PG-Tool

Report on baseline measurement of FAB performance of farms

Deliverable WP T2 D2.1

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Project partners:

Content

Acknowledgement

The PG-Tool has been developed by the Organic Research Centre (ORC) in the UK. The FABulous Farmers project has the authorization to use and to adopt the existing PG-Tool without any additional costs. For this kindness we would like to express our great thanks to the ORC. Additional thanks to the participating farmers.

1 Introduction

The agricultural sector, the basis for the agro-food sector in North West Europe, is today heavily dependent on external inputs (fertilizers, pesticides, etc.) and creates several negative effects on the quality of natural resources (soil, water, biodiversity). Functional Agrobiodiversity (FAB) (targeted stimulation of biodiversity to deliver ecosystem services such as pest and disease control, pollination, soil and water quality) offers opportunities to drastically reduce the dependence on inputs, but the knowledge in this area is still highly fragmented and insufficiently embedded in agricultural practice, policy and society. The FABulous Farmers project aims to accelerate the implementation of FAB by farmers and other land managers in NWE, by collecting, deepening and sharing knowledge and practical experiences about FAB between farmers, scientists, citizens and policy makers in 12 pilot regions in NWE over 5 countries (FR, NL, UK, BE and LUX). 10 FAB solutions are developed in a region-oriented manner, tested and demonstrated across 315 farms and evaluated for ecological performance and economic profitability, with the aim of reducing the dependence on external inputs. In each pilot region, a FAB learning network is set up, in which farmers exchange knowledge and experiences and draw up a FAB action plan. In addition, we collaborate with local actors, citizens, policy makers and value chain partners to embed FAB more widely in society, policy and market, through the design and implementation of FAB landscape integration plans and the rollout of citizen science tools; development of policy papers (at EU and national / regional level), and 12 business cases for valorisation of FAB via the market. Finally, a long-term development plan is drawn up for the continuation and expansion of the FAB learning networks after the end of the project.

FAB can be achieved in many different ways. As a consequence, FAB-measures may concentrate on very different aspects of the farm management: Pollination, pest and disease control, nutrient regulation, water regulation and erosion control (see Figure 1)

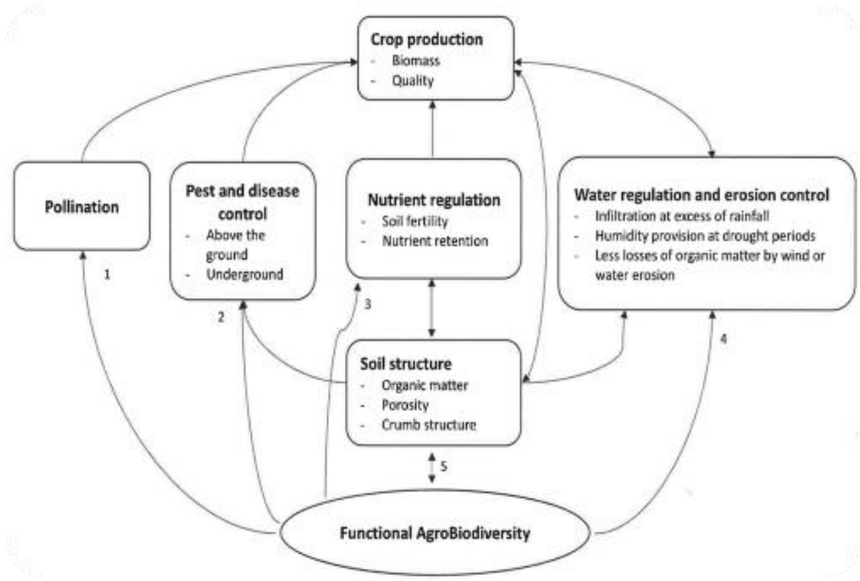

Figure 1: Diverse Fab-measures.

Agricultural farms operate with biological processes that are all interconnected. Therefore, the implementation of specific FAB measures does not generally affect only one aspect of the farm, but influences the entire farm and its overall sustainability.

The FABulous Farmers project covers 12 pilot regions in 5 countries. FAB solutions are implemented and monitored in more than 300 farms distributed over the project area. Due to regional specifics in climate, soil, rotation, tradition the implemented FAB-measures may be very different and so are the individual farm-types.

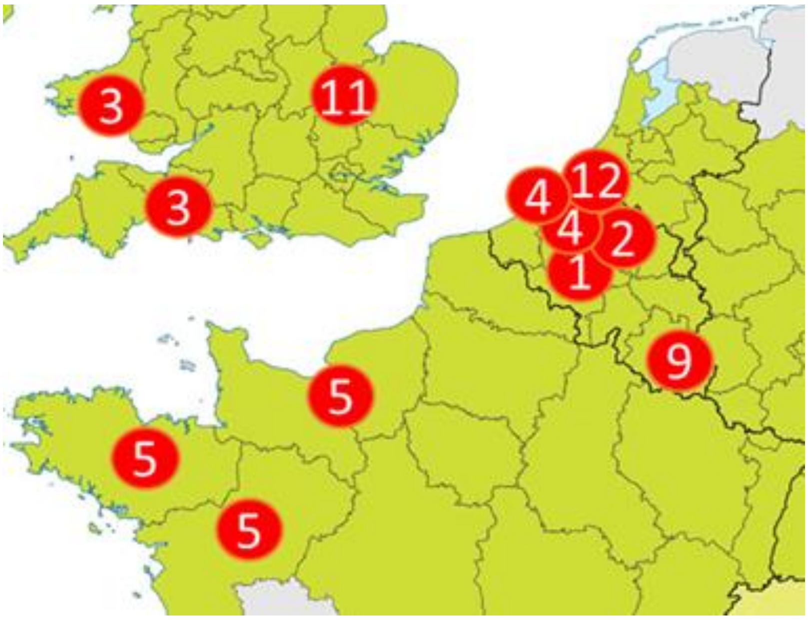

Figure 2: The FABulous Farmers project covers 12 pilot regions in the 5 countries United Kingdome, the Netherlands, Luxembourg, Belgium and France.

In a coherent project approach it is important to bring all these differences together in order to have a common basis that allows comparisons between farms and regions as well as to monitor possible evolutions after the implementation of specific FAB-measures.

One of the principle goals of the FABulous Farmers project is the implementation of FAB-measures on the Pilotfarms and to evaluate these towards their ecological performance and economic profitability, with the aim of reducing the dependence on external inputs. Making a sustainability evaluation at farm level means “taking a picture” of the farm in a defined way and at a precise moment! The result of first sustainability evaluation at the project start could thus provide a baseline about the sustainability level on the farm and in the region. This allows to identify possible weak points on the farm and in the region as well as the comparison of regions in the project. On this basis, FAB-measures to be implemented in each region can be specifically adapted to the situation in the project region. A second sustainability evaluation at the project end allows to evaluate the impact of implemented FAB-measures and the new sustainability status on the farms and in the regions.

2 Material and Methods

The MS-Excel based SustainFARM Public Goods Tool (PG-Tool) has been selected as a medium for the sustainability assessment on the agricultural pilot farms within the FABulous Farmers project.

2.1 PG-Tool characterisation

The PG-Tool has been developed by the Organic Research Centre (ORC) in the UK (Organic Research Centre, 2019) and has been adopted to the needs of the project resulting in a "FAB-version" of the PG-Tool. The PG-Tool in general is "a sustainability assessment for farms that combine food and non-food production" within a 12-month period (Smith, 2019). It identifies impacts of a change on performance across the range of sustainability indicators. With the help of the tool a farm is evaluated across a range of spurs (sustainability areas) that can be impacted by farm management practices and are related to public goods such as water quality, air quality, etc. Each spur consists of a variety of activities assessed (Smith, 2019). Table 1 lists the spurs and corresponding activities evaluated during the sustainability assessment.

Table 1: Overview of the 11 spurs and according activities focused on within the PG-Tool (Smith, 2019).

Spurs	Activities
Agri-environmental management	Agri-environmental participation Rare species Conservation plan 3rd party endorsement Habitats Herbicide and other pesticide use
Landscape and heritage	Historic features JCA and landscape features Management of boundaries Genetic Heritage
Soil management	Soil analysis Soil management Winter grazing Erosion Cultivation
Water management	Reducing pollution Water management plan Water harvesting Irrigation Flood defenses
Fertiliser management	NPK balance Fertiliser management and application Nutrient Planning Manure management Disposal of farm waste
Energy and carbon	Benchmarking

	Energy balance Energy saving options Greenhouse gases Land use change Renewable energy
Food security	Total Productivity Local food Off farm feed 3rd Party Endorsement Food Quality certification Production of fresh produce
Agricultural systems diversity	Cropland diversity Livestock diversity Marketing On-farm processing
Social capital	Employment Skills and knowledge Community Engagement CSR initiatives and accreditations Public access Human Health Issues
Farm business resilience	Financial viability Farm resilience
Animal health and welfare management	Staff resources Health plan Animal health Ability to perform natural behaviours Housing Biosecurity

Responses are scored on a scale of 1 (poor) to 5 (excellent) and an overall score is given for each performance (Smith, 2019). The results are presented on a spider diagram.

The sustainability assessment within the FABulous Farmers project is performed twice, at the beginning and at the end of the project. At the beginning, the baseline of the sustainability status is investigated. To investigate the effects of changing or introducing new practices or management to the farm (FAB measures) on the sustainability indicators, the assessment will be repeated at the end of the project.

By choosing 2018 as the reference year for the first data collection, the baseline is drawn before the start of the FABulous Farmers project. This guarantees that the data is not influenced by FAB-measures implemented in the context of the project.

2.2 Workflow of the sutsainability assessment

Before using the PG-Tool on the farms within the pilot regions, the tool had to be adapted to the needs of the FABulous Farmers project by e.g. deleting unnecessary external links, adjusting currency issues to common Euro (€) and adding an assistance sheet to calculate the herd composition. Farms were contacted and selected by the country-specific contact persons. The data collection took place in 2020 but was extended due to COVID-19 until 2021. After data collection was finished, the data have been merged, reviewed and a data quality control took place. This step, as well as the following, was done by the Luxembourgish partner at IBLA. A masterdata table was created afterwards that enables a data analysis and a comparison of the countries investigated. An individual farm report was generated and sent to each of the participating farms, at least in the pilot region of Luxembourg (see Table 2).

Table 2: Overview of the sustainability assessment workflow within the FABulous Farmers project.

Farm-Level Sustainability Assessment	Task 1.1	Adaptation of the PG-Tool
	Task 1.2	Contact and selection of farms
	Task 1.3	Data collection
	Task 1.4	Data review and quality control
	Task 1.5	Masterdata table
	Task 1.6	Statistical analysis of farm-level data
	Task 1.7	Report generation: Individual farms
	Task 1.8	Interpretation of results and report

2.3 Data analysis

With the help of the created masterdata table that gives an overview of the sustainability scoring of the investigated farms, descriptive statistics is used to summarize the data set. Mean and standard deviation as well as the median of the activities and spurs scoring was calculated country-specific.

Mean total utilizable agricultural (UAA) and overall sustainability level was calculated for each country. A differentiation between management type (conventional / organic) and farm type (livestock / no livestock) was done to show treatment effects on the spurs level.

The data evaluation of the sustainability assessment goes along with the different FAB solutions that were defined as: 1 reduced tillage; 2 mixed crops / rotation; 3 cover crops; 4 organic matter input; 5 modify manure quality; 6 agroforestry; 7 hedgerow management; 8 field margin management; 9 reduction in the use of plant protection products. Hence, a detailed focus of the evaluation is mainly set to the spurs and activities that include these predefined FAB solutions. Spider diagrams of these spurs were used to show differences between countries, management types and farm types.

3 Results and discussion

3.1 Farm structure and sample distribution

The sustainability assessment using the PG-Tool was implemented on a total of 25 farms within the FABulous Farmers region. The sampling includes 2 farms in Belgium, 7 in France, 5 in Luxembourg, 5 in the United Kingdom (UK) and 6 in the Netherlands (see Table 3).

The average farm size of the sample amounts to 107.0 ha and is much higher than the typical size of family runed farms in Western Europe, that amounts to 38.9 ha on average (Loughrey et al., 2016). The mean farm size in whole Euope is 16.1 ha and also considerably lower (Eurostat, 2015).

In terms of management, the sample consists of two fully organic managed farms since more than 18 years, whereas each one farm is in the pilot regions of Luxembourg and the UK (see Table 3). Consequently, 8 % of the farms are managed organically. This number goes along with the share of European organic farm land that was 8.5 % in 2019 (European Union, 2021). The sample distribution is therefore representative with the European farm status.

Table 3: Sample overview with numbers of assessed farms in each country (n) and numbers of farms per management and farm type. Mean and standard deviation are given for utilisable agricultural area (UAA) in ha.

country		BE	FR	LU	UK	NL	all farms
n		2	7	5	5	6	25
management type	conventional	2	7	4	4	6	23
	organic	0	0	1	1	0	2
farm type	livestock	2	5	5	5	2	19
	no livestock	0	2	0	0	4	6
total UAA [ha]	mean	43	89	109	54	166	101
	stdw	48	32	72	45	132	84

Nearly three-quaters of the farms are livestock farms and 24 % of the farms have no livestock, whereby these are only located in the countries France and the Netherlands (see Table 3). Having a closer look at animal husbandry, the main share of the sample focuses on ruminant farming, while one third of all farms have dairy production (located in Belgium, France and Luxembourg) and 20 % of the farms have meat prodution (located in Belgium, UK and the Netherlands). Monogastric farming (pigs or poultry) is done on 16 % of the farms in particular in France, Luxembourg and the Netherlands. Both, ruminant as well as monogastric farming combined (meat, dairy or wool production) can be found at 8 % of the investigated farms and are located in the UK (see Table 4).

Table 4: Detailed farm type overview of the samples divided in ruminant (dairy, meat), monogastric and both ruminant and monogastric farming.

country		BE	FR	LU	UK	NL	all farms
n		2	7	5	5	6	25
No animal husbandry		0	2	0	0	4	6
animal husbandry	ruminant (dairy)	1	4	3	0	0	8
	ruminant (meat)	1	0	0	3	1	5
	monogastic	0	1	2	0	1	4
	both ruminant and monogastric	0	0	0	2	0	2

The sample includes all kinds of farm types and animal husbandry and is therefore very diverse in its structure.

The 25 farms laboured in sum 2523.1 ha of agricultural land. The utilisable agricultural area (UAA) varies on average between 43 and 166 ha (see Table 3). The highest mean UAA in the sample is in the Netherlands and Luxembourg and the smallest in the UK and Belgium. Comparing the sample with average data of UAA per farm in the single countries, the average UAA of the agricultural holdings is smaller in the Netherlands (27.4 ha), Luxembourg (63.0 ha) and higher in the UK (93.6 ha); France (58.7 ha) and Belgium (34.6 ha) are similar in average UAA and average UAA of the sample (Eurostat, 2015).

Two farms that are located in France are run by the “successional tenant”, the remaining ones are thus “owner occupied”. One pilot-farm in BE and one in LU are very small farm in terms of UAA (BE: 8.7 ha, LU: 9.1 ha) and herd size. These farms are propably not run on full-time but on part-time. The largest farm is found in the Netherlands managing 341 ha of total UAA (see Figure 3).

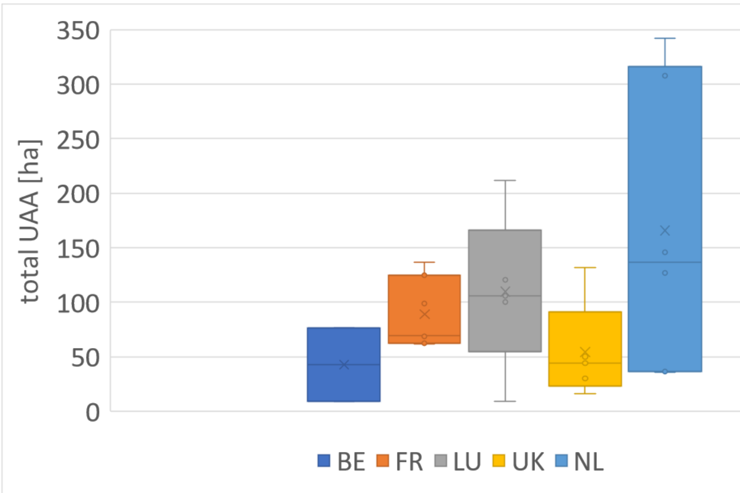

Figure 3: Left: Distribution of total UAA (ha) along the investigated countries Belgium (BE), France (FR), Luxembourg (LU), United Kingdom (UK) and the Netherlands (NL).

The UAA includes the area of arable land and permant grassland. With a share of 84 % of arable land and 16 % of permanent grassland, the sample has a high amount of arable land. Comparing the distribution of the two categories in the European Union, the ratio of arable land to grassland is 60 : 40 (European Environment Agency, 2018).

Organically managed farms had on average a smaller farm size than the participating conventional farms (see Table 5). Farms with no livestock were smaller in farm size than farms with livestock. In terms of animal husbandry, farms with ruminant husbandry tended to have smaller agricultural area than farms with no animals but higher agricultural area than only monogastric husbandry. Arable land is highest on farms with no livestock and permanent grassland that serves as fodder is thus highest on dairy farms.

Ponds and watercourses, designated non cropped nature reserve land or agri-environmental land (e.g field margins, wild bird mixtures) as well as other non agricultural land are summarized in the PG-Tool under the term "other land" (see Table 5). These biodiversity areas are of high importance within the FABulous Farmers project and have a share of 3.2 %.

Table 5: Distribution of farm size and managed area in total and for the treatment categories. Numbers are mean values presented in the unit ha.

		sample size n	mean farm size(ha)	mean arable land (ha)	mean permanent grassland (ha)	mean total woodland (ha)	mean other land (ha)
total		25	107.0	2113.2	389.6	79.3	85.1
management type	organic	2	77.8	42.8	35.1	4.9	3.1
	conventional	23	102.9	88.2	13.9	3.0	3.4
farm type	livestock	19	78.5	57.6	19.9	2.7	2.4
	no livestock	6	171.8	169.8	2.0	4.7	6.6
animal husbandry	No animal husbandry	6	171.8	169.8	2.0	4.7	6.6
	ruminant (diary)	9	85.0	66.2	18.4	3.0	3.3
	ruminant (meat)	4	50.2	25.1	24.0	0.8	0.5
	monogastic	4	111.7	97.4	14.3	2.8	3.1
	both ruminant and monogastric husbandry	2	40.0	4.1	29.5	5.0	0.8

As can be seen in Table 5, the mean biodiversity areas of organic and conventional managed farms is nearly the same within the pilot region. Farms with no livestock tend to have higher mean biodiversity area (6.6 ha) than livestock farms (2.4 ha). In the latter, mainly farms focusing on meat production show lowest mean biodiverstiy areas (0.5 ha).

3.2 Sustainability level

The sustainability level of a farm is expressed in the PG-tool by 11 different spurs, covering the three dimensions of sustainability: ecology, economy, social aspects. Each spur again is split in its activities that detailly describe the source of the sustainability evaluation. The sustainability level is expressed on a scale of 1 to 5, while 1 corresponds to a low level of achievement of the sustainability targets and 5 to a maximum achievement of the sustainability goals. The overall sustainability enables a first sight into the sustainability assessment. Table 6 gives an overview of the overall sustainability per country investigated. All farms surveyed with the PG-Tool have an average sustainability level of 3.06 and show therefore a good achievement of the sustainability targets. The range from 2.88 in Belgium to 3.26 in the UK is very small and all monitored pilot farms had already a good sustainability level (> 2.5) in the year 2018 before the start of the FABulous Farmers project.

Table 6: Sample overview with numbers of assessed farms in each country (n) and mean overall sustainability level on a scale of 1-5 and respective standard deviation.

country		BE	FR	LU	UK	NL	all farms
n		2	7	5	5	6	25
overall sustainability	mean	2.88	2.89	3.19	3.26	3.06	3.06
	stdw	0.22	0.21	0.49	0.26	0.34	0.34

If the farms are classified according to the treatment effects, organically managed farms show a high level of sustainability (> 3.5), while conventional managed farms tend to have a slightly lower sustainability level and are in the good range of sustainability goal achievement (>2.5). This statement must be interpreted with caution, since the sample size of organic farms is only n = 2. Farm type seems to have no influence on the overall sustainability since the mean values are identical for livestock and no livestock. Both categories show a mean overall sustainability level of 3.06 (see Table 7). Focusing on animal husbandry in detail, the highest achievement of the sustainability goals is found in the category of both ruminant and monogastric husbandry. Here, a high level of sustainability is reached. The lowest, but still good sustainability, is found with dairy farming.

Table 7: Mean overall sustainability level and standard deviation (stdw) in each treatment category (management type, farm type and animal husbandry and numbers of assessed farms in each category (n).

			overall sustainability	
		n	mean	stdw
total		25	3.06	0.34
management type	organic	2	3.54	0.41
	conventional	23	3.02	0.30
farm type	livestock	19	3.06	0.33
	no livestock	6	3.06	0.38
animal husbandry	No animal husbandry	6	3.06	0.38
	ruminant (diary)	9	3.00	0.33
	ruminant (meat)	4	3.02	0.23
	monogastic	4	3.03	0.38
	both ruminant and monogastric husbandry	2	3.47	0.30

3.3 Spurs

The 11 spurs assessed within the PG-Tool provide a detailed overview of the ecological, economic and social sustainability goal achievement.

3.3.1 Mean spurs of sample

Focusing on all the observed farms, the mean sustainability level is highest with 4.23 in the soil management spur and lowest in food security (2.52) and agricultural system diversity (2.54). Thus, the last two spurs mentioned are still just within the good range of sustainability. The spurs of farm business resilience (3.76) and animal health and welfare management (3.58) reach high levels of sustainability (see Figure 4). Whereas these two are not directly linked to specific FAB-measures (see Figure 1). A good level of sustainability is furthermore achieved by all farms in the spurs of agri-environmental management (2.67), landscape and heritage features (2.64), water management (3.00), fertiliser management (3.37), energy and carbon (2.80) and social capital (2.71).

The soil management is a key element of the FAB-measures, that is influenced by many other elements / spurs, that reach lower levels of sustainability. A principal reason for the high score in soil management goes certainly back to the fact that specific measures of the recent Common Agricultural Policy (CAP) (like Agri environment climate programs, Biodiversity schemes, …) were considered (and financed) aspects of soil management (soil analysis, soil cover, soil erosion, …) adopted by the farmers. In other aspects however (systems diversity, energy, fertiliser and water management, …) this was not always the case. This shows on the one hand the importance of a well-adjusted CAP-framework. On the other hand it demonstrates that many aspects of farming may be positively influenced in future by the implementation of efficient FAB-measures.

Agricultural system diversity plays an important role within the Fabulous Farmers project. Its low sustainability level averaged by all farms signals the need for action in the project. The development under different FAB solutions is shown at the end of the project during the second sustainability assessment.

3.3.2 Spurs per FAB-country

Figure 4 gives an overview of the mean sustainability level in each spur in dependence of the countries. Highest sustainability goals are achieved with soil management in Belgium (4.48) and Luxembourg (4.56), whereas the remaining countries also show high sustainability levels in this spur. Food security and landscape and heritage features, water management and energy and carbon show widest ranges between the countries. Farm business resilience and agri-environmental management are rated similar for all countries.

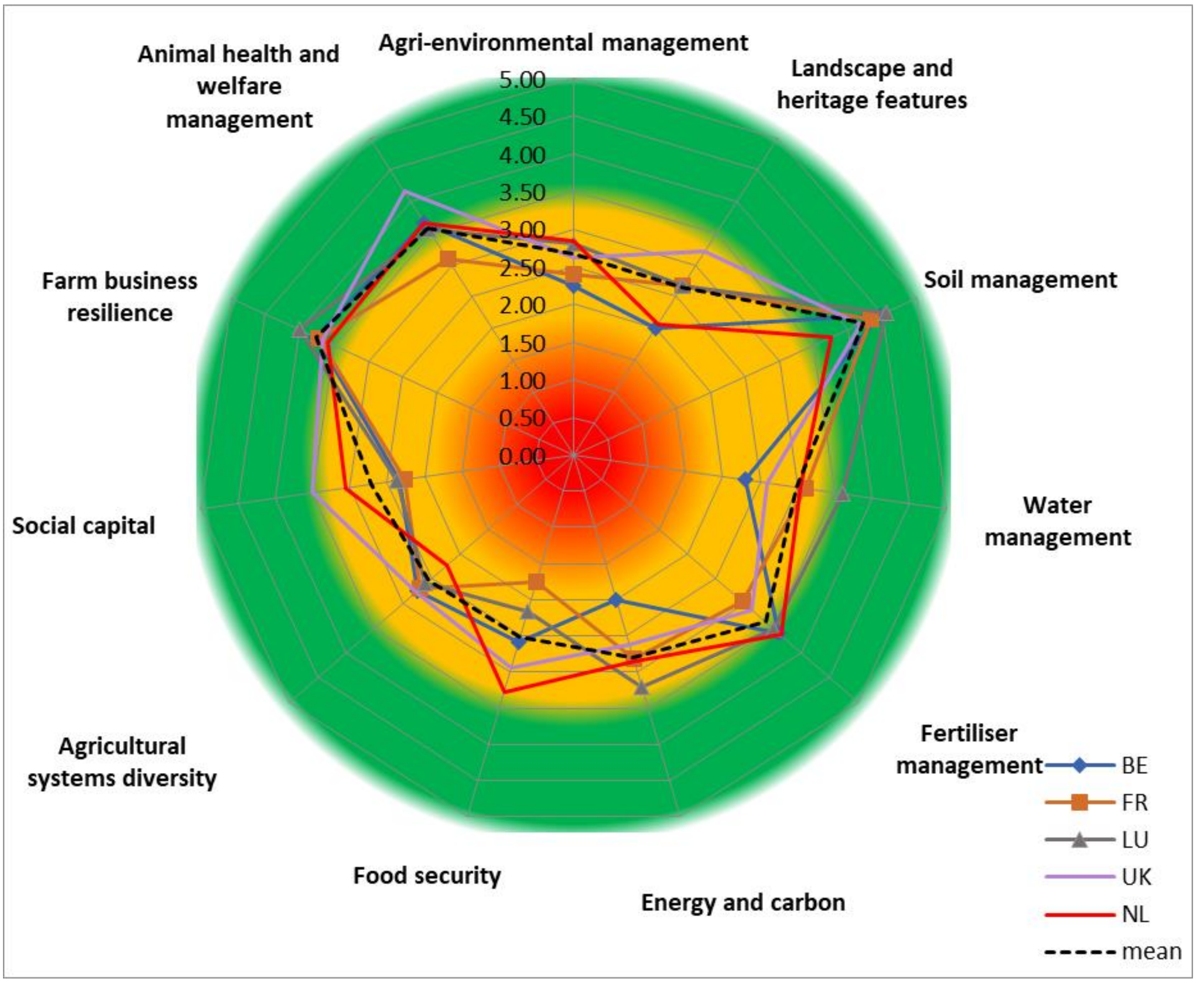

Figure 4: Mean sustainability of all farms in the sample (dotted in black) and mean sustainability level per country for all 11 spurs.

3.3.3 Treatment effects

One of the key aspects of sustainable farming is to drastically reducing the dependence on external inputs, by keeping operating resources (nutrients, etc.) in a closed circle. An important requirement to achieve this is the combination of animal husbandry and arable crops on the same farm (see Figure 5).

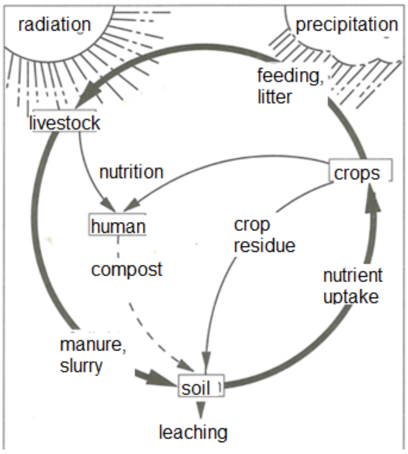

Figure 5: Sustainable farming systems with reduced dependence on external inputs are working with closed resource-circles (modified after Heckman et al., 2009).

On organic farms, this basic principle is usually given and this is confirmed on the two monitored organic farms in the project. In all the spurs, higher sustainability level is reached by organic farms compared to conventional managed farms (see Figure 6). Lowest sustainability goal is found in agricultural system diversity (2.83) for organic farms and in food security for conventional farms (2.51). Landscape heritage features (3.50), soil management (4.40), water management (3.60), farm business resilience (4.00) and animal helath and welfare management (4.00) are set with high sustainability targets by organic farms. Conventional farms show high sustainability levels with soil management and farm business resilience, whereas the first one is of high importance for the project and shows the already good status of the farms within the baseline.

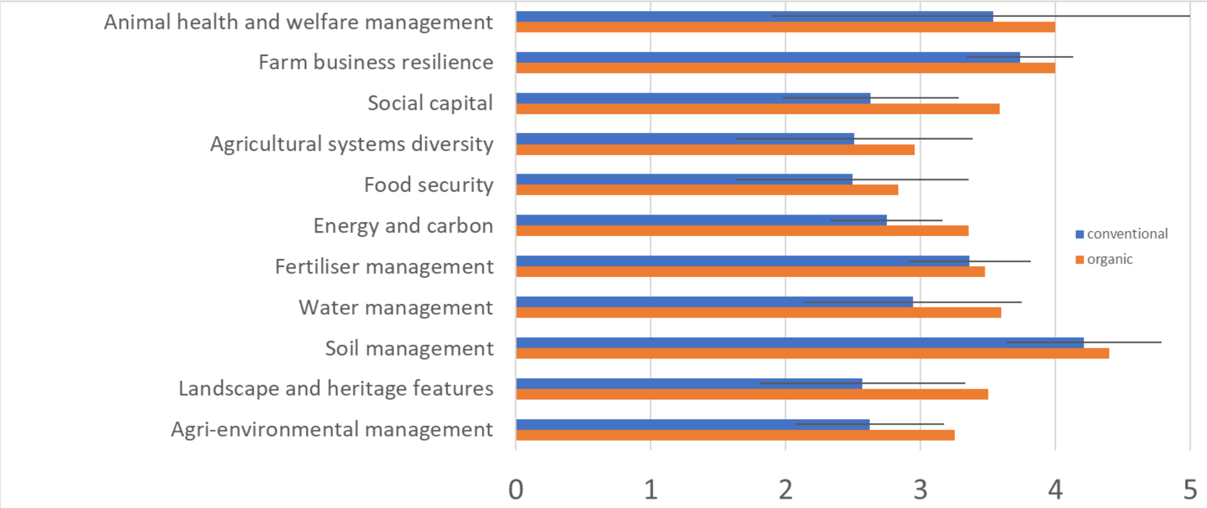

Figure 6: Mean sustainability level and standard deviation for conventional and organically managed farms in each spur.

Focusing on the farm type, farms with livestock tend to have a higher sustainability level regarding soil management (4.36) than farms without livestock (3.79) (see Figure 7). Nevertheless, both farm types have a high sustainability target achievement (>3.5). Water management is less sustainable in both farm types, but with a slight tendency to better management with livestock farms (3.01). Agricultural system diversity as well as agri-environmental management show higher values for farms without livestock (2.67 and 3.00 vs. 2.50 and 2.57).

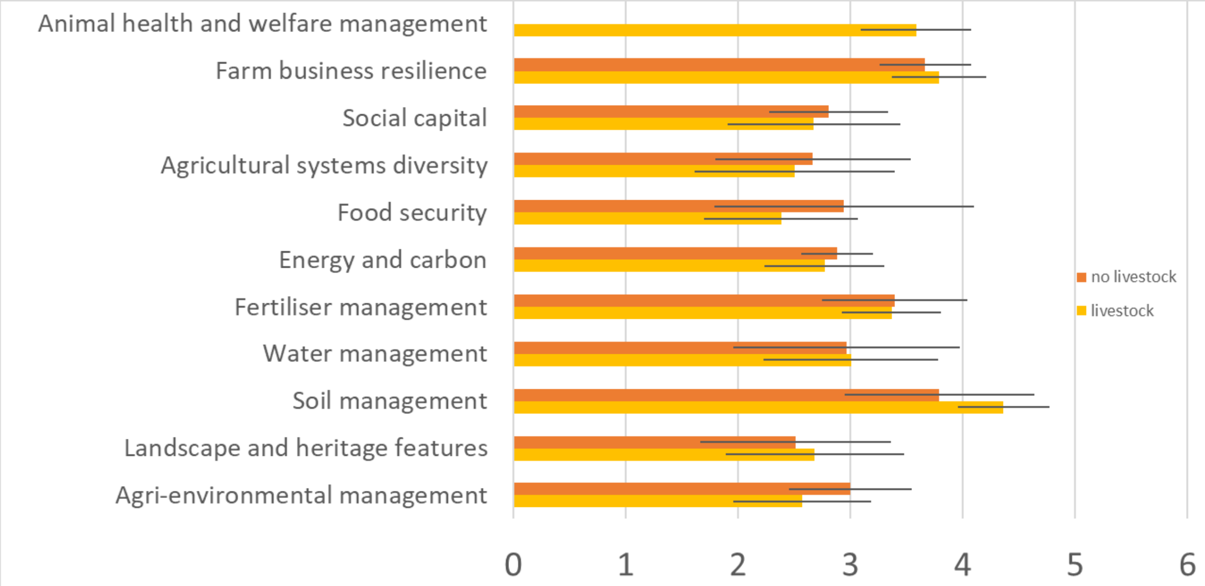

Figure 7: Mean sustainability level and standard deviation for farms with livestock and farms withou livestock in each spur.

To better interprete the tendencies oberserved in each spurs, it is necessary to have a closer look into the single activities of the spurs that are of highest importance in the FABulous Farmers project.

3.4 Activities

The FAB measures that are defined in the FABulous Farmes project are mainly reflected by five of the observed activities in the PG-tool. Agri-environmental management, soil, water and fertiliser management as well as agricultural system diversity are the activities of highest importance in the project.

3.4.1 Agri-environmental management

According to Bullock et al. (2021), changed on-farm practices, especially agri-environmental management, may enhance delivery of multiple services and, ultimately, achieve sustainable farming. The implemented FAB-measures also aim to improve sustainable farming and hence implement functional agrobiodiversity (Figure 1). "Agri-environmental management in Europe involves, in general, agri-environmental schemes by which governments make payments to farmers to encourage them to limit their environmentally-damaging activities, and/or put in place management actions that enhance the farmed environment. While the initial purpose of these schemes was to protect biodiversity, the emphasis has shifted to enhancing ecosystem services" (Bullock et al., 2021). Specific agri-environmental actions can affect individual or multiple ecosystem services. Bullock et al. (2021) pointed for example that wildflower seeding increases crop yields, riparian buffer strips improve water quality, or grassland restoration increases carbon storage, as well as non-cropped field margins can provide natural pest regulation, pollination, carbon sequestration, nutrient cycling, nutrient capture and reduced erosion.

In the PG-tool agri-environmental management is defined by the 6 activities that are agri-environmental participation, rare species, conservation plan of the farm, 3rd party endorsement, habitats and herbicide/pesticide use. The mean sustainability target achievement of all the investigated farms is presented in Figure 8. Worse sustainability level (<1.5) is reached with 3rd party endorsement. The receipt of biodiversity awards or certifications (including awards but excluding certifications such as organic or LEAF) gives a high score with national awards scoring highest of all. Out of the sample, only six farms received a biodiversity award. Five farms in the Netherlands were awarded on national level, while one farm in Belgium was awarded on local level (Figure 8). Another poorly rated category with a sustainability level of 1.8 is the possession of a nature conservation plan. Having a written voluntary conservation plan which is revised and acted on gives the best scores. One farm out of the sample owns a whole farm conservation plan acted on and revised regularly (in Luxembourg). Three farms (in France and the UK) have developed a whole farm plan and three farms in the Netherlands perform IF (Integrated Farming) and are therefore rated with 3 (see Figure 8).

The highest sustainability level was achieved with herbicide and pesticide use (4.2). The less herbicides, insecticides, fungicides or other products are used or the more closely the farmer follows voluntary initiative and advice the more highly they score as these approaches will minimise the impact of pesticides on the wider environment. Farms in the UK reach the highest sustainability level, while farms in Belgium were only rated with a good sustainability level of 2.5 (Figure 8).

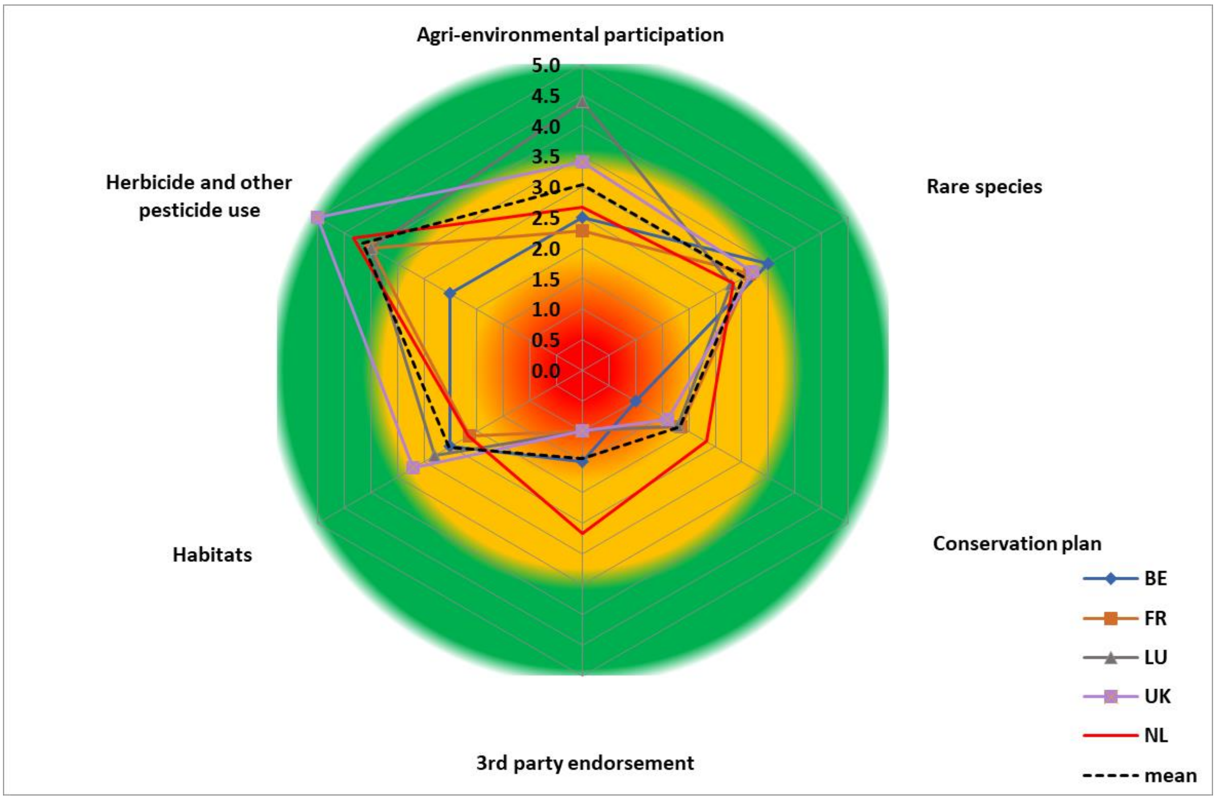

Figure 8: Mean sustainability of all farms in the sample (dotted in black) and mean sustainability level per country for the activities within the agri-environmental management spur.

Focusing on the management type, a tendency to highest achievement of sustainability level is observed with organic farming (5.0) compared to convetnional farming (4.1). The forbidden use of herbicides, insecticides, fungicides or other products contributes to the high scoring. But again, conventional farms were rated with a high level of sustainability within this activity (seeFigure 9). In general, organic farms tend to have higher sustainability levels than conventional managed farms within the agri-environmental management spur, except for the activity of 3rd party endorsement. A tendency to higher sustainability level goes with organic farming in the activity of rare species (4.0). Surveying and monitoring species levels and having a high level of red list species for the region combine to give a high score. Conventional managed farms were only rated with a good sustainability level (3.0).

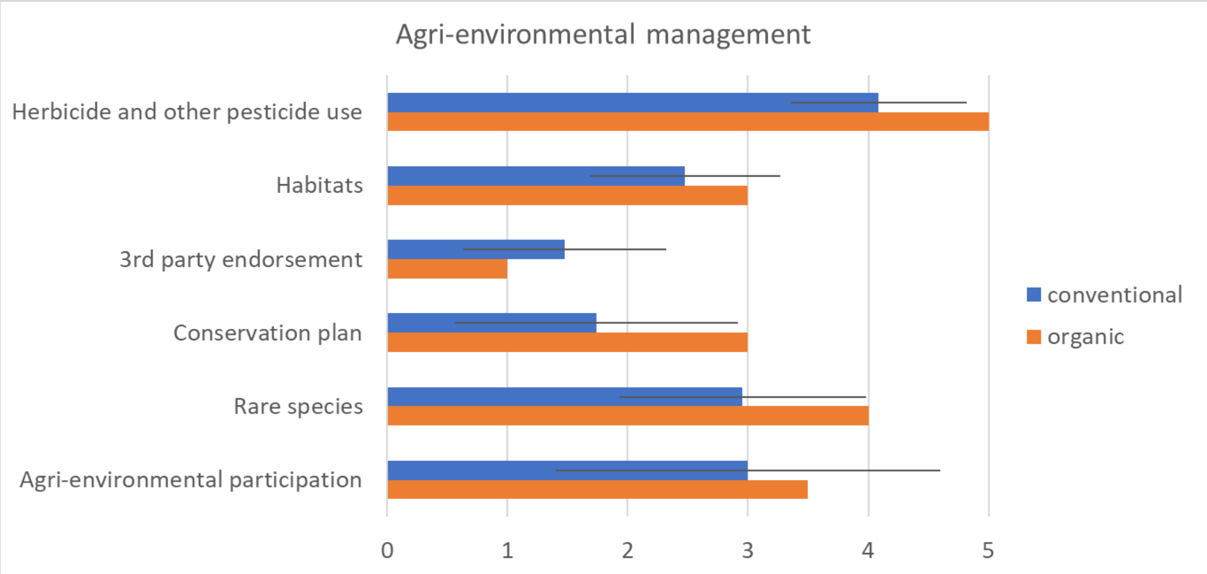

Figure 9: Mean sustainability level and standard deviation (bars) for conventional and organically managed farms for each activity within the spur of agri-environmental management.

The farm type seems to have no influences on the sustainability targets achievements in the activities herbicide/pesticide use and agri-enviornmenal participation (see Figure 10). A slight tendency goes to higher sustainability level with no livestock in the activity of rare species (3.3) than with livestock (2.9). Livestock farms were again rated with a worse sustainability level in reagrd to owning a conservation plan (1.5) and 3rd party endorsement (1.2) compared to livestock farms (3.0 and 2.3).

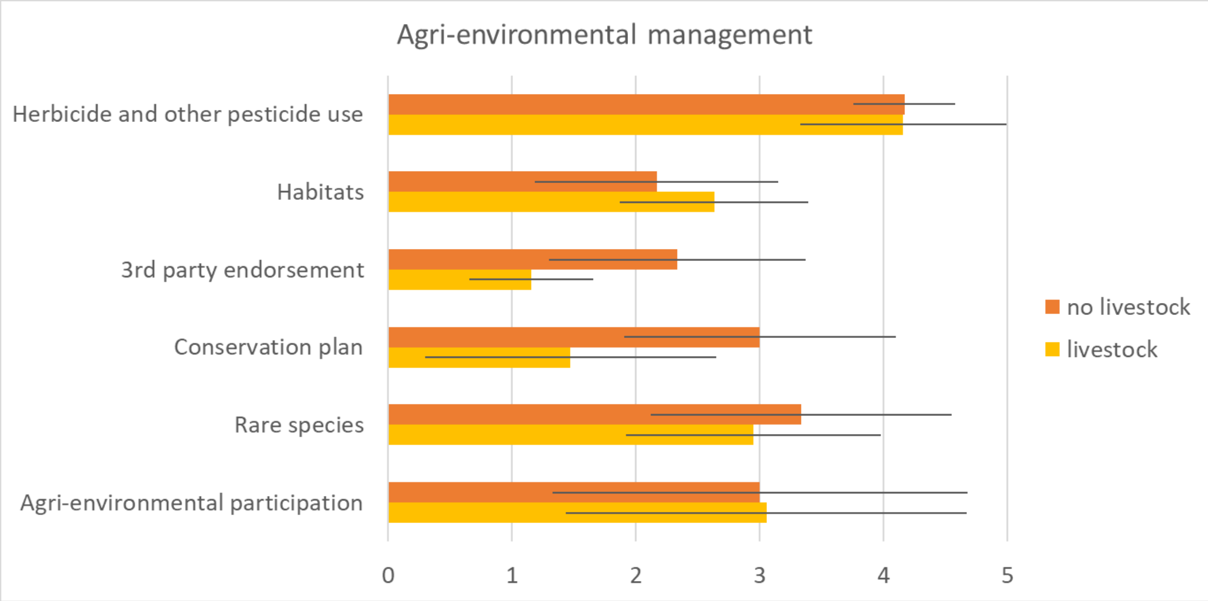

Figure 10: Mean sustainability level and standard deviation (bars) for farms with livestock and no livestock for each activity within the spur of agri-environmental management.

3.4.2 Soil management

Soil management is an integral part of sustainable land management. According to the FAO (2017), "soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity. The balance between the supporting and provisioning services for plant production and the regulating services the soil provides for water quality and availability and for atmospheric greenhouse gas composition is a particular concern".

All the acitvites within soil management are rated with a high level of sustainability of scores greater than 3.5 (Figure 11). Highest level is reached with erosion. This means that the farms investigated are managing almost no agricultural land on areas affected by sheet, wind, gully, rill or other kind of erosion. Soil management that includes covered arable land over winter and cropped arable land (not including pasture) harvested before the 1st of October, is rated with a very high sustainability level of 4.6 for all the farms. Measures taken to reduce the risk of erosion are summarized within the cultivation activity. Here, highest variances can be observed between the participating countries with ratings of 2.0 for the Netherlands and 4.6 for Luxembourg.

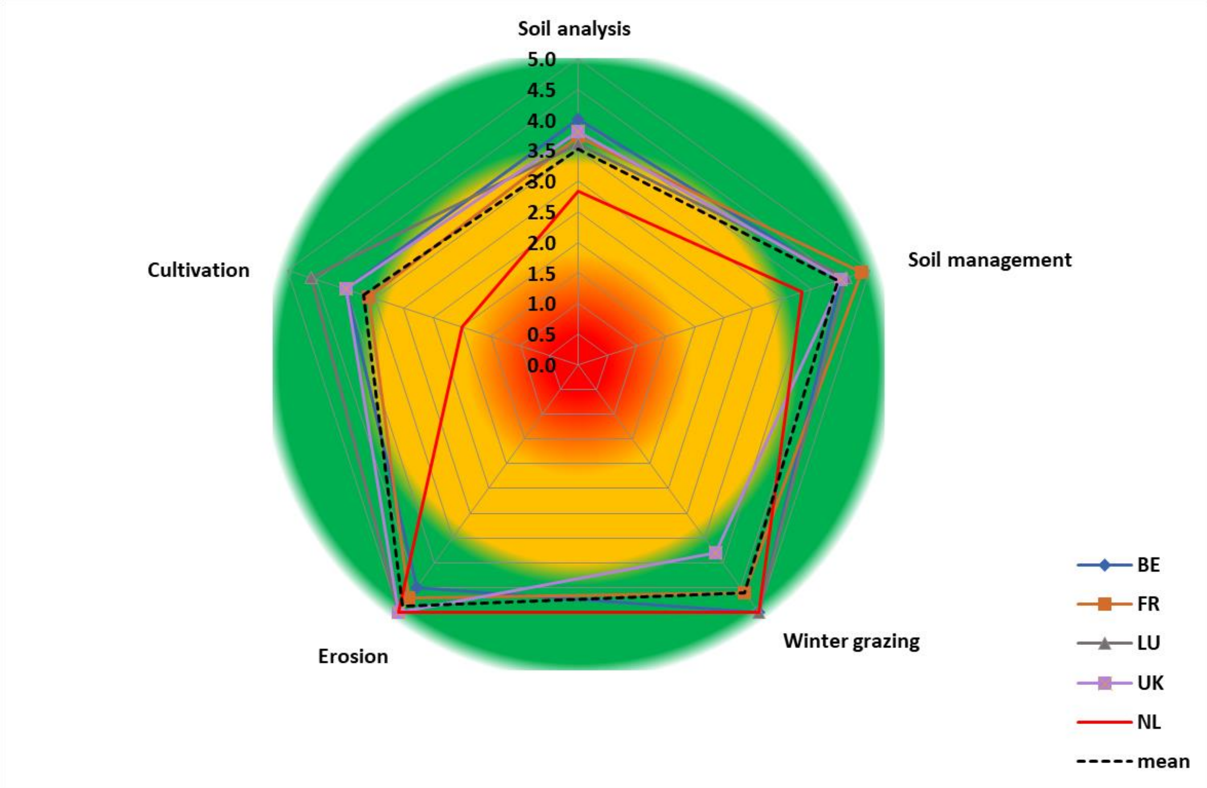

Figure 11: Mean sustainability of all farms in the sample (dotted in black) and mean sustainability level per country for the activities within the soil management spur.

Conventional managed farms tend to have slightly higher sustainability levels with not performed winter grazing (4.6) and soil management that includes covered arable land over winter and cropped arable land (not including pasture) harvested before the 1st of October (4.5). The other way round, organic tend to undertake soil analysis and improve soil organic matter in a better way (4.0) (seeFigure 12).

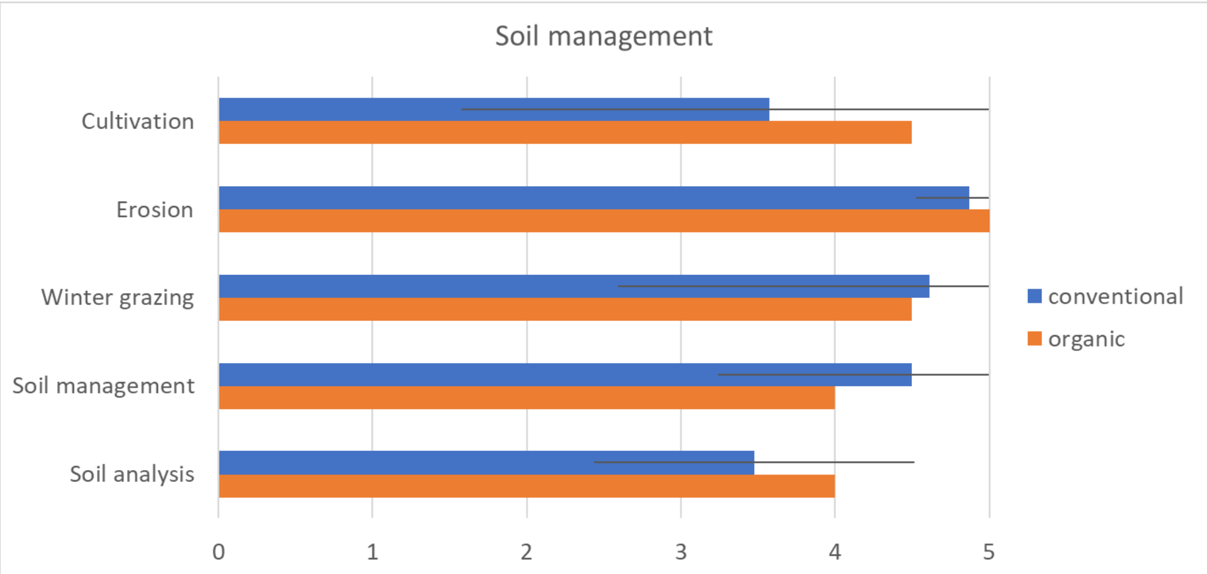

Figure 12: Mean sustainability level and standard deviation (bars) for conventional and organically managed farms for each activity within the spur of soil management.

Focusing on the farm type, livestock farms reach a high level of sustainability in all the soil management activities (>3.5), while farms without livestock showed only good level of sustainability (>2.5) with soil analysis and cultivation (Figure 13). A tendency to much higher sustainability levels of livestock farms can be observed with cultivation (4.0) and soil analysis (3.7) compared to farms with no livestock (2.8 and 2.8). Winter grazing is not performed with no livestock farms, since there is no animal husbandry on the farms.

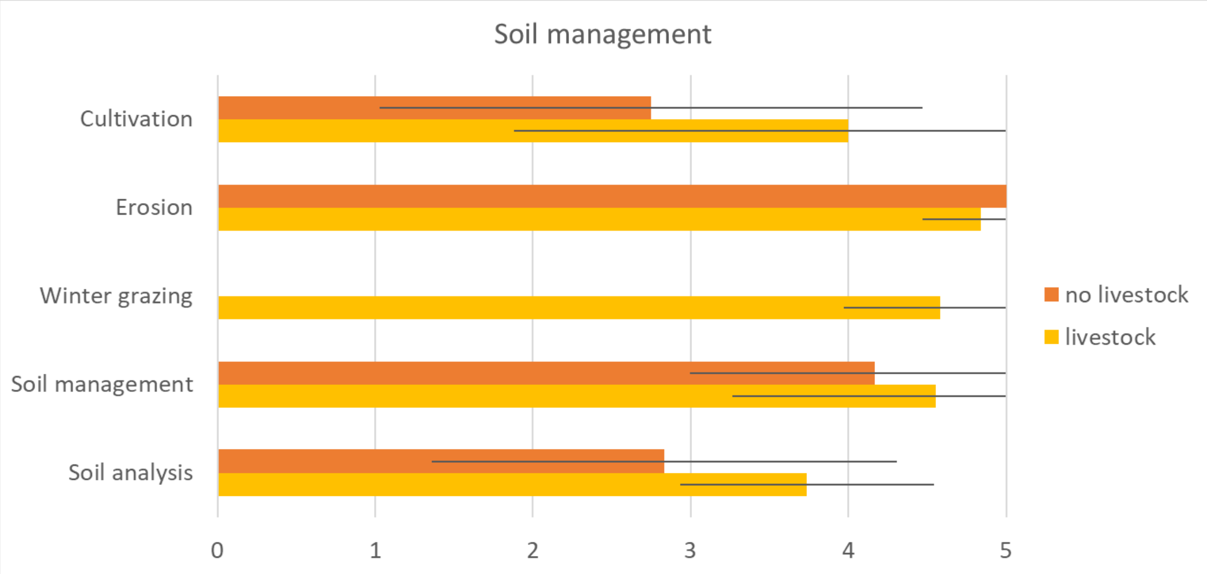

Figure 13: Mean sustainability level and standard deviation (bars) for farms with livestock and no livestock for each activity within the spur of soil management.

3.4.3 Water management

"Sustainable water management means using water in a way that meets current, ecological, social, and economic needs without compromising the ability to meet those needs in the future. It requires water managers to look beyond jurisdictional boundaries and their immediate supply operations, managing water collaboratively while seeking resilient regional solutions that minimize risks" (Water Foundation, 2020).

The sustainability levels reached within the water management spur are distributed very heterogenous (Figure 14). Highest level of all farms on average are gained with crop irrigation (4.7), that is defined by the score in relation to implementation of efficiency options and audit of the systems applied. A worse sustainability level (2.0) is reached with the presence of a water management plan and its actions taken. In the latter, the range between countries is very large with Belgium and the UK (both rated with 1.0), where the farms do not have a water management plan up to 3.5 with Luxembourg. In sum, five of the investigated farms completed a water audit/management plan and are acting fully on it.

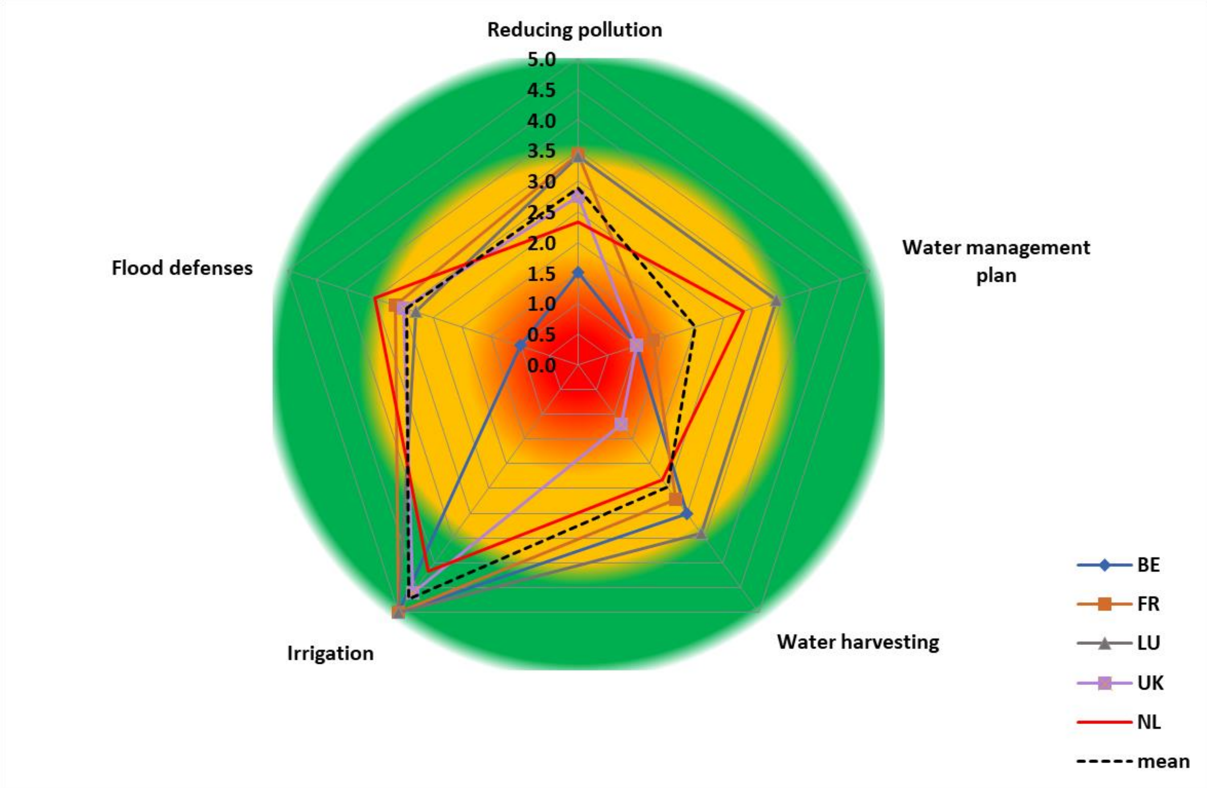

Figure 14: Mean sustainability of all farms in the sample (dotted in black) and mean sustainability level per country for the activities within the water management spur.

Organic farms tend to implement measures to minimise water pollution and maximise water efficiency in a more sustainable way. High intensity actions are being taken, e.g. by planting and maintaining riparian/buffer strips that score the level of 5.0 (see Figure 15). Conventional farms on the other hand are scored on average with 2.8 meaning that medium intensity actions are being taken, e.g. by non inversion tillage or contour ploughing. Flood defenses and runoff prevention is higher scored with organic (4.0) than conventional (2.9) farming.

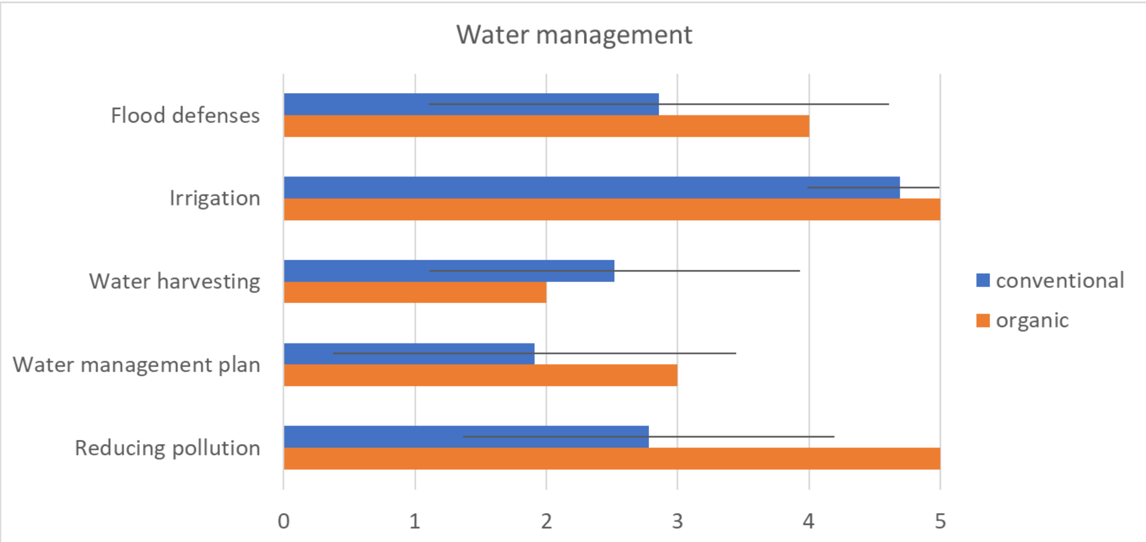

Figure 15: Mean sustainability level and standard deviation (bars) for conventional and organically managed farms for each activity within the spur of water management.

Having a look at the differences with farm type (Figure 16), the presence of a water management plan and water harvesting are the activities the worst rated for both types. Water harvesting includes the amount of recycled water used as well as the amount of harvested rainwater. With the latter, livestock farms show a slightly higher sustainability level (2.6) than farms without livestock (2.2). Highest levels of sustainability are reached within this spur with irrigation for farms without livestock (4.8) and with livestock (4.7). A very good irrigation management can hence be observed in both the categories.

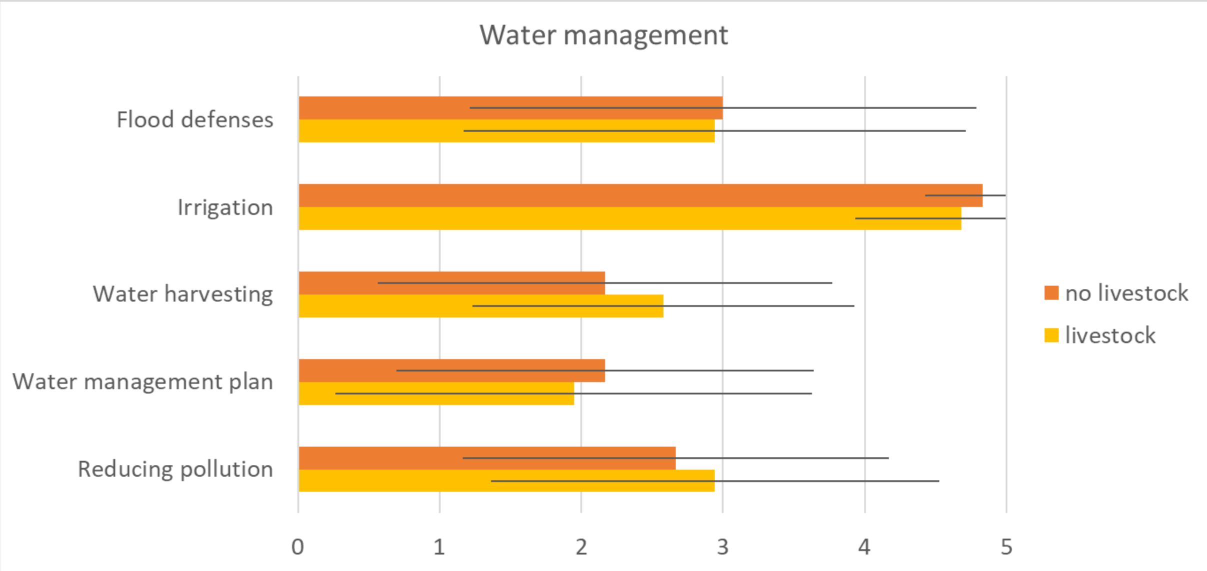

Figure 16: Mean sustainability level and standard deviation (bars) for farms with livestock and no livestock for each activity within the spur of water management.

3.4.4 Fertiliser management

Fertilizers provide crops with nutrients like nitrogen, potassium or phosphorus which allow crops to improve in yields. The CAP is the key tool in supporting the sustainable use of fertilisers in agriculture, ensuring that farmers can maintain productivity while also reducing the harmful effects of fertilization (European Commission, 2022). A sustainable fertiliser management is essential for a sustainable farming system (see Figure 5). A high level of sustainability for all the farms is found with the activity of fertiliser management and application (4.0). This includes how often fertiliser spreaders are inspected and maintained, how regularly are fertiliser application rates checked during the growing / spreading season as well as at what times of a year manufactured nitrogen fertilisers are spread. The activity of NPK balance is scored with worse level of sustainability for all the farms (2.0). The ideal surplus for N should be around 30 kg N/ha/year. Surpluses significantly greater than 30 kg N/ha/year may indicate that the farm is at pollution risk. Phosphorus should show a surplus of close to zero, long term depletion of P and K should be avoided where possible. Potassium should show a surplus of close to zero, long term depletion of P and K should be avoided where possible.

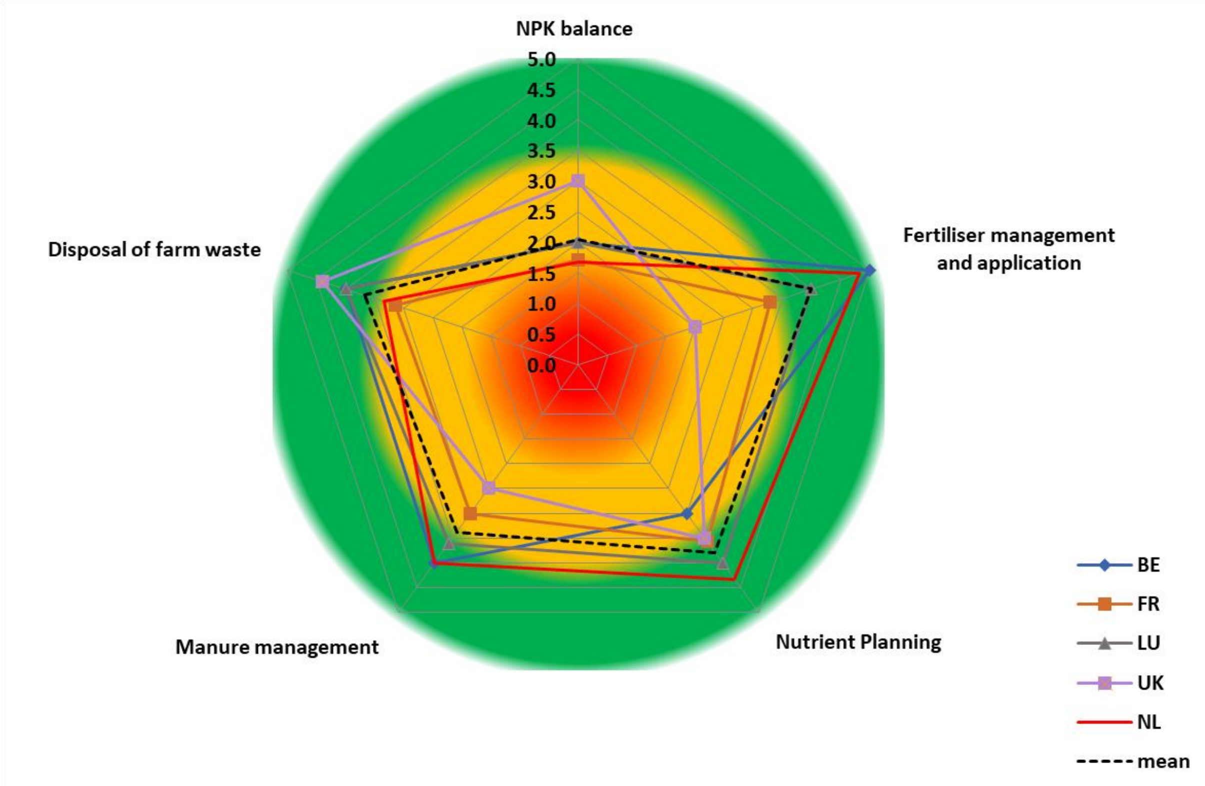

Figure 17: Mean sustainability of all farms in the sample (dotted in black) and mean sustainability level per country for the activities within the fertiliser management spur.

Differences in management type could be observed with advantages to organic farming with disposal of farm waste (5.0) and fertiliser application (5.0). (see Figure 18). The first activity mentioned includes the percentage of recycled farm waste, dispose of unused/unwanted medicines and the presence of a written waste strategy. Nutrient planning tends to be more sustainable with conventional farming (3.9). This activity is rated by the determination the level of nutrient application for crops, the regularlity of monitor/record levels of major nutrients (eg: P, K, Mg, C, S) in the soil as well as the farmers knowledge of the N,P, K content of organic manures/composts applied.

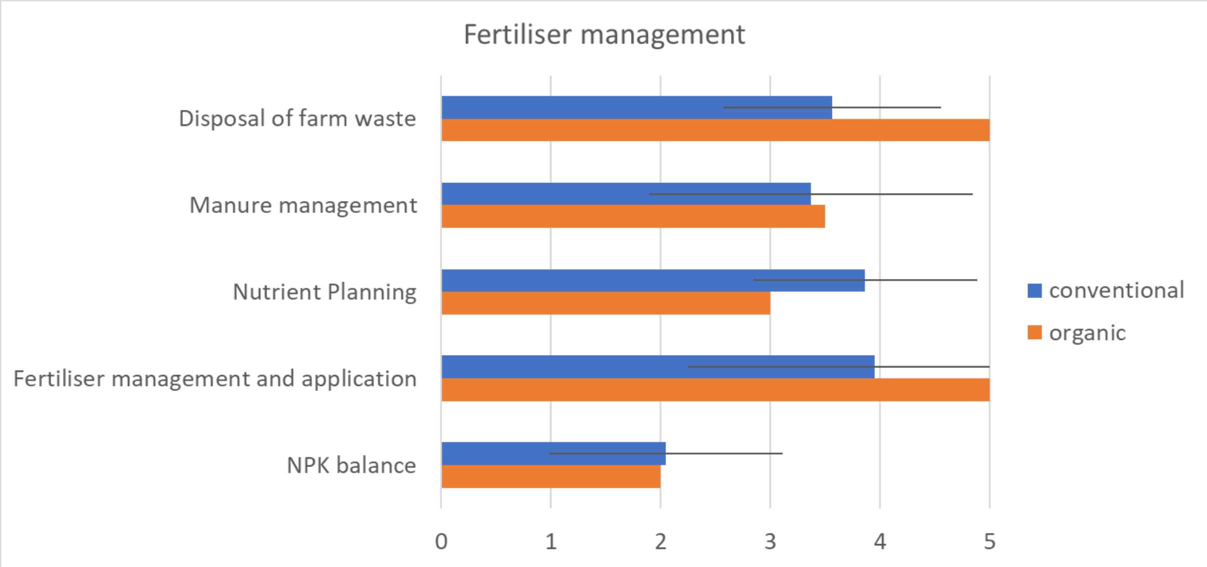

Figure 18: Mean sustainability level and standard deviation (bars) for conventional and organically managed farms for each activity within the spur of fertiliser management.

Fertiliser management is done nearly similar on livestock and no livestock farms, since the sustainability levels of both do not differ significantly in the investigated avtivities (Figure 19). Except manure management, that tends to be more sustainable with farms without livestock (4.0) than livestock farms (3.3). Manure management includes factors regarding manure storage (e.g. kind and condition of manure and slurry storage) and manure application (e.g. spreading and incorporating times).

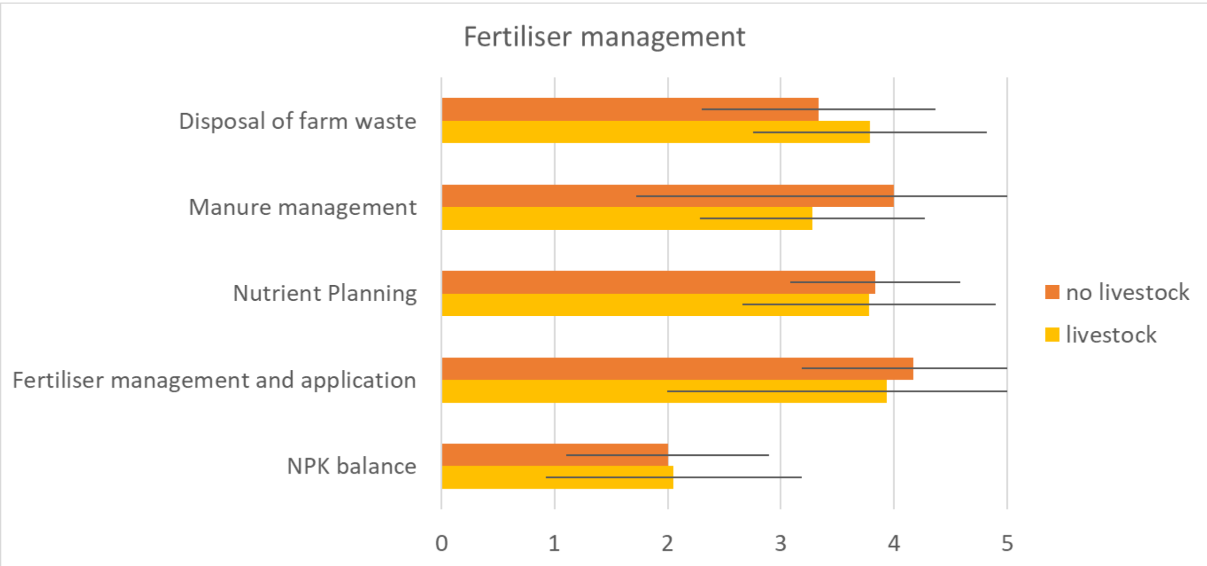

Figure 19: Mean sustainability level and standard deviation (bars) for farms with livestock and no livestock for each activity within the spur of fertiliser management.

3.4.5 Agricultural system diversity

The diversity of an agricultural system includes livestock as well as cropland. The number of outlets the produces are marked through as well as the presence of on-farm processing are additionally counted in the diversity spur within the PG-tool.

Figure 20 shows the average sustainability levels of the observed farms for each activity in the spur of agricultural systems diversity. A good level of sustainability which is in the yellow range is reached with marketing, the number of outlets produces are market, (3.1) and cropland diversity (3.0), the number of species/varieties a farmer grows in total. A worse sustainability is observed with on-farm processing (1.6). Livestock diversity, how diverse is the livestock system on the farm with regard to numbers of breeds/crossbreeds, is rated on average with 2.4

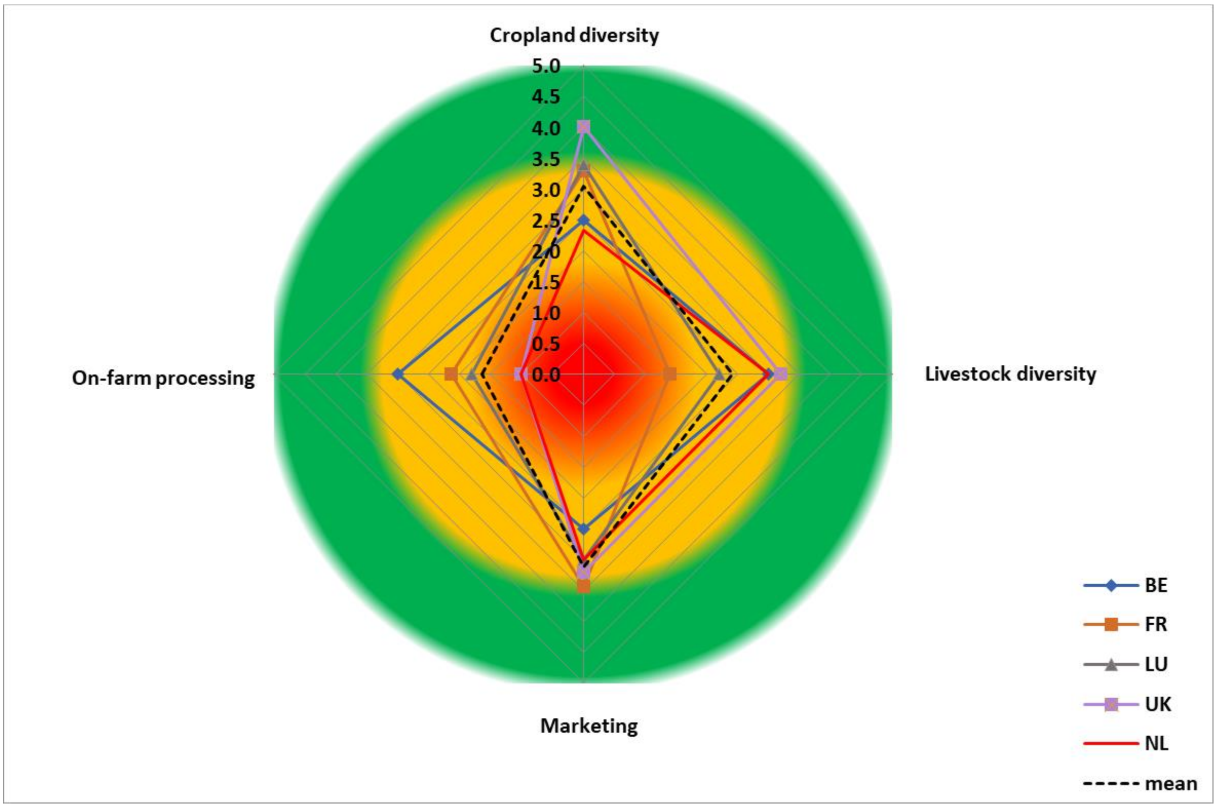

Figure 20: Mean sustainability of all farms in the sample (dotted in black) and mean sustainability level per country for the activities within the agricultural system diversity spur.

Focusing on management type, highest level of sustianability are found with crop diversity and marketing on organic farms (4.0) (see Figure 21). On-farm processing is again rated poorly in both the categories but on a slightly higher level for conventional farming (1.7).

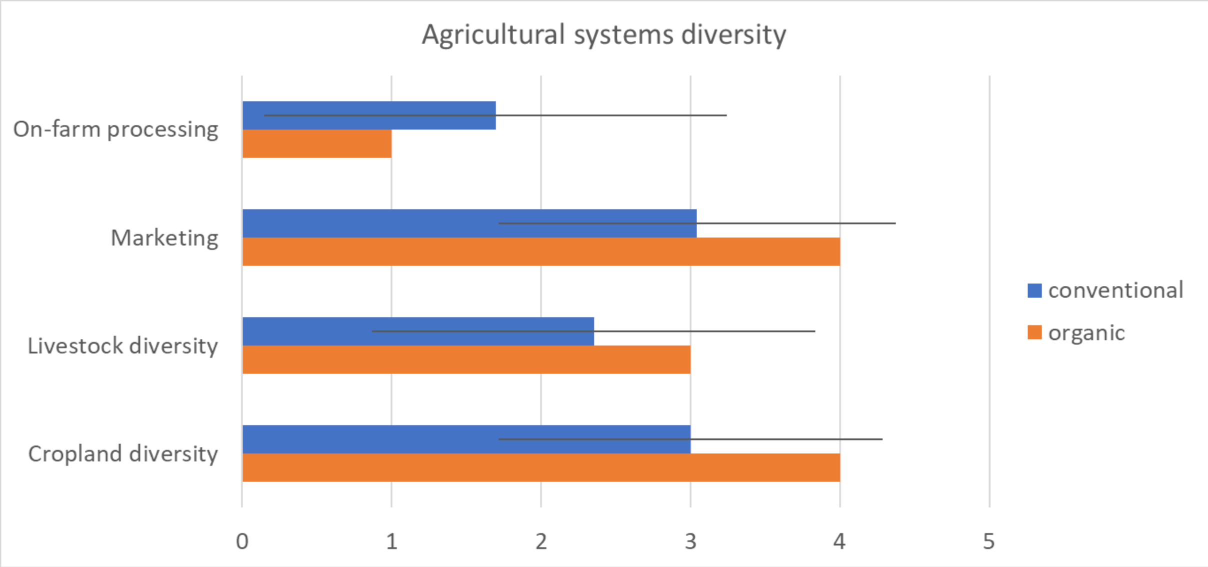

Figure 21: Mean sustainability level and standard deviation (bars) for conventional and organically managed farms for each activity within the spur of agricultural system diversity.

The farm types seems to have no significant differences on the acitvities within the agricultural systems diversity, since both the categories are rated similar (see Figure 22).

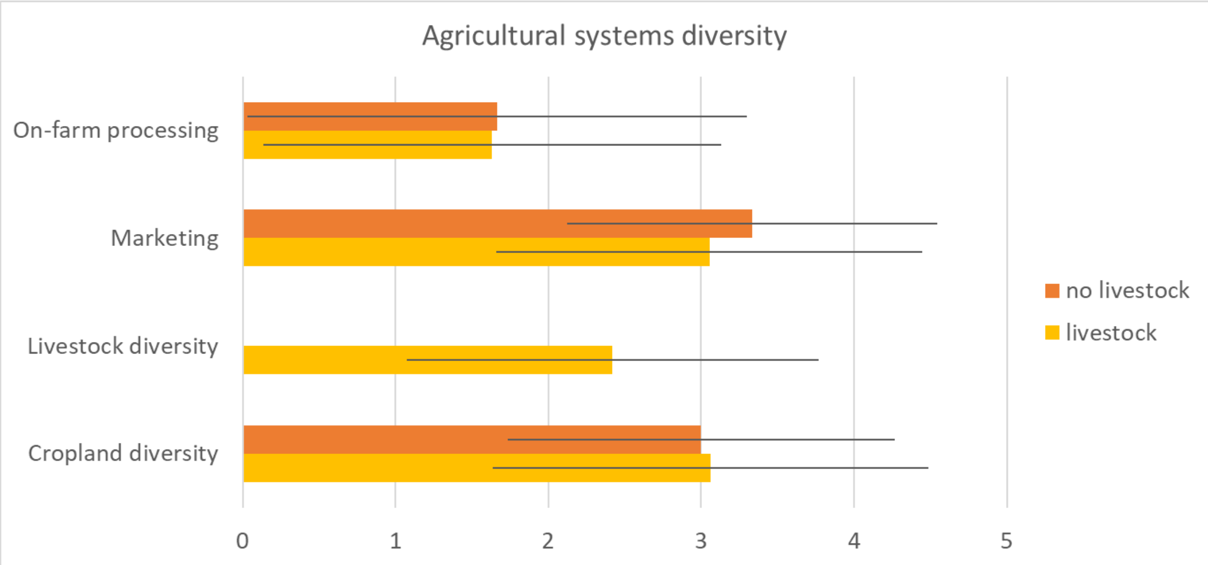

Figure 22: Mean sustainability level and standard deviation (bars) for farms with livestock and no livestock for each activity within the spur of agricultural system diversity.

4 Conclusion and outlook

The baseline of the sustainability assessed farms for the year 2018 shows already a good sustainability goal achievement in all the countries and for all treatment categories. The sample is already good distributed along the categories of animal husbandry. The small number of organic managed farms in the sample makes it difficult to draw clear conclusions regarding differences to conventional management but shows tendencies to higher sustainability levels.

Soil management showed already high sustainability ratings with potential to higher levels regarding soil analysis and cultivation. Here, the regularity of undertaking soil analysis and the improvement of soil organic matter as well as the implementation of measures taken to reduce the risk of erosion could increase the sustainability level.

The poorly performed spur of agri-environmental management requires room for action. This is where FAB-measures and actions can be taken to increase the achievement of the sustainability objectives.

Focusing on water management, improvements can be done with harvesting more rainwater and using recycled water during the daily farming. A water management plan will help implementing these actions and resulting in a higher sustainability level for the farms. The medium rated spur of agricultural systems diversity should be focused on in further communication mediums with the farmers. Increasing cropland and livestock diversity leads higher sustainability levels. Strategies for enhancing agricultural system diversity may be the diversification of the farm by including more species of crops and livestock, by using legume-based crop rotations and mixed pastures, intercropping or annual crops as well as mixed varieties of the same crop.

The baseline of the sustainability assessment within the FAB Farmers project region shows the current status of the farms in the year 2018. The FAB-measures and actions taken within the four years project timeframe are tried to be monitored with the second PG-tool analysis. This analysis will take place at the end of the project in 2022 with the reference year of 2021. All the investigated farms will be assessed again to monitor effects of implemented measures. The comparison of the final years results with the baseline report will show if differences between the years investigated are displayable and if the implemented measures could improve the levels of sustainability, at least in a few actions.

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