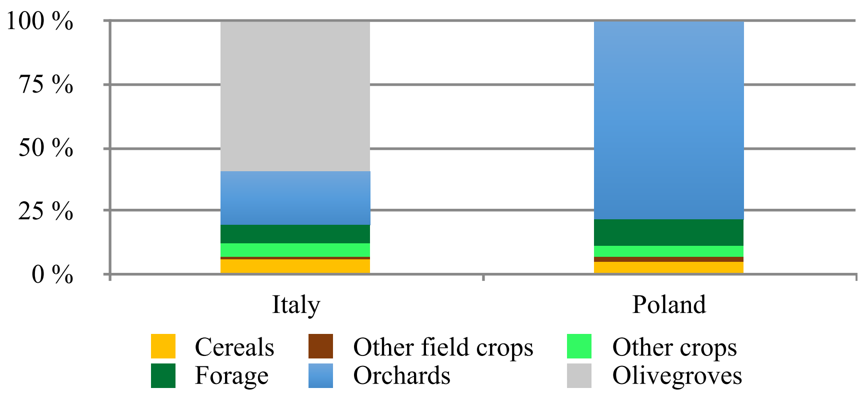


Fig.19. Structure of crops for TF4 organic farms in selected countries (average 2016-2018).
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN

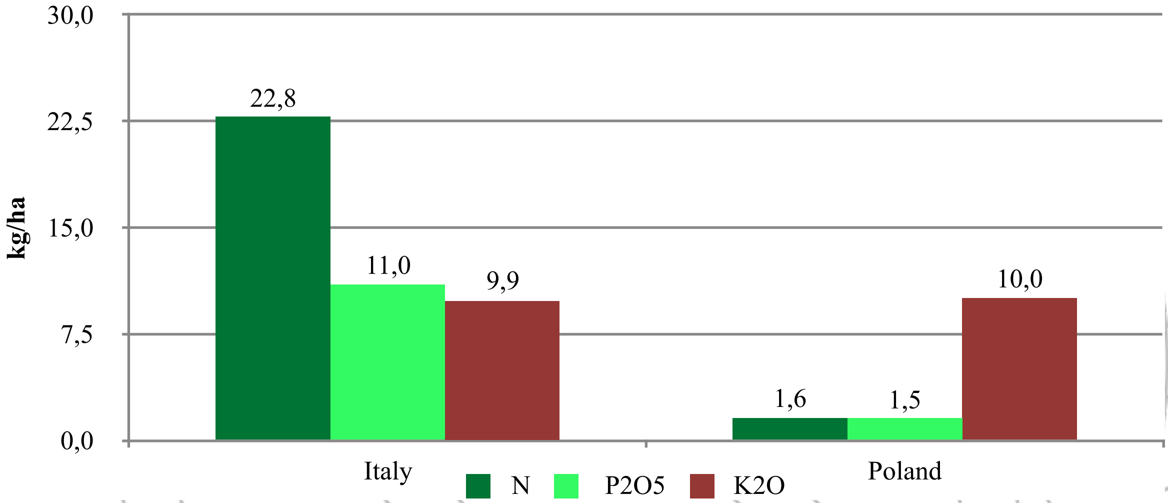


Fig.20. Quantity of N, P2O5 and K2O in mineral fertilisers used for TF4 organic farms per hectare (average 2016-2018). Source: EU-FADN

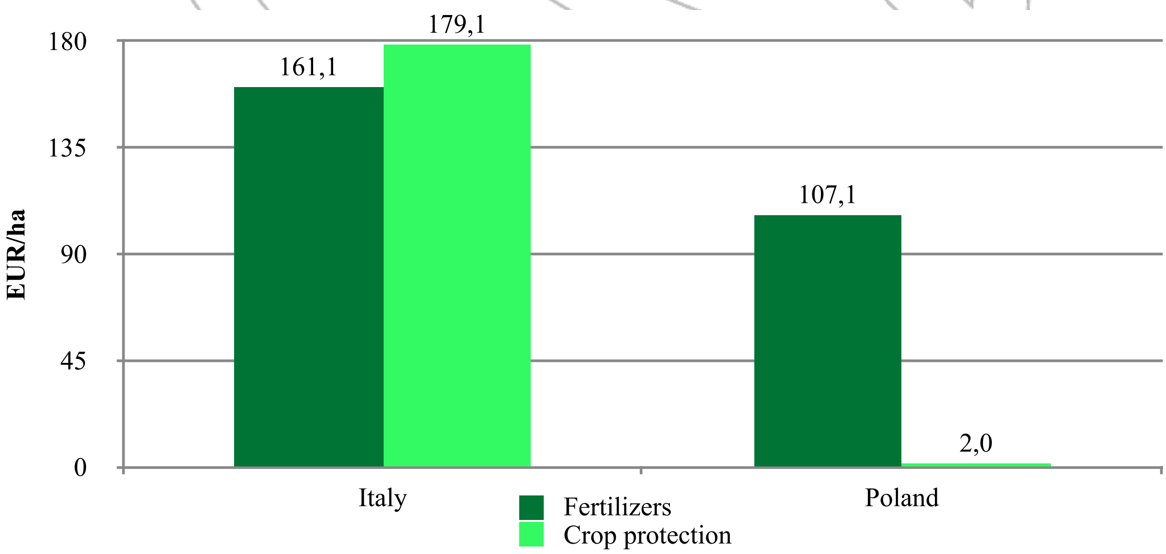


Fig.21. Average costs of fertilisers and crop protection products per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area for other permanent crops is much higher in Italy (39%) than for Poland (fig. 22).

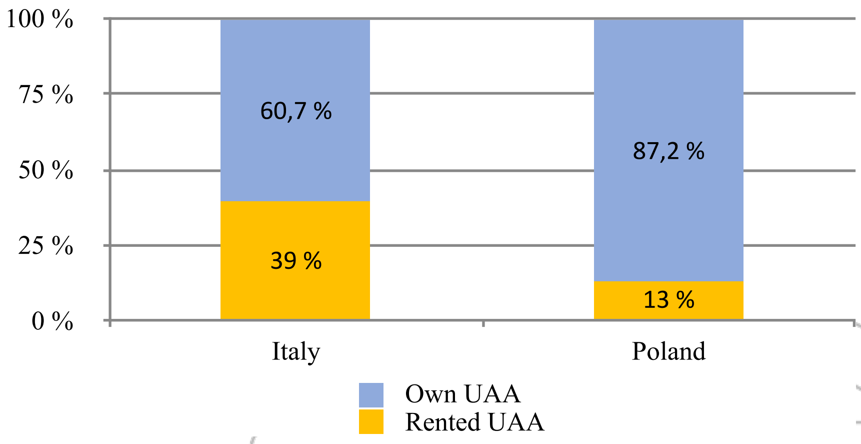


Fig.22. Share of rented organic UAA for TF4 farms in selected countries (average 2016-2018). Source: EU-FADN

4.3.4. Milk farms (TF5)

The most comparable organic farm types are those specialized in livestock, as almost all considered countries (except Romania) have the data. The farms can be divided into dairy farms (TF5) and farms keeping beef cattle (46), dual purpose cattle (47) and other grazing livestock (48) – combined in "other grazing livestock" (TF6) category.

Dairy farms **(TF5)** structure varies between countries (tab. 10). The important indicator of farm is the physical size, measured by the average amount of agricultural land per farm. The TF5 farms, represented in the FADN are on average largest in United Kingdom (511 ha), followed by Belgium (247 ha), Finland (183 ha) and Germany (136 ha). The smallest farms are in Poland (23 ha). Poland has significantly largest labour input in organic dairy farming than other countries (2-5 times larger), followed by Italy. A clear difference can be observed between Poland and other countries both in terms of total farm output as of gross farm income. Total output reach the highest values for Italy and UK, respectively, however the balance of subsidies and taxes is the best in Finland, while gross farm income is most beneficial for organic dairy farmers in Italy.

Tab. 10. The structure of TF5 organic farms in analysed countries in years 2016-2018 (weighted average).

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Belgium	23	247	68	62	2 811	485	1 816
Germany	220	136	57	67	2 611	753	1 794
Italy	65	110	30	111	4 228	518	2 530
Poland	46	23	16	212	912	473	911
Finland	18	183	88	56	2 470	1086	1 311
United Kingdom	40	511	161	42	3 042	293	1 190

*Thousands of EURO. Description of columns as in tab. 5. Source: EU-FADN.

Figure 23 shows crop structure of TF5 organic farms in each analysed country. Dairy farms are characterised in general by large share of forage crops, particularly in UK (94%). The second most common crop is cereals (2-19%).

The utilization level of mineral fertilizers, that are allowed in organic farming is highly varied between countries. Italy, Belgium, Germany and UK use relatively high quantities of N, P, K in TF5 farms, while Poland very small amounts (fig. 24). However this trend cannot be observed in terms of costs. The incurred costs of organic plant protection are negligible, except Italy (fig. 25).

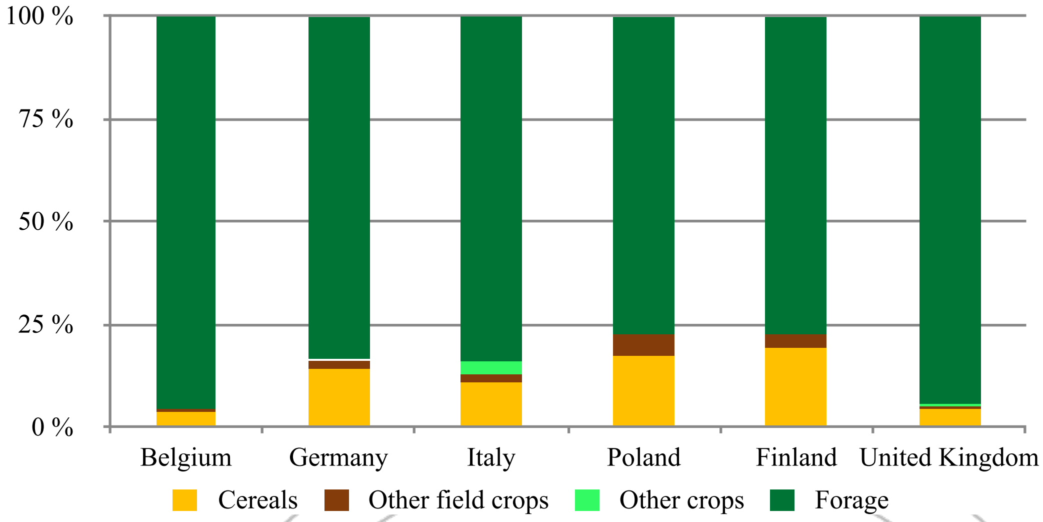


Fig.23. Structure of crops for TF5 organic farms in selected countries (average 2016-2018).
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN

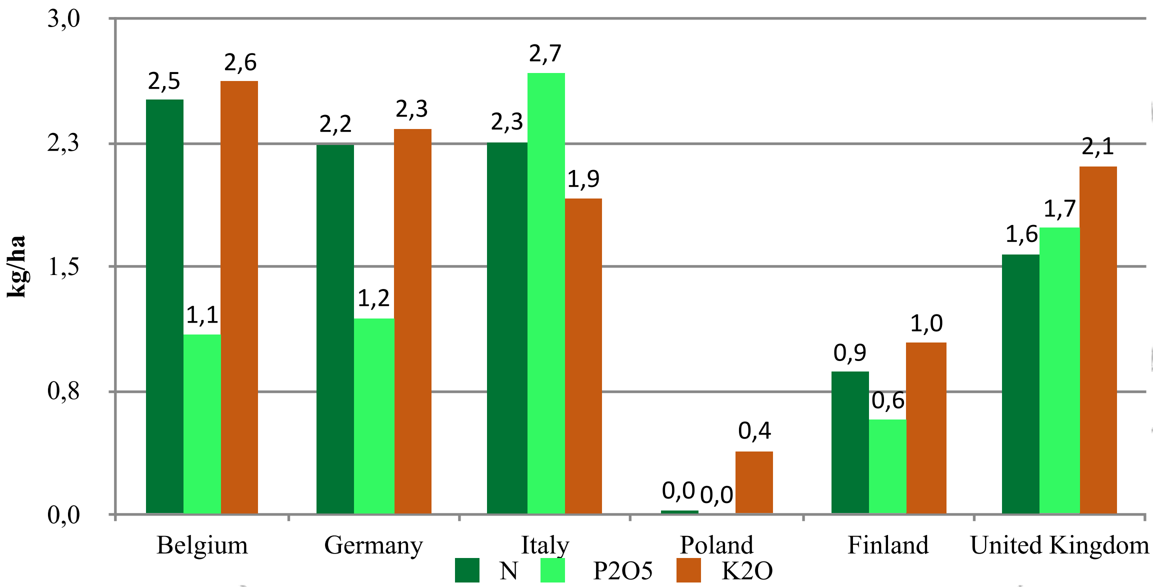


Fig.24. Quantity of N, P2O5 and K2O in mineral fertilisers used for TF5 organic farms per hectare (average 2016-2018). Source: EU-FADN

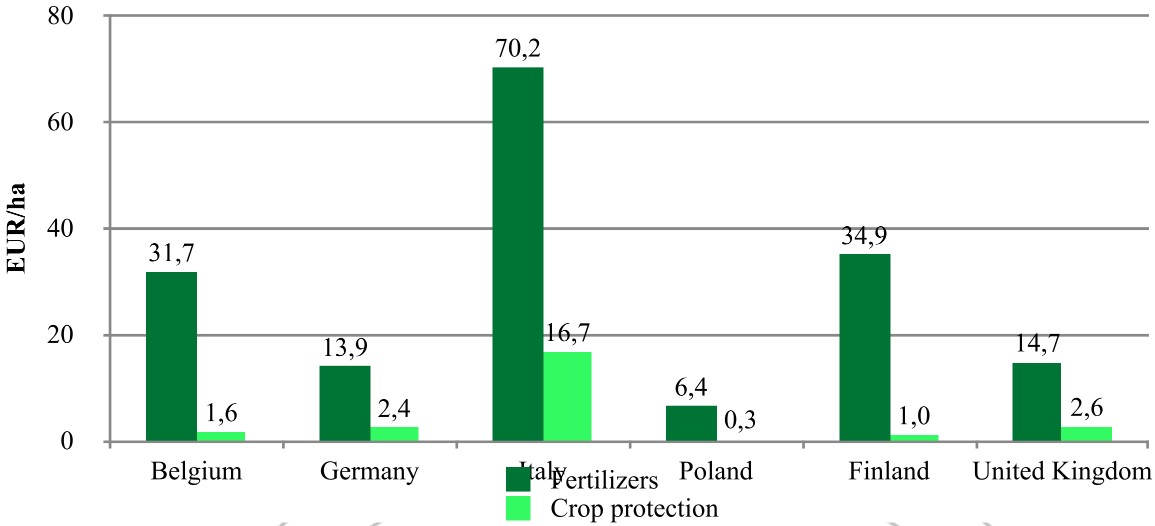


Fig.25. Average costs of fertilisers and crop protection products per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area for dairy farms is varied strongly between countries from 12% in Poland to 62% in Germany (fig. 26).

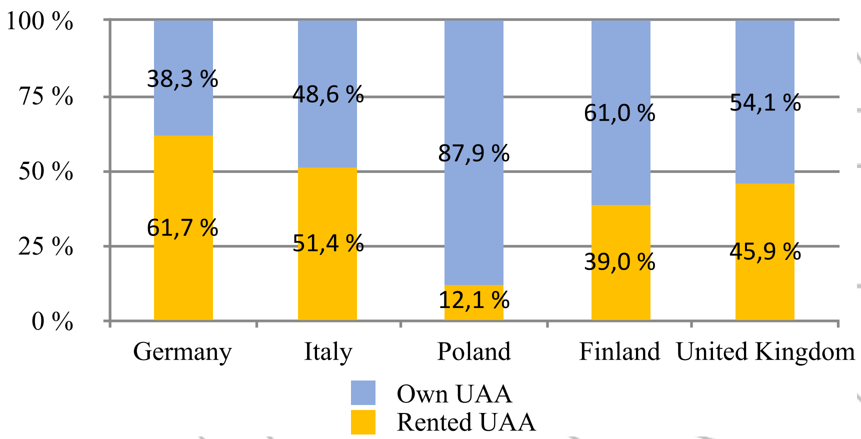


Fig.26. Share of rented organic UAA for TF5 farms in selected countries (average 2016-2018). Source: EU-FADN

Intensity of livestock production in TF5 farms, measured by livestock density is the highest in Italy (almost 1.2 dairy cows per hectare), while the lowest in Finland and Poland (0.45 - 0.54) (tab. 11). The costs of feeding animals from external sources is the highest in Finland and cost of feedingstuffs for grazing livestock within the farm is also relatively the highest among the countries. The lowest internal costs of feeding can be found in German and Belgian farms. The most extensive livestock production in terms of total feeding costs and livestock density is in Poland.

Tab. 11. Selected intensity indicators for TF5 milk farms (average 2016-2018).

Country	**Livestock density (dairy cows/ha UAA)**	**Area of forage crops (% UAA)**	**Purchased feed (EUR/dairy cow)**	**Home-grown feed (EUR/dairy cow)**
Belgium	0.93	94	605	84
Germany	0.68	84	616	93
Italy	1.17	84	993	413
Poland	0.54	77	314	195
Finland	0.45	77	2 100	944
United Kingdom	0.87	94	1262	428

Source: EU-FADN

4.3.5. Other grazing livestock (TF6)

“Other grazing livestock” farms **(TF6)** structure varies between countries (tab. 12). The important indicator of farm is the physical size, measured by the average amount of agricultural land per farm. The TF6 farms, represented in the FADN are on average largest in Belgium (145 ha), followed by UK (108 ha) and Italy (104 ha). The smallest farms are in Poland (17 ha). Poland has significantly largest labour input in TF6 farming than other countries (4-9 times larger). A clear difference can be observed between countries in terms of total farm output with largest values for Finland and Belgium and the smallest for Poland and UK. The balance of subsidies and taxes is the most beneficial in Finland, as in the case of dairy farming. Gross farm income of TF6 farms is the highest for Finland as well, however the incomes are quite low for all the countries, when compared to other organic farm types.

Tab. 12. The structure of TF6 organic farms in analysed countries in years 2016-2018 (weighted average).

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Belgium	33	145	66	44	1035	487	692
Germany	104	71	87	32	696	616	711
Italy	240	104	71	43	913	327	799
Poland	80	17	20	159	392	450	529
Finland	30	66	78	38	1 069	1 044	843
United Kingdom	76	108	194	17	596	271	362

*Thousands of EURO. Description of columns as in tab. 5. Source: EU-FADN.

Figure 27 shows crop structure of TF6 organic farms in each analysed country. TF6farms are characterised in general by large share of forage crops, particularly in UK (94%). The second most common crop is cereals.

The utilization level of mineral fertilizers, that are allowed in organic farming is highly varied between countries. Belgium use relatively high quantities of N, P, K in TF5 farms, while Poland very small amounts (fig. 28). However this trend cannot be observed in terms of costs. The incurred costs of organic plant protection are relatively high in Italy and UK, when compared to other countries (fig. 29).

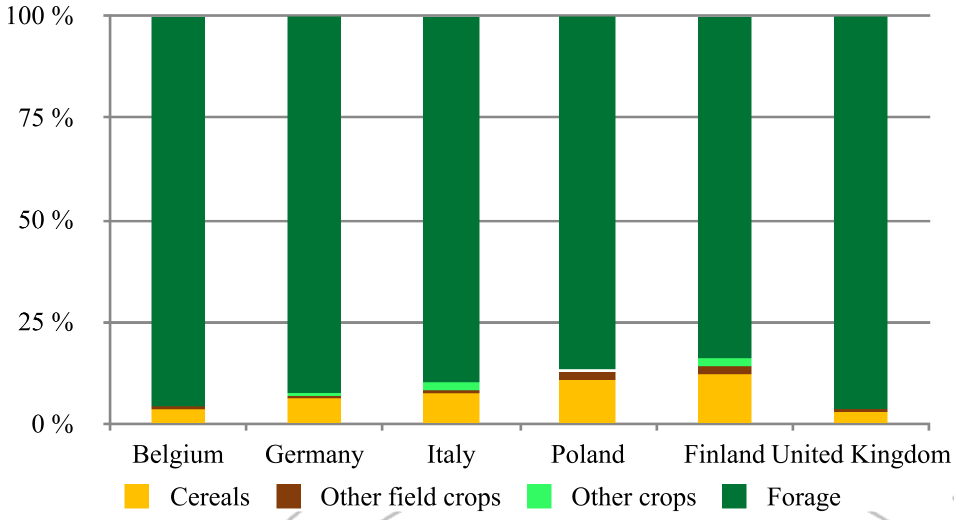


Fig.27. Structure of crops for TF6 organic farms in selected countries (average 2016-2018). Source: EU-FADN
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN

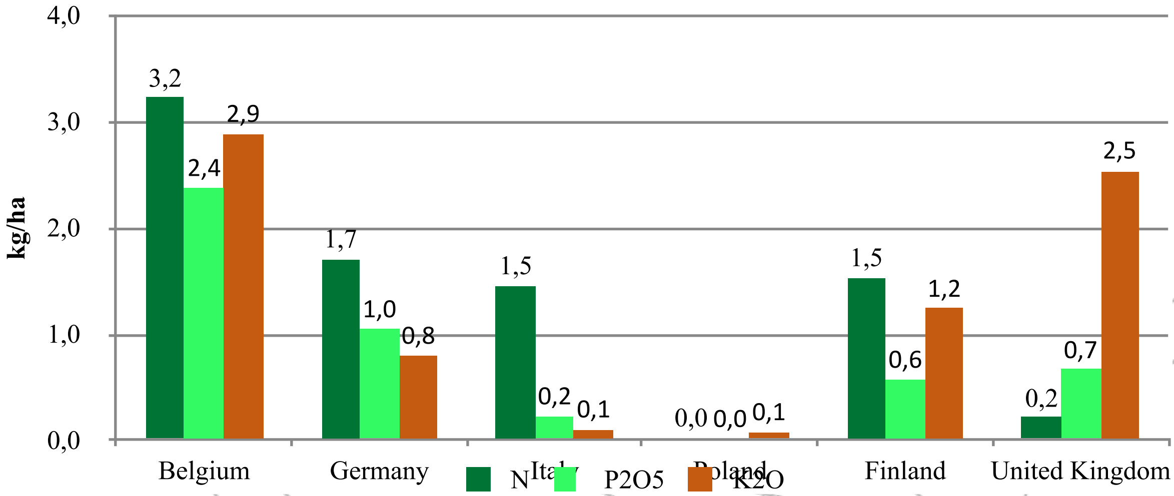


Fig.28. Quantity of N, P2O5 and K2O in mineral fertilisers used for TF6 organic farms per hectare (average 2016-2018). Source: EU-FADN

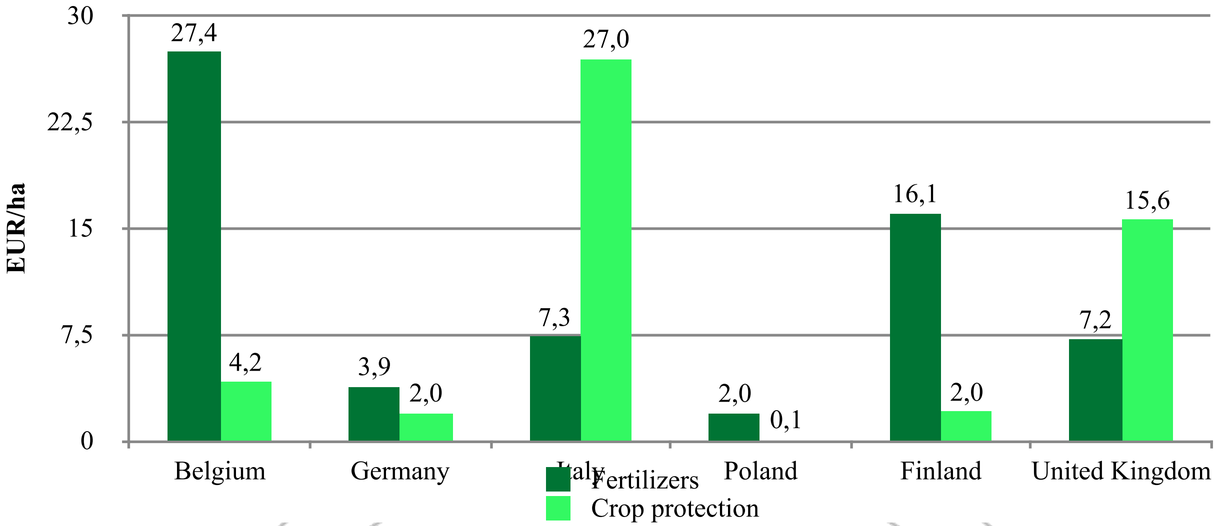


Fig.29. Average costs of fertilisers and crop protection products per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area for TF6 farms is varied strongly between countries from almost 18% in Poland to 71% in Italy and 74% in Germany (fig. 30).

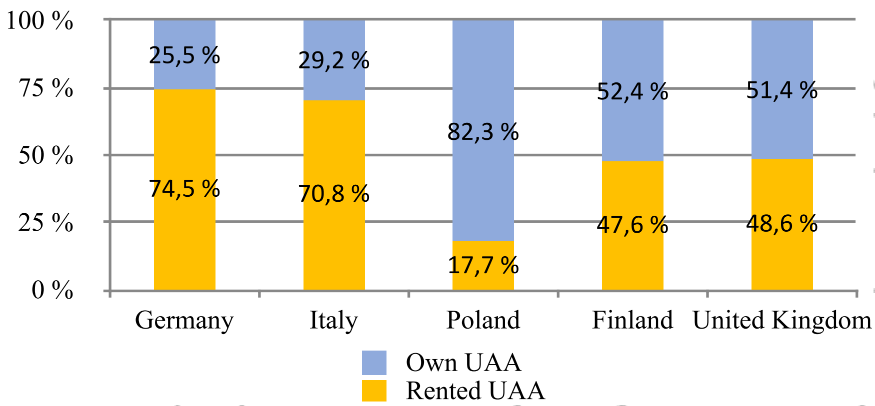


Fig.30. Share of rented organic UAA for TF6 farms in selected countries (average 2016-2018). Source: EU-FADN

Intensity of livestock production in TF6 farms, measured by livestock density is the highest in Belgium (1 cow per hectare), while the lowest in Finland, UK and Italy (0.31-0.39) (tab. 13). The costs of feeding animals from external sources is the highest in Finland and cost of feedingstuffs for grazing livestock within the farm is also relatively the highest among the countries. The lowest internal costs of feeding can be found in German and Belgian farms. The most extensive livestock production in terms of total feeding costs is in Germany and Poland.

Tab. 13. Selected intensity indicators for TF6 other grazing livestock farms (average 2016-2018).

Country	Livestock density (other cattle/ha UAA)	Area of forage crops (% UAA)	Purchased feed (EUR/dairy cow)	Home-grown feed (EUR/dairy cow)
Belgium	1.01	96	227	30
Germany	0.55	93	58	21
Italy	0.39	90	208	147
Poland	0.55	87	64	45
Finland	0.31	84	334	283
United Kingdom	0.38	96	204	158

Source: EU-FADN.

4.3.6. Granivores (TF7)

Granivores **(TF7)** farms are households specialized in pigs production (51), poultry (52) or various granivores combined (53). FADN data were available only for Germany and Italy.

The structure of TF7 organic farms varies greatly between both countries (tab. 14), both in physical (farm area) as well as in financial terms. Although average Italian farmland is 37% of average German farmland, it is much more labour intensive and total output and gross farm income is higher by 227% and 351%, respectively. In crops structure (fig. 31), the larger share of cereals (50%) is observed in Germany, contrary to Italy (approx. 33%). Italian farms have much higher share of other crops category, while German farms increased slightly share of other field crops category.

Tab. 14. The structure of TF4 organic farms in analysed countries in years 2016-2018 (weighted average).

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Germany	19	223	47	95	9 019	866	4 443
Italy	27	805	18	313	20 505	494	15 602

*Thousands of EURO. Description of columns as in tab. 5. Source: EU-FADN.

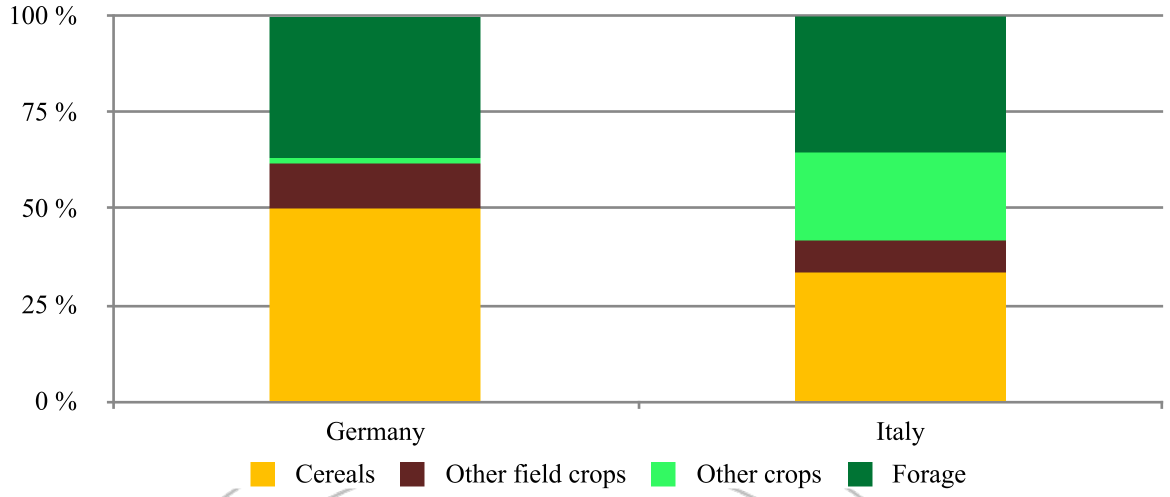


Fig.31. Structure of crops for TF7 organic farms in selected countries (average 2016-2018).
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN

The utilization level of mineral fertilizers, that are allowed in organic farming is much higher in Italy for nitrogen and phosphor (fig. 32), resulting in higher costs of fertilizers than in Germany (fig. 33). Crop protection is more intensive in Italy as well in terms of costs (fig. 33).

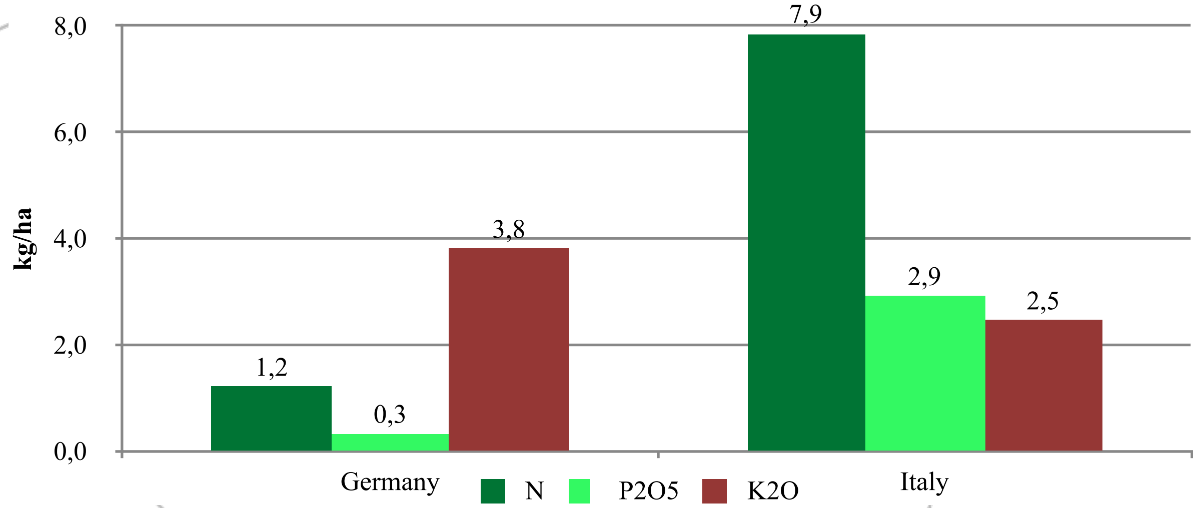


Fig.32. Quantity of N, P2O5 and K2O in mineral fertilisers used for TF7 organic farms per hectare (average 2016-2018). Source: EU-FADN

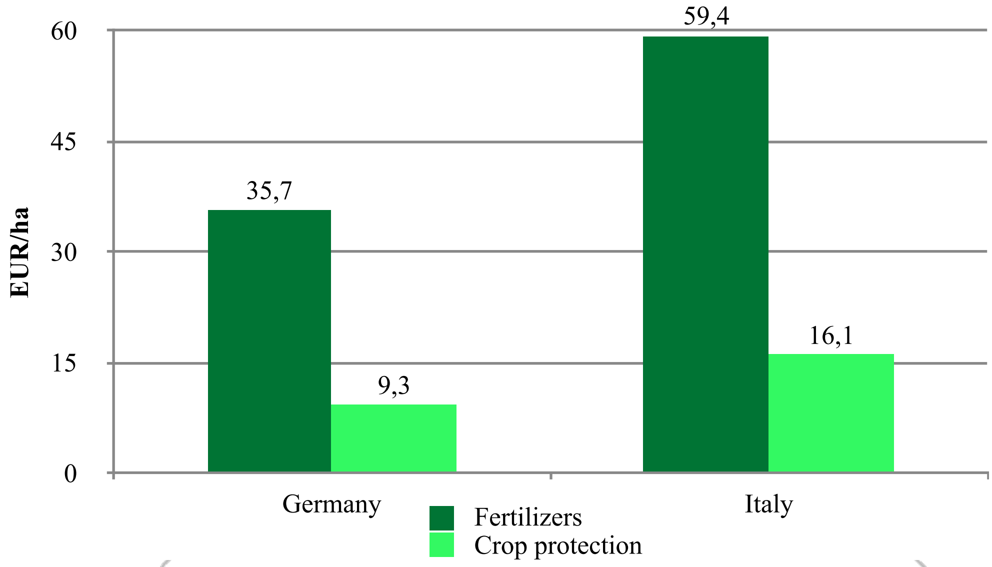


Fig.33. Average costs of fertilisers and crop protection products per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area for TF7 farms is slightly higher in Germany (46%) comparing to Italy (41%) (fig. 34).

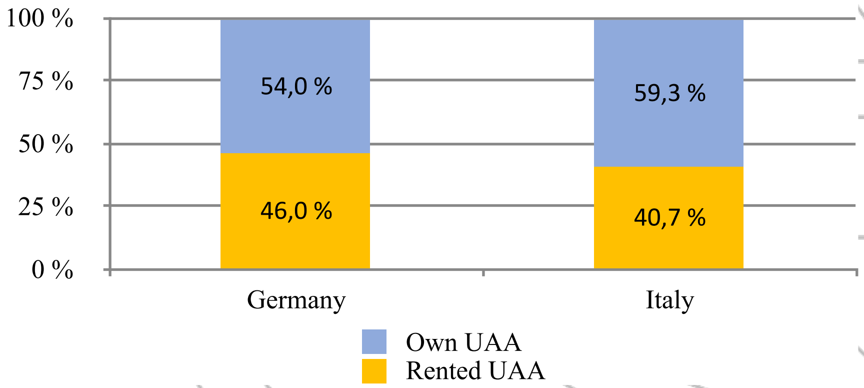


Fig.34. Share of rented organic UAA for TF7 farms in selected countries (average 2016-2018). Source: EU-FADN

4.3.7. Mixed farms (TF8)

Mixed farms **(TF8)** might include different combinations of crops and livestock (83, 84) as well as mixed livestock – grazing animals (73) or granivores (74). Four countries (Germany, Italy, Poland, UK) do have sufficient FADN dataset to present the results.

The important indicator of farm is the physical size, measured by the average amount of agricultural land per farm. The TF7 farms, represented in the FADN are on average largest in Germany (157 ha), followed by Italy (82 ha) and UK (62 ha) (tab. 15). The smallest farms are in Poland (15 ha). Poland has significantly largest labour input in TF7 farming than other countries (3-18 times larger). There is a difference between countries in total farm output with larger values for Germany and Italy and the smaller for Poland and UK. The balance of subsidies and taxes is the best in Germany. Gross farm income of TF6 farms is the highest for Germany and Italy, while the income of mixed organic farms in UK and Poland accounts on average only approx. half and quarter of their average value, respectively.

The crop structure of TF8 organic farms is very diversified and additionally varies significantly between countries (fig. 35). TF8 farms are characterised in general by large share of forage crops (from 46% to 65%). The second most common crop is cereals (24% to 41%).

The utilization level of mineral fertilizers, that are allowed in organic farming is highly varied between countries. Germany use relatively high quantities of N and K in TF6 farms, while Poland very small amounts (fig. 36). The trend can be observed very well for all the countries in terms of costs. The incurred costs of organic plant protection are relatively high in Germany and Italy, when compared to Poland and UK (fig. 37).

Tab. 15. The structure of TF8 organic farms in analysed countries in years 2016-2018 (weighted average).

Country	Sample (No farms)	Economic size (EUR)*	UAA (ha)	Labour input/ ha (hours/ha)	Total output (EUR/ha)	Balance current subsidies and taxes (EUR/ha)	Gross Farm Income/ (EUR/ha)
Germany	94	157	103	49	1860	643	1214
Italy	99	82	44	73	1309	392	1130
Poland	74	15	15	214	618	425	600
United Kingdom	20	62	68	12	500	150	284

*Thousands of EURO Description of columns as in tab. 5. Source: EU-FADN.

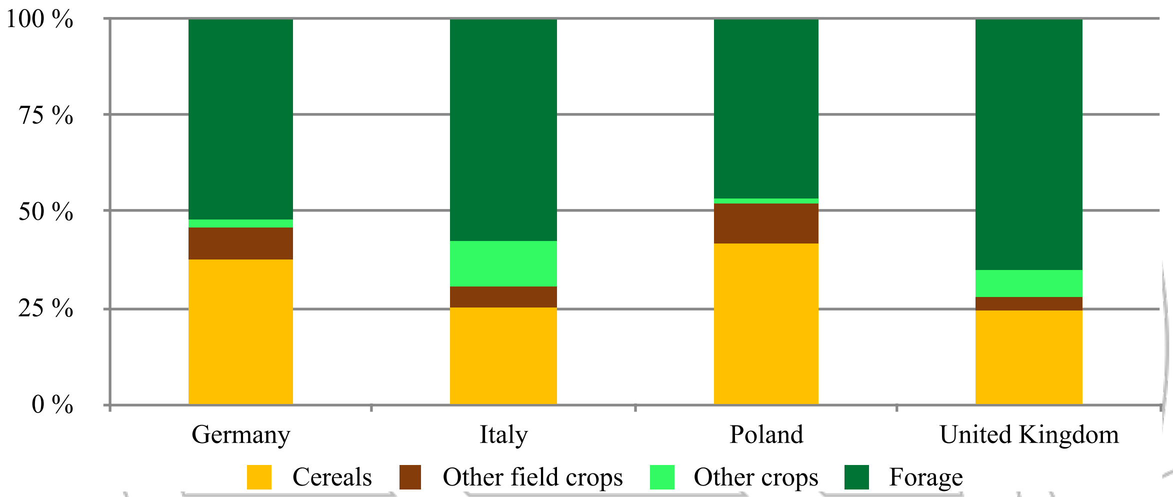


Fig.35. Structure of crops for TF8 organic farms in selected countries (average 2016-2018).
Other field crops = Energy crops + Vegetable + Vineyards +Permanent crops + Out of production
Source: EU-FADN

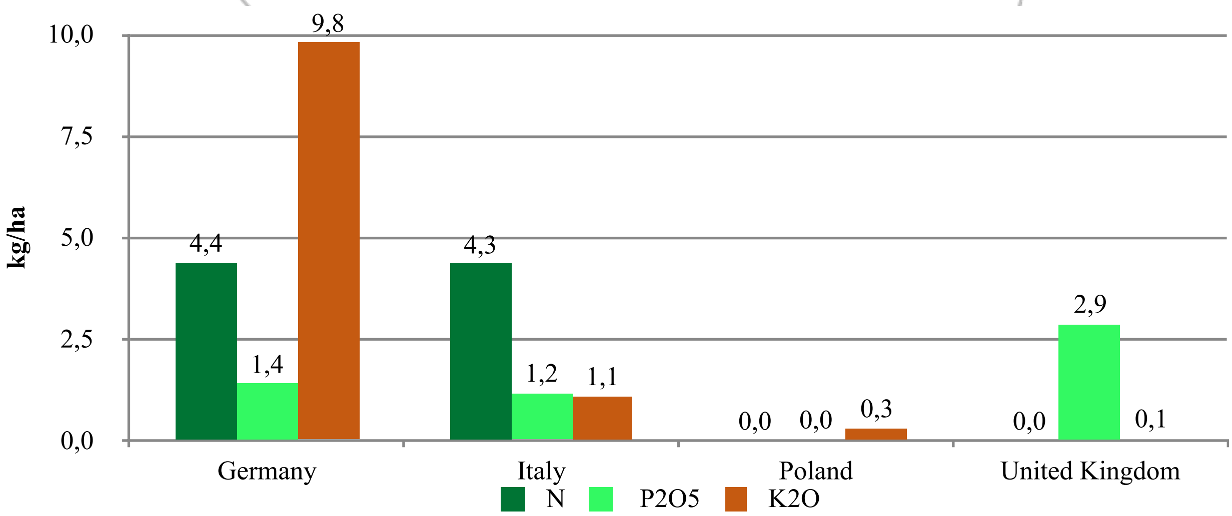


Fig.36. Quantity of N, P2O5 and K2O in mineral fertilisers used for TF8 organic farms per hectare (average 2016-2018). Source: EU-FADN

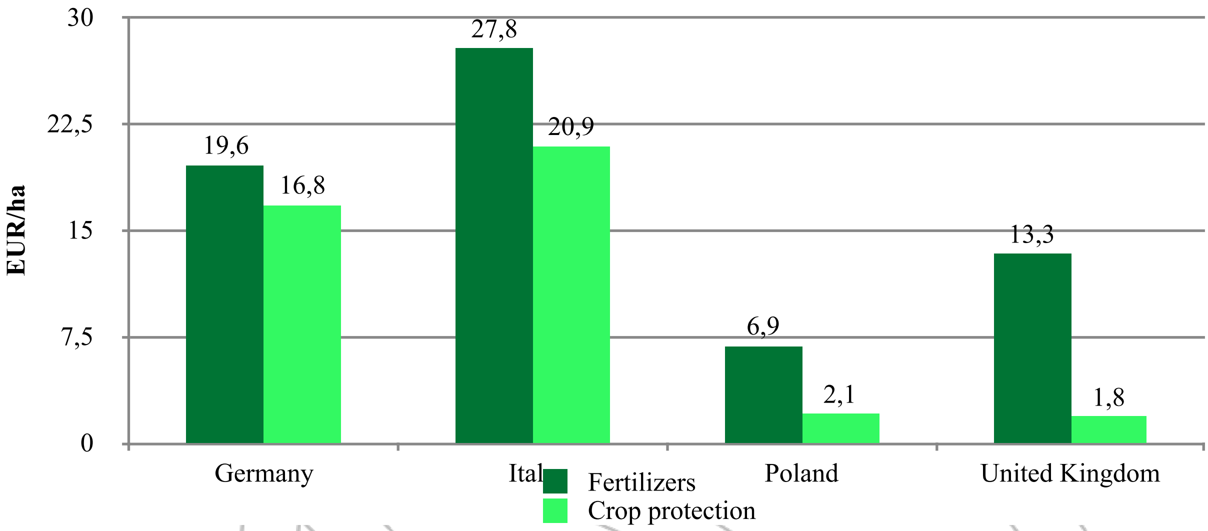


Fig.37. Average costs of fertilisers and crop protection products per hectare (average 2016-2018). Source: EU-FADN

The share of rented land in totally cultivated organic area for TF8 farms is much higher in Germany (68%) comparing to UK (44%) and Poland (16%) (fig. 34).

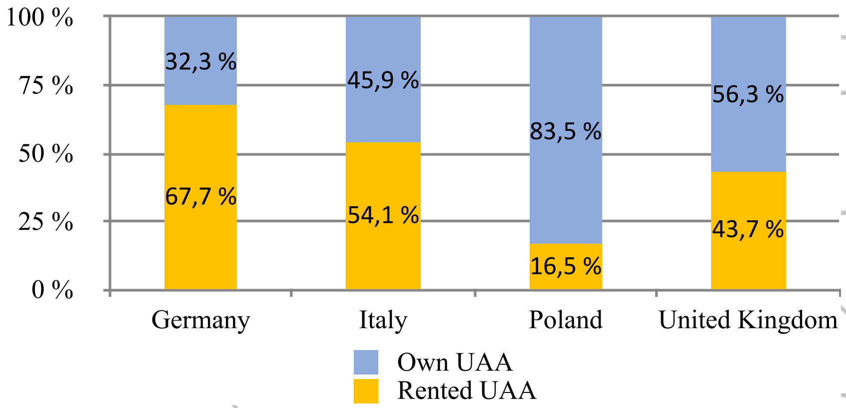


Fig.38. Share of rented organic UAA for TF8 farms in selected countries (average 2016-2018). Source: EU-FADN

Intensity of livestock production in TF8 farms, measured by livestock density is quite similar in all the countries (0.25-0.35 of other cattle/ha) (tab. 16). The costs of feeding animals from external sources is the highest in Italy and UK and cost of feedingstuffs for grazing livestock within the farm is also relatively the highest among the countries there. The lowest costs of feeding in total can be found in German farms.

Tab. 16. Selected intensity indicators for TF8 mixed farms (average 2016-2018).

Country	Livestock density		Area of forage crops (% UAA)	Purchased feed (EUR/other +dairy cattle)	Home-grown feed (EUR/other +dairy cattle)
	other cattle/UAA	dairy cows/UAA			
Germany	0.31	0.07	52	251	157

Italy	0.24	0.02	58	575	432
Poland	0.25	0.05	47	325	290
United Kingdom	0.35	0.00	64	557	493

Source: EU-FADN

4.4. Characteristics of mainstream organic counterparts for innovative case studies in FOODLEVERS countries

FOODLEVERS project studies critical points (pressures, barriers and levers) of innovative organic farming systems by measuring their environmental impacts, resource efficiency and other sustainability aspects from farm to fork. Selection of innovative case studies was carried out considering four areas of innovation (products, products and techniques, marketing, organization and governance) and using following selection criteria: coverage of the OECD innovation categories, coverage of the three realms of leverage (re-connect, re-structure, re-think), coverage of product types, coverage of production systems (conventional, organic, biodynamic). The innovative case studies are shown in table 17. In order to perform correct assessment, each of selected case studies should correspond to control mainstream organic farm, which is to be their counterpart to be compared with. Based on available national datasets from FADN and national benchmarking data, description of mainstream organic farming model for each FOODLEVERS country has been developed, using FADN grouping by type of farming criteria (TF8).

Tab. 17. Characteristics of selected FOODLEVERS innovative case studies and their allocation to FADN farm type categories (TF8).

Country	**Project partner**	**Case study name**	**Products**	**Main product of farm**	**TF8 type**
Germany	UMR	Die Kooperative Frankfurt am Main -biodynamic farm	Vegetables, Fruits, Honey, Eggs, Juice, Bread, Noodles	Brussels sprout	Specialist horticulture (TF2)
Italy	CNR	Fattoria Cupidi - silvopastoral farm (walnuts, olive orchard, laying hens grazing)	Eggs, nuts and extra virgin olive oil.	Eggs	Specialist granivores (TF7)
Poland	IUNG-PIB	OIKOS Farm – beef farm	Beef, fruits, wood	Beef	Other grazing livestock (TF6)
UK	RAU/ORC	Stroud CSA - biodynamic mixed farm	Vegetables, beef, pork, poultry meat, eggs, dairy	Carrot, beef	Mixed (TF8)
Romania	USAMVCJ	Ferma Ecologica Topa - biodynamic mixed farm	Vegetables, fruits, dairy, medicinal plants, jams, pickles,	Milk	Dairy organic farm type (TF5)
Finland	EFI	Mushroom cultivation in forests	Edible and medicinal mushrooms, wood products	Mushrooms (Shiitake)	Specialist horticulture (TF2)
Belgium	EV ILVO	Het Polderveld	vegetables, herbs, flowers, potatoes, fruits, sheep meat, poultry	Carrot	Specialist horticulture (TF2)

4.4.1. Specialist granivores (TF7) organic farm type in Italy

The preliminary characteristics of the farms are presented in the Chapter 4.3.6. The FADN sample of the Italian organic farms of type TF7 (granivores) are described in more detail below as an average for 2017 and 2018. The focus is on the information needed to determine the physical flows for LCA analyses. The data obtained from the FADN are presented in the table 18. It is not possible to separate data for e.g. only egg production.

Table 18. Selected physical and economic flows of Italian organic farm type TF7. Data refer to one year and to one farm (averaged).

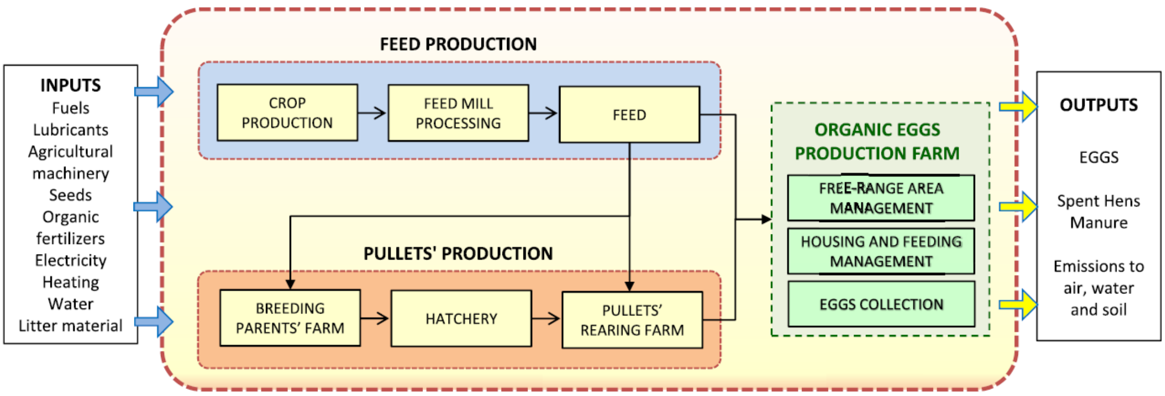
Variable	Unit	Value
UAA	ha	18.2
Land use		
Cereals	ha	6
Other field crops	ha	1.6
Vegetables and flowers	ha	0.1
Vineyards	ha	0.3
Permanent crops	ha	3.3
Orchards	ha	0.9
Olive groves	ha	2.5
Forage crops	ha	6.5
Agricultural fallows	ha	0.4
Total agricultural area out of production	ha	0.4
Woodland area	ha	0.3
Livestock population		
Other cattle	LU	1.1
Sheep and goats	LU	1.41
Pigs	LU	80.6
Poultry	LU	253.2
Farm inputs		
Seeds and plants	EUR	1229.8
Seeds and plants home-grown	EUR	0.9
Fertiliser. Quantity of N in mineral fertilisers used	kg	141.6
Fertiliser. Quantity of P2O5 in mineral fertilisers used	kg	52.4
Fertiliser. Quantity of K2O in mineral fertilisers used	kg	44.4

Crop protection	EUR	957.6
Labour	h	6539.4
Machinery & building current costs	EUR	3915.2
Energy	EUR	14309.2
Feed for pigs & poultry	EUR	53482.2
Feed for pigs&poultry home-grown	EUR	975.5
Outputs		
Beef and veal	EUR	76.0
Pork	EUR	44892.2
Sheep and goats meat	EUR	649.6
Poultry meat	EUR	21318.7
Eggs	EUR	51788.2
Ewes' and goats' milk	EUR	622.2
Other livestock & products	EUR	168900.2
Other output	EUR	64627

Source: EU-FADN

A more detailed source for comparisons of mainstream organic egg system can be found in Costantini et al. (2020)[60] assessing the life cycle of organic eggs. This work is based on data collected from a farm specialized in organic egg production located in the North-Eastern Italian region of Friuli-Venezia Giulia. The study was carried out in a cradle-to-farm gate perspective, system boundary is presented in fig. 38. Therefore, all inputs related to the rearing cycle, such as the production, purchase and on-farm transportation of feed and pullets, as well as the supply of other inputs such as electricity, water and litter material, were considered.

Fig. 38. Organic eggs production system boundaries.



Source: Constantini et al.,2020

4.4.2. Specialist horticulture (TF2) organic farm type in Germany

Since the FADN database does not provide data for the farming type of organic horticulture (TF2) (see tab. 6), German benchmarking data as well as average economic data was reviewed and requested from the respective associations, most importantly the *Zentrum für Betriebswirtschaft im Gartenbau e.V.* (ZBG – Centre for Business Management in Horticulture). This data is expected to build the basis for the subsequent sustainability assessments of the German case study which predominantly practices horticulture with a focus on vegetable cultivation.

Data availability on organic horticulture in Germany is quite limited which explains the small sample size of 14 to 22 holdings producing organic vegetables. Notwithstanding, the average sample size within the time period under investigation (2016-2018) is not less than 15 farms which would be too small to allow for significant results. Table 19 summarizes structural data on horticultural holdings producing vegetables in Germany within the time period of 2015/16 until 2018/19.

Tab. 19. The structure of horticulture holdings in vegetable production in Germany (2016-2018).

Financial year	**2018/19**	**2017/18**	**2016/17**	**2015/16**	**average**
Sample (No holdings)	14	22	17	17	17,5
Sales revenue (EUR)*	2 064	2 060	1 062	1 078	1 566
Utilised Agricultural Area (ha)	23	45	16	15	24.75
Base area garden plants (ha)	16	29	12	11	17
Leased area as % of the farm area	38	67	34	80	54.75
Total labour force (no)**	24	26	13	13	19
Total horticulture income (EUR)*	2 031	2 023	1 055	1 069	1 545
Operating income (EUR)*	2 197	2 175	1 112	1 085	1 642

* In thousands of EURO. ** "full-work force" is recorded, seasonal workers are recorded in hours, then converted with the key 2000h/work force. Source: Zentrum für Betriebswirtschaft im Gartenbau e.V.

The sales revenue of German horticulture holdings active in organic vegetable production has almost doubled over the financial years. However, due to the different sample sizes this observation might be distorted. On average annual sales have reached 1,566,000 EUR. The average physical size of a holding accounts for almost 25 ha of utilized agricultural area (UAA), while 17 ha are used as a base area for garden plants and around 55 % of the farms' area are leased. Between 2016 and 2018 vegetable horticulture in Germany needed a labour input of 19 workers on average. The annual income generated from horticulture is slightly lower (almost 6 % on average) than the operating income.

Unlike FADN data that provides information on the crop structure of the different farming types, the ZBG has very little information on the crops grown by German organic vegetable producers. An evaluation in mean values would hardly have any significance. There is also no data available on the balance of current subsidies and taxes since the ZBG solely evaluates the annual financial statements, they do not have any information on the taxation of the income of sole proprietorships. For corporations, trade taxes and corporate income taxes are recorded by the ZBG. Table 20 summarizes subsidies as well as taxes, except for taxes on income.

Tab. 20. The structure of horticulture holdings in vegetable production in Germany (2016-2018).

Financial year	**2018/19**	**2017/18**	**2016/17**	**2015/16**	**average**
Sample (No holdings)	14	22	17	17	17,5
Bonus for holdings (decoupled from area reference) (EUR)	6 481	10 197	4 929	2 244	5 963
Area-related bonus (EUR)	3 839	14 926	5 285	1 751	6 450
Other bonuses and grants (EUR)	8 374	12 423	16 501	3 565	10 216
Investment grants from the public sector (EUR)	0	21.834	511	0	5 586
Vehicle taxes (EUR)	2 016	1 840	1 163	2 376	1 849
other operating taxes (EUR)	4 555	3 373	3 105	3 036	3 517

Source: Zentrum für Betriebswirtschaft im Gartenbau e.V.

Moreover, there is no data on the quantity of N, P2O5 and K2O in mineral fertilisers used in organic vegetable cultivation. Nevertheless, according to an advisor for organic vegetable production in the Federal State of Hesse (Landesbetrieb Landwirtschaft Hessen), the amount of N-fertilisation is based on the specifications of the German Fertiliser Regulation (this also applies to P-fertilisation) (DüV) and the specifications of the cultivation guidelines of the associations or the EU Organic Farming Ordinance. Table 21 shows, however, the costs spent for fertilizers and crop protection in organic vegetable horticulture.

Tab. 21. Costs of fertilisers and crop protection products used for organic vegetable horticulture (2016-2018).

Financial year	2018/19	2017/18	2016/17	2015/16	average
Sample (No holdings)	14	22	17	17	17,5
Fertiliser (EUR)	26 246	40 243	18 890	24 708	27 522
Plant protection products (EUR)	42 005	27 959	12 694	15 721	24 595

Source: Zentrum für Betriebswirtschaft im Gartenbau e.V.

4.4.3. Specialist horticulture (TF2) organic farm type in Finland

Due to the lack of data from the FADN system for organic horticulture (TF2) farms in Finland, literature review data should be used for LCA purposes. Data in table 22 and 23 are obtained from the Natural Resources Institute Finland website (www.luke.fi). Tables include basic economic indicators and yields of outdoor horticulture production in Finland.

Tab. 22. Characteristic of organic outdoor horticulture farms in Finland.

Variable	**Value**
Farms represented	620
Farms in sample - minimum	5

Farms in sample - maximum	10
Arable land	47.8
Livestock units	0
Entrepreneurial profit	-26,000
Family farm income	-840
Profitability ratio	-0.03
Earnings (€/farm)	-12,000
Hours of family work	880
Hourly earnings (€/h)	-13.7
Equity 31.12.	252,500
Total assets 31.12.	366,500
Equity ratio, %	68.9
Net result	-12,300
Total assets	364,600
Return on assets	-3.4

Source: https://stat.luke.fi/en/organic-production-statistics

Tab.23. Organic outdoor horticulture enterprises description.

	Enterprises (nb)	Area (ha)	Yield (t)
Vegetables Total	198	1,399	5,813
Garden Pea	67	1,042	638
White Cabbage	17	25	712
Carrot	40	88	3,176
Onion	45	24	476
Other Vegetables		220	811
Tomatoes	21	4	676
Cucumber	11	1	162
Berries Total	288	770	631
Strawberry	171	216	382
Currants		424	162
Raspberry	77	24	29
Other Berries		106	58
Apple	70	69	1

Source: https://stat.luke.fi/en/organic-production-statistics

4.4.4. Specialist horticulture (TF2) organic farm type in Belgium

Due to the lack of information from the FADN system for organic horticulture in Belgium, data from de Backer et al. (2009)[61] was used to describe the mainstream organic system. This publication compares conventional and organic leek cultivation in Belgium. Specific data relating these on-farm processes for organic as well as conventional farming were obtained from two research centres, the Interprovincial Research Centre for Organic Farming and the Provincial Research and Advisory Centre for Agriculture and Horticulture. The data provided are average production data based on many years. Below in table 24 there is presented overview of activities and inputs and output for the organic production of leek (1ha).

Tab.24. Foregroud data for organic leek production (1ha).

Variable	Unit	Value
UAA	ha	1
Farm inputs		
Plantlets home-grown	#/ha	150000
Fertilizer. Manure	t/ha	30
Fertiliser. Lime	t/ha	1

Fertiliser. Organic N fertilizer	kg/ha	75
Crop protection	kg/ha	2
Farm operations		
Rotary cultivator 120Hp	h/ha	6
Plouhing 100hp	h/ha	2
Manure incorporation 120hp	h/ha	1.5
Rotary harrowing 120hp	h/ha	3
Planting (manualy)	h/ha	24
Weeding; tractor 50 to 50 hp	h/ha	15
Harvesting 120hp	hrs	80
Output		
Leek yield	t/ha	27.5

Source: de Backer et al., 2009

More specific information on mainstream organic vegetable farm in Belgium to be acquired from the selected mainstream case study.

4.4.5. Other grazing livestock (TF6) organic farm type in Poland

Data from the Polish FADN contain information on organic farms of the SE090 type (other grazing livestock). Population size in 2019 consisted of 30,186 animals and constituted 0.5% of total beef cattle. It should be noted that this category includes not only beef cattle but also other herbivores such as sheep and goats, so the description should be treated only as an approximation. Below in table 25 there is presented basic information on this category production in Poland.

Tab. 25. TF6 organic farms in polish FADN

Country	Sample (No farms)	Economic size (thous. EUR)	UAA (ha)
Poland	80	20.55	28.8

Source: FADN EU

Detailed information on the crop structure is not available. The average area of farms is 28.8 ha, of which 24.53 ha are forage crops, including meadows and pastures, 2.96 ha of grain, 1.04 ha of other crops. The average stocking is 0.82 LU/farm. The FADN database also does not contain information about amount of inputs used; only their cost. Selected results are presented in table 26. The PLN/EUR exchange rate of 4.5 was assumed for the calculations.

Tab. 26. Standard results obtained by polish organic farms TF6. Below are presented average values by farm.

Variable	Value (EURO)

Total Inputs	**13425**
Total intermediate consumption	**7934**
Total specific costs	**2671**
Specific crop costs / ha	22
Seeds and plants	348
Seeds and plants home-grown	121
Fertilizers	72
Crop protection	2
Other crop specific costs	228
Specific livestock costs / LU	91
Feed for grazing livestock	1546
Feed for grazing livestock home-grown	1007
Feed for pigs and poultry	72
Feed for pigs and poultry home-grown	58
Other livestock specific costs, incl. veterinary expenses	402
Forestry specific costs	0
Total farming overheads	**5262**
Machinery & building current costs	1783
Energy	2085
Contract work	584
Other direct inputs	808
Depreciation	**4644**
Total external factors	**847**
Wages paid	197
Rent paid	457
Interest paid	192

Source: FADN EU

The share of rented land in totally cultivated organic area for TF6 farms is about 20%. Intensity of livestock production in TF6 farms, measured by livestock density presented in table 27. It seems that additional data on the method of cultivation need to be found for the LCA assessment.

Tab. 27. Selected intensity indicators for TF6 other grazing livestock farms (average 2016-2018).

Country	Livestock density (other cattle/ha UAA)	Area of forage crops (% UAA)	Purchased feed (EUR/dairy cow)	Home-grown feed (EUR/dairy cow)
Poland	0.55	87	64	45

Source: EU-FADN.

4.4.6. Dairy (TF5) organic farm type in Romania

In the absence of FADN data on organic dairy farms in Romania, data from Italy was used to describe the mainstream system. It should be noted that in both regions there are similar average annual temperatures (~16C) and total rainfall (~600mm). No mineral fertilizers and pesticides are used in the farm of interest. Inventory data includes herd management, purchased feed, electricity, diesel, and animal shelter. The description of the basic flows and operations is shown in table 28. Table 29 contains the results of LCA for 1 kg of raw FPCM (Fat and Protein Corrected Milk).

Tab.28.Main characteristics of organic dairy farm in Italy.

Variable	Unit	Value
UAA	ha	90
Pasture	ha	40
Arable	ha	50
Herd		
Lactating cows	#	38
Dry cows	#	5
Heifers	#	20
Calves (females)	#	10
Culled cows	#	10
Farm characteristic		
Involuntary culling rate (%)		23.2
Resting area		paddock
Shed size	m2	968
Milking parlor size	m2	milk-line in shed
Milking system		milk-line + 3 groups
Milk tank	l	1400
Feed (farm origin)		
Pastured grass	kg/head/day	19
Meadow hay	kg/head/day	9
Feed (purchased)		
Soybean meal	kg/head/day	1.48
Wheat flour shorts	kg/head/day	0.57
Maize flour	kg/head/day	4.71
Field bean	kg/head/day	1.48
Sugarcane molasses	kg/head/day	0.27

Alfaalfa dehydrated	kg/head/day	0.67
Farm maintenance		
Diesel	l	11000
Electricity	kWh	15000
Output		
FPCM milk	total kg	313888
FPCM milk	kg/head/day	27.1

Source: Romano et al., 2021

Tab.29. Cradle-to-farm gate life cycle impact categories related to organic dairy farm in Italy.

GWP, kg CO2-eq	1.25
TA, g SO2-eq	19.3
FE, mg P-eq	236
ME, g N-eq	9.21
ALO, m^2/year	7.07
WD, m^3	0.5
MD, g Fe-eq	26.9
FD, g oil-eq	139.6

Functional Unit, 1 kg FPCM raw milk; GWP, Global Warming Potential; TA, Terrestrial Acidification; FE, Freshwater Eutrophication; ME, Marine Eutrophication; ALO, Agricultural Land Occupation; WD, Water Depletion; MD, Metal Depletion; FD, Fossil Depletion.
Source: Romano et al., 2021

4.4.7. Mixed (TF8) organic farm type in UK

Three-years of data from the UK Farm Business Survey (FBS) reported and utilised in a recent study[63] were used to describe the mainstream “Mixed” system within the UK:

Tab.30. Main characteristics of Mixed farms in England and Wales – crop areas:

Mixed Farm Results	Year of FBS data collection / reporting		
	2009/10	**2010/11**	**2011/12**
Sample number (number of farms)	43	10	34
Average farm size (ha)	210	243	138
Land use (ha)			
Wheat	27.7	33.7	30.9
Barley	10.3	8	18.8

Other cereals	12.1	5.3	16.5
OSR	0	0	0
Peas/Beans	8.1	8	4.4
Potatoes	0	0	0.9
Sugarbeet	0	0	0
Horticulture	0	0.1	4.5
Other crops	3.6	0.5	0.3
Tillage - fodder	2.8	6.8	2.7
Grassland (grazing, hay, silage)	176.9	166.2	121.2
Permanent grass	126.5	110.1	73.9
Temporary grass	50.4	56.1	47.3
Fallow and land let	7	9.9	7.7
Rough grazing	1.8	2.8	1.1
Total area (UAA)	250.3	241.3	209
Total tillage area	115.0	118.5	126.3
Livestock numbers (head)			
Dairy Cows	11	11	2
Beef cows	67	69	31
Other cattle	152	153	103
Cattle over 2 years	17	22	25
Cattle 1-2 years	51	44	25
calves	81	83	50
Bulls	3	4	2
Breeding sheep	90	82	161
Other sheep	99	77	137
Sows	1	2	0
Weaners	1	1	2
Growers	1	1	1
Cutters	1	0	1
Baconers	1	0	1
Poultry	83	86	6891
Other livestock	3	3	1

Feed energy requirements based on three-year average UK data were derived from the data presented in Table 30, incorporating metabolisable energy requirements of the different types of livestock reported within industry sources and technical guides[64-66].

Tab.31. Main characteristics of Mixed farms in England and Wales - livestock:

Livestock type	**Total annual ME requirements per head**	**Total ME required based on livestock numbers for "Mixed" farm type**
Dairy Cows	61,000	488,000
Beef cows	30,650	1,706,183
Other cattle:		
Cattle over 2 years	27,050	522,287
Cattle 1-2 years	13,600	645,929
calves	6,750	553,996
Bulls	32,321	117,116
Breeding sheep	6,375	707,625
Other sheep	3,000	313,000
Sows	4,642	4,642
Weaners	3,854	5,139
Growers	7,227	7,227
Cutters	8,517	5,678
Baconers	9,028	6,018
Poultry	418	983,693
Other livestock	29,061	67,809

Fossil fuel requirements:

Fossil fuel requirements for organically produced crops and livestock products were defined using a Life Cycle Assessment (LCA) model of organic farming systems within a Defra funded research project[67]. A summary of the calculated requirements is presented in Figure 39 and Figure 40.

Fig. 39. Energy input for organic and conventional crops by category on an area basis (MJ/ha).
Source: Cormack and Metcalfe, 2000.

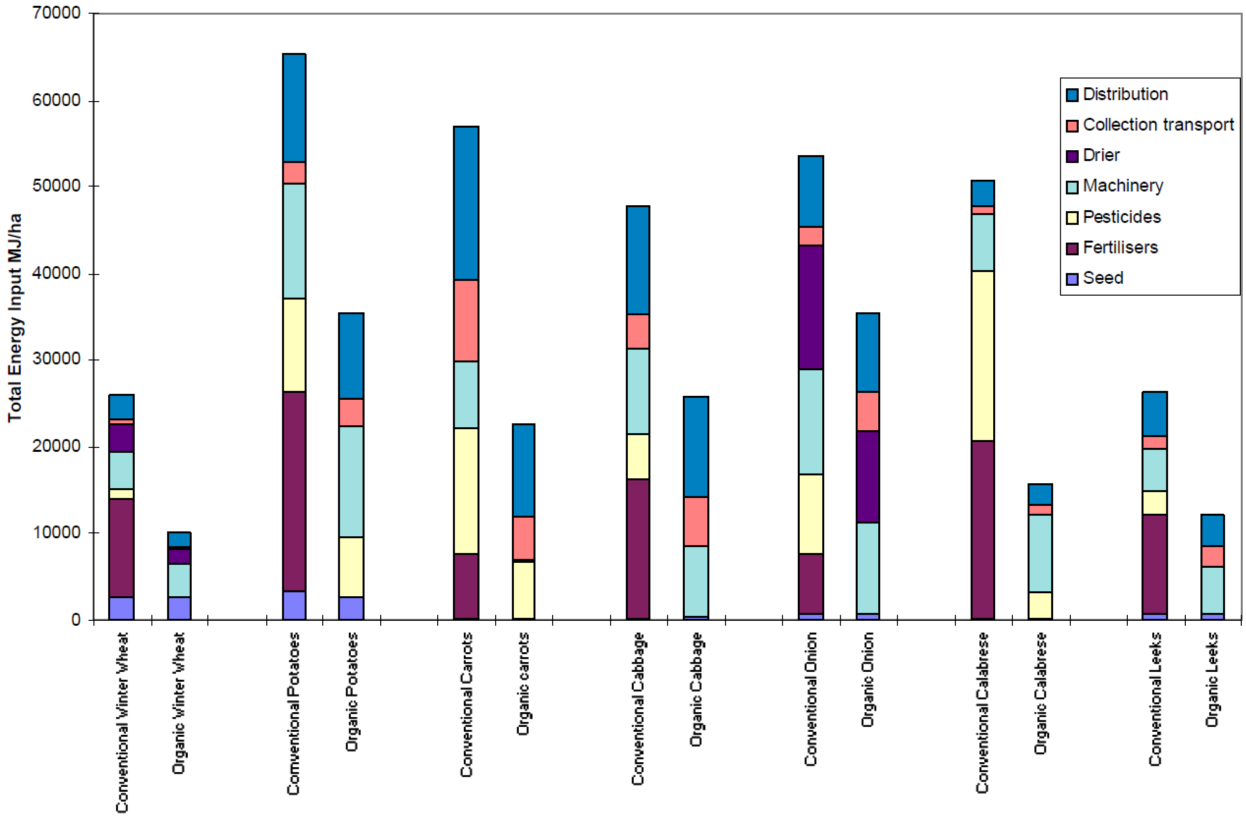
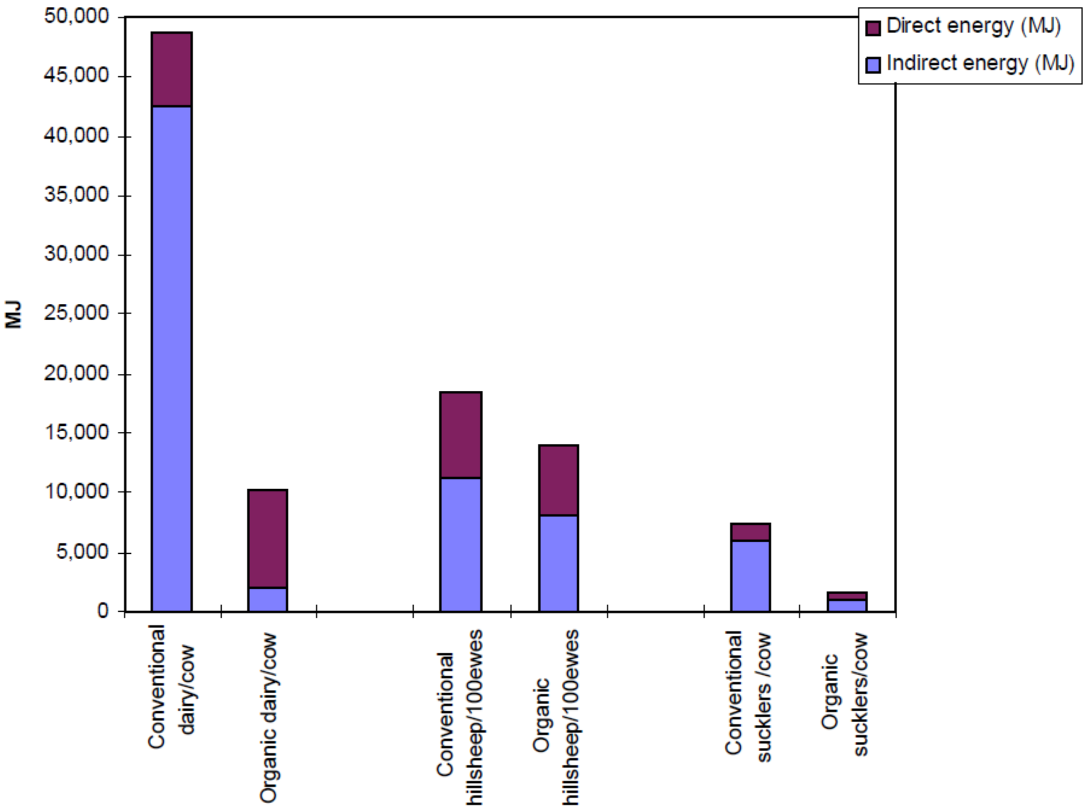


Fig. 40. Energy input by category on unit of livestock basis. Source: Cormack and Metcalfe, 2000.


Direct energy (MJ)
Indirect energy (MJ)
MJ
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Conventional dairy/cow
Organic dairy/cow
Conventional hillsheep/100ewes
Organic hillsheep/100ewes
Conventional sucklers /cow
Organic sucklers/cow

5. Summary

The report analyses the situation of the organic farming sector in the EU in terms of farming characteristics, food production, sustainability and the farms features. Although the organic area, the number of producers and processors is increasing at EU level, the development of the organic sector varies greatly between the EU countries, as regards the general conditions, market competitiveness and policy support. Organic agriculture is subject to strict regulations and controls, imposed by certification bodies to keep allegedly a sustainability standard of agricultural production, however the holistic performance of organic farming against conventional systems continues to be debated. The environmental footprint of organic food systems depends on the functional unit of assessment (area vs. product). Reliable valuation of climate impact needs to include particularly organic inputs and agricultural materials. In order to be precise, it should also extend to ecosystem services. All that increases complexity and remains the challenge.

At the moment, the most useful dataset for sustainability assessment of organic mainstream farms remains the FADN. The reference system is corresponding here to the country and farm type, due to farm specific features. Despite FADN database includes only economic data it is considered the most representative source of data related to agricultural holdings in the Union. An important shortcoming of the FADN is the surveys cover only farms that have proper economic size. Moreover, the EC does not publish averaged results data from the set comprising fewer than 15 farms. The analysis found representativeness level of organic farms in the total country pool of FADN farms is much varied - from 0.5% for Poland and 0.9% for Finland to 16,7% for Italy. In terms of physical (area) size, organic farms are on average largest in United Kingdom (171 ha) and the smallest in Poland (15 ha) and in Italy (25 ha). Poland and Italy are the countries with the greatest labour inputs in organic farming. A clear difference can be observed between Poland/Romania and other countries in terms of total farm output (almost 4 times less in Poland than for Italy where organic farms are most profitable), however gross farm income proved to be the lowest in UK organic farms. Unfortunately, there was too little information on organic farms in Romania to obtain the data for further analysis, hence the country was excluded from further detailed analysis. Small number of horticultural organic farms did not allow to gather data at level of each of country studied as well. Only two countries could be assessed in terms of organic wine farms, organic farms with other permanent crops and organic farms with granivores production (for Germany and Italy; Italy and Poland; Germany and Italy, respectively). Farms keeping specialised livestock production are most numerous organic farms, hence we can consider them the most comparable organic farm types.

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