MIXED

EFFICIENT AND RESILIENT
MIXED FARMING & AGROFORESTRY

MIXED	
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Main authors:	Werner Zollitsch (BOKU), Francesco Accatino (INRAE), Anne Grete Kongsted (AU), Christina Marley (ABER), Guillaume Martin (INRAE), Miranda Meuwissen (WU), Simon Moakes (FIBL), Lisbeth Mogensen (AU), Jaroslaw Stalenga (IUNG-PIP), Kairsty Topp (SRUC), Christine Watson (SRUC)
Internal reviewers:	Christine Watson (SRUC), Cláudia Marques dos Santos Cordovil (ISA/ULisboa)
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Executive Summary

The aim of Task 2.2 was to collect and discuss indicators of resilience and efficiency at the farm level. These indicators were to be compiled in this handbook for use in Task 2.3 and for work in several other work packages.
In an iterative process, a list of indicators and data collection points were defined, which contain basic agronomic and environmental indicators, and indicators developed to measure integration from the point of view of the farming system. Indicators are both qualitative and quantitative and should be interpreted as summary measures which combine different types of information. If data needed for the calculation of indicators is not available at farm level, complementary data will be taken from data bases.
Not all indicators listed in the handbook will necessarily be used in the farm data collection. The list will be refined based on the developing needs of the WPs and networks as they are established. The indicators and data collection points described herein address soil, crop, livestock, environmental impacts, economics, social aspects, the position of farmers in respective value chains, efficiency, and resilience of MIFAS.

Abbreviations

AU	Annual Family workforce Unit
AWU	Annual Workforce Unit
CDI	Crop Diversity Index
D	Deliverable
DM	Dry Matter
EC	European Commission
GDPR	General Data Protection Regulation
GE	Gross Energy
GIS	Geographic(al) Information System
LU	Livestock Unit
MIFAS	Mixed Farming and Agroforestry System(s)
NE	Net Energy
NRE	Non-Renewable Energy
UAA	Utilised Agricultural Area
WP	Work Package

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1 Introduction

The aim of Task 2.2 (Work package 2, *Co-design and evaluation of farm systems for efficiency and resilience*) was to collect and discuss indicators of resilience and efficiency at the farm level. The indicators agreed on by the partners involved were to be compiled in this handbook for use in Task 2.3 (mainly 2.3a, *Farm management data collection and collation*) and 2.4 (*Field testing strategies for increased integration*).

The collection and critical review of potential indicators was conducted by a multidisciplinary expert group in which the relevant expertise was represented. The members of the expert group acted as the main authors of this handbook (names in alphabetical order below). All those involved have extensive experience of working in multidisciplinary projects on farming systems at a European level. At several points in the process of collection and revision of indicators, these experts were supported by experienced members of their research groups as appropriate.

- Francesco Accatino: Researcher at INRA and expert in agro-ecology, environmental modelling and sustainability assessment. He works on modelling and analyzes trade-offs and synergies between the different dimensions of sustainability. He develops models for optimizing land use in terms of agricultural production and other ecosystem services.
- Anne Grete Kongsted: Senior scientist at Aarhus University, Dept. Agroecology (AU-AGRO) with large experience in research on free-range pig production systems with a focus on improving animal benefits, nutrient recycling and resource-efficiency through implementation of integrated agroforestry- and mobile concepts. She has extensive experience in coordinating cross-disciplinary projects with a strong stakeholder involvement.
- Christina Marley: Researcher and lecturer at Aberystwyth University, Dept. of Biological, Environmental and Rural Sciences. Her expertise includes the optimisation of nutrient use from soil to animal products within ruminant livestock systems to reduce reliance on imported feeds and fertilisers and the use of nutrition to improve animal health.
- Guillaume Martin: Researcher and leader of one of the five scientific challenges of the Environment and Agronomy division of INRAE, focusing on the design and evaluation of sustainable farming systems. With a background in agronomy and modelling, his main expertise is in the development of participatory and model-based methods for the analysis and design of agroecological crop-livestock farms.
- Miranda Meuwissen: Professor of Risk Management in Food and Agri-Supply Chains at Wageningen University, Dept. of Social Sciences. She is an expert in risk modelling, teaches finance and risk management internationally, and is senior scientist of Wageningen Graduate School of Social Sciences (WASS). She is highly experienced in dealing with multi-actor environments.
- Simon Moakes: Farm system researcher, formerly in the socio-economic team at the Research Institute of Organic Agriculture (FiBL), Switzerland. Moved to the University of Aberystwyth, Institute of Biological, Environmental and Rural Sciences in 2022. With a broad background in sustainable agriculture, he is an expert in modelling and the integrative assessment of economic and environmental impacts of current and potential agricultural systems.
- Lisbeth Mogensen: Associate Professor at Aarhus University, Dept. of Agroecology (AU-AGRO). She has more than 20 years' experience with farming systems research, particularly the development of organic livestock farming systems, using experiments conducted on private farms and modelling. She also has extensive experience in estimating the environmental impact of food and farming systems, including identification of hotspots and potential mitigation options.
- Jaroslaw Stalenga: Senior scientist at the State Research Institute of Soil Science and Plant Cultivation (IUNG-PIB), Poland. With a background in Agronomy, his scientific expertise focuses on analysis of different farming systems; issues covered include nutrient

management, wheat variety testing, CAP policy, farmland biodiversity and crop quality in organic farming.

- Kairsty Topp: Agricultural systems modeller at Scotland's Rural College (SRUC). She has a background in agriculture and its interaction with climate and in mathematical modelling. Her expertise includes the synthesis and analysis of data and information from cropping and livestock systems and, particularly, the impact of agricultural systems on the environment and their integration into economic and social models of farming systems.
- Christine Watson: Professor of Agricultural Systems at Scotland's Rural College (SRUC). She is a soil scientist with extensive experience in soil and nutrient management in organic and conventional farming systems. She works in crop and livestock-based systems across Europe.
- Werner Zollitsch: Professor for Sustainability of Livestock Production Systems at University of Natural Resources and Life Sciences, Vienna (BOKU), Dept. of Sustainable Agricultural Systems. With an animal nutrition background, he is a specialist in sustainability of livestock production systems and in organic livestock production.

We collected a first list of indicators among the authors, which included information from reviews of the outcomes of other projects (e.g. A Review of Farm Level Indicators of Sustainability with a Focus on CAP and FADN, FLINT; Steering Animal Production Systems towards a Sustainable Future, AnimalFuture; Legume-supported cropping systems for Europe, Legume Futures; Legumes Translated – Translating knowledge for legume-based farming for feed and food systems; Redesigning European cropping systems based on species MIXtures, ReMIX; Sustainable Resilient EU Farming Systems, SURE Farm). This first draft was discussed and refined in several rounds both inside WP2 and with the leaders and other partners responsible for project activities related to the calculation of indicators in other WPs. In an iterative process, the indicators initially suggested, were prioritized according to

i) their relevance for efficiency and resilience of MIFAS and
ii) the needs of project partners.

We additionally tried to include the perspective of network coordinators and farmers about indicators by asking the following questions:

i) Will data be available for indicator calculation (i.e. will farmers have access to this type of information or will it be possible within the available resources to collect the data in the course of the project)?
ii) Will network coordinators and/or farmers be interested in the information provided with the assessed indicators?
iii) What can the network/coordinators/farmers use this type of information for (benchmarking, development of MIFAS, etc.)?

The proposed list of indicators presented in the handbook includes basic agronomic and environmental indicators, and indicators developed to measure integration from the point of view of the farming system. Indicators are both qualitative and quantitative and should be interpreted as summary measures which combine different types of information. In the process of developing the list of indicators, two limitations were identified:

i) Not all data needed for the calculation of indicators will be available at farm level and it is accepted it may not be available for all farms. In this case, farm data will be complemented by data available in standard data bases. Information from data bases will be selected by persons who have a sound knowledge of the respective MIFAS or farming system and the regional conditions which will be important in determining the representativity of data taken from data bases.
ii) Not all indicators listed in the handbook will necessarily be included in the actual farm data collection. It was always accepted that there would be a need for pragmatic selection of a final set of indicators dependent on the needs of the WPs and the developing networks as they emerge through the establishment stage of the project.

In the process of identifying indicators, several indicators were suggested which address actors in the value chain other than farmers and their sphere of activity. Some of these indicators are not included in this handbook, for others the information necessary for their calculation may not be available in sufficient quality at the farm level. This has to be taken into account when planning and implementing the actual data collection process.

The selected indicators are presented in Chapter 2 and in sub-chapters which mirror the aspects addressed in a MIFAS context.

2 Suggested indicators for efficiency and resilience

The following sub-chapters contain i) the indicators which are suggested for characterising efficiency and resilience of MIFAS at farm level and ii) the farm data to be collected for the calculation of the indicators. Both data and indicators shall address the MIFAS level; however, in cases where the MIFAS is one component integrated within the overall farm, it may be not meaningful to differentiate between MIFAS and farm level. In such cases, data will be collected at, and indicators will address, the farm level.
It is suggested that the indicators and hence the data they are based on should represent the respective traits over a time period of about 3 years in order to avoid a bias due to, e.g., particularly dry or wet, cold or warm years, etc. In many cases data will not be available for a sequence of several years. In such cases it is suggested that data is collected for a particular year, but the representativity of that collected data for the MIFAS is discussed and confirmed with farmers, network coordinators or scientists familiar with the respective MIFAS or farming system in the region.
The indicators and farm data connected to them will be structured according to the different elements of MIFAS (e.g., soil, crop, livestock, economics, etc.), which will be covered in different sub-chapters.
To allow for a quick and broad overview of the MIFAS (farm) type and as a start on the process of collecting information, the MIFAS (farm) should be first characterised by the following two categories:

- Farm type according to relative share of income from products (in the order from highest to lowest); e.g. dairy – lambs – wheat.
- Proportion of UAA owned vs. rented

2.1 Soil indicators

Table 1 contains a list of suggested indicators for MIFAS-relevant soil characteristics and the data these are based on.

Table 2. Indicators for soil characteristics and soil data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	Total nitrogen	mg/kg	N content (DUMAS or Kjeldahl)	
2	Organic matter content	%	Loss on ignition	Calculated from organic C
3	Available nitrogen supply	%	Potentially mineralizable N	
4	Soil texture	categorical	Type of soil (estimated); from FAO soil maps and database	Proportion of sand, silt and clay to be derived by expert depending on soil type
5	Soil erosion risks	% UAA	Total UAA, ha; fallow soil during winter, ha	
6	Farm slope angle	degree	Average slope of farmland	
7	Soil pH		pH, H_2O	If <5, it may be necessary to calculate Al and other metals contents. pH correction to be calculated when applicable
8	Mn content	mg/kg	Mn content	When pH <5

2.2 Crop indicators

Table 2 contains a list of suggested indicators for MIFAS-relevant crop (including grassland) characteristics and the data these are based on.

Table 2. Indicators for characteristics and data needed from crop production at crop (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	Nutrient recommendation	kg/ha per nutrient	Total nutrition needs for the crop, according to local standard recommendations available	Per crop type
2	Mineral N input	kg/ha	Total UAA and by crop, ha; kg mineral N applied & type of fertilizer	# = to be collected for each type of crop
3	Organic N input	kg/ha	Total UAA and by crop, ha; tonnes or m^3 of slurry/manure	# = to be collected for each type of crop; separately for on farm and imported organic N input; kg organic N applied calculated from collected data
4	Total N input	kg/ha	none; sum of above	
5	Mineral P input	kg/ha	Total UAA and by crop, ha; kg mineral P applied & type of fertilizer	# = to be collected for each type of crop
6	Organic P input	kg/ha	Total UAA and by crop, ha; tonnes or m^3 of slurry/manure	# = to be collected for each type of crop; separately for on farm and imported organic P input; kg organic P applied calculated from collected data
7	Total P input	kg/ha	none; sum of above	
8	Mineral K input	kg/ha	Total UAA, ha; kg mineral K applied & type of fertilizer	# = to be collected for each type of crop
9	Organic K input	kg/ha	Total UAA, ha; tonnes or m^3 of slurry/manure	# = to be collected for each type of crop; separately for on farm and imported organic K input; kg organic K applied calculated from collected data
10	Total K input	kg/ha	none; sum of above	
11	Agrochemical use	kg per year	Type (active ingredient rather than product name) and quantity used	Specify per pesticide, fungicide, etc. if feasible
12	Irrigation	yes / no	If yes, quantity used per year	
13	Irrigation type	categorical	Type of irrigation device used	Drip, sprinkler, pivot, etc
14	Output crop #	kg DM/ha	UAA cultivated with crop #, ha; crop yield, kg	# = to be collected for each type of crop

Table 2 (contd.). Indicators for characteristics and data needed from crop production at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
15	Output by-product A	kg DM/ha	UAA cultivated with crop #, ha; yield of by-product A, kg	# = to be collected for each type of crop; by-product including cultural residues
16	N-output crop #	kg N/ha	None (yield from above; N-content to be taken from database)	to be repeated for P-, K- and energy-outputs
17	N-output by-product A	kg N/ha	None (yield from above; N-content to be taken from database)	to be repeated for P-, K- and energy-outputs
18	N-output by-product B	kg N/ha	None (yield from above; N-content to be taken from database)	to be repeated for P-, K- and energy-outputs
19	Total output crop (by-product) # to livestock	kg DM/LU	yield crop (by-product) # to which type of livestock; LU	
20	Total N-output crop (by-product) # to livestock	kg N/LU	yield & N-content crop (by-product) # to which type of livestock; LU	N-content taken from database; to be repeated for P-, K- and energy-outputs
21	N-balance of crop production	t/ha	calculated from above (N applied, t; N harvested, t; UAA for crop production, ha)	
22	Share of land with legume crops and mixtures containing legume crops	ha/ha	Total UAA and by crop, ha; UAA with legumes, ha; in case of mixtures with legumes: proportion of legumes in plant communities (from 0 to 1)	% legumes within e.g. extensive, intensive permanent grassland or temporary grasslands
23	Share of land with permanent grassland	ha/ha	Total UAA, ha; UAA with permanent grassland, ha; intensity of land use (1=low, 2=moderate, 3=high intensity; grazing intensity included)	Permanent grassland is grassland persisting for more than 5 years
24	Number of harvests	n/year	Number of cuts	Per type of grassland (as above)
26	Use of stubble	ha	Stubble grazing Y/N, duration and intensity of grazing	When applicable estimate N exported *versus* N left
27	Share of land with non-permanent meadows	ha/ha	Total UAA, ha; UAA with non-permanent meadows, ha; intensity of land use (1=low, 2=moderate, 3=high intensity; grazing intensity included)	
28	Number of harvests	n/year	Number of cuts	
29	Crop Management	qualitative description	Description of soil cultivation & crop management processes (e.g., ploughing, no tillage, fertiliser application, intercropping, use of cover crops, etc.)	Description shall allow to avoid questions on fuel (diesel) usage etc.; to be specified for most important crops. Differentiation into different process steps may be necessary.

Table 2 (contd.). Indicators for characteristics and data needed from crop production at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
30	Soil Organic Matter Balance	t/ha	UAA cultivated with all crops, ha; manure and slurry application	Need to know if straw is removed, or e.g. deliberate low stocking rate of grassland (residue forming)
31	Crop Diversity Index	0-1	UAA cultivated with all crops; CDI = ∑Pi^2; where, Pi = UAA of particular crop/ total UAA (in ha)	
32	Productive trees per ha	number	Number of fruit/nut trees per ha of crop or grassland (differentiate)	
33	Average biomass/size of an average tree	m^3	Average biomass/size of an average tree; or: type, estimated diameter and height of tree	
34	Years of growth/tree and replacement age	years	Years of growth/tree and replacement age	
35	Yield of trees	t/ha	Yield of different tree types (primary fruit/nuts, secondary - wood?)	
36	Further additional (marginal) products	kg	e.g. cork, mushrooms, acorns, asparagus, etc.	If applicable and if products are sold or processed
37	Specific ecosystem services	categorical	Tourism or any other (immaterial) services	If applicable

2.3 Livestock indicators

Table 3 contains a list of suggested indicators for MIFAS-relevant characteristics of livestock production and the data these are based on.

Table 3. Indicators for characteristics and data needed from livestock production at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	Output livestock category #	kg, litres	Number of livestock #, n and LU; yield of product (milk, eggs, age and live weight or growth rate of animals intended for slaughter, or sold for breeding or other purposes, wool, etc.)	# = to be collected for each livestock category and type of product
2	N-, P-, K-output livestock category #	kg N, P, K	Number of livestock #, n and LU; yield & N-, P-, K-content of product (to be collected for all products; non-primary products eventually from data bases)	# = to be collected for each livestock category and type of product; similar for energy-outputs
3	Compound feed imported	t	Amount and composition of compound feed imported; content of DM; N, P, K from data bases	
4	Compound feed produced on farm	t	quantity collected under "crops"; DM-, N-, P-, K-content	
5	Forage imported	t	Amount and composition of forage imported; content of DM, N, P, K	
6	Forage produced on farm	t	quantity collected under "crops"; DM-, N-, P-, K-content	Can also be estimated from livestock numbers and production as a cross-check
7	Feed self-sufficiency (DM)	t/t	Amount of feed grown on farm, t DM; amount of feed required, t DM; calculated from other data	
8	Feed self-sufficiency (N)	t/t	Amount of N in feed grown on farm, t DM; amount of N in feed required, t DM; calculated from other data	
9	Share of feed coming from permanent grassland (DM basis)	t/t	Amount of feed from permanent grassland, t DM; total amount of feed input into livestock, t DM; calculated from other data	
10	Land available to livestock per livestock unit	ha/LU	Total UAA for livestock (including feed production), ha; number of livestock #, n and LU	
11	Breed type	categorical	Specialised, dual purpose?	
12	Longevity & Replacement rates (and mortality)	years or cycles; %	Duration of time or production cycles which animals typically spend in the herd (flock); proportion of animals replaced per year	

Table 3 (contd.). Indicators for characteristics and data needed from livestock production at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
13	Purchased livestock	number, age, weight	Type, number, age, weight of purchased animals	
14	Share of forages in livestock diet	t/t	Amount of forages for livestock, t DM; total amount of feed input into livestock, t DM; calculated from other data	
15	Outdoor access for animals	days/year	Number of animals per pen (housing unit) and area of land available per pen (housing unit); type of outdoor area (floor type, pasture or other land type)	
16	Husbandry system	categorical	Flooring (proportion of slatted and solid floor), lying area (slatted, solid, rubber mats, litter material)	
17	Manure management (i)	categorical	Type of manure (slurry vs. solid dung); cleaning frequency; manure storage (open or covered slurry tank, manure heap); composting of manure (yes/no); duration of storage; method of application of slurry (manure)	
18	Manure management (ii)	categorical	Ratio of slurry to solid manure	
19	Manure management (iii)	t	Type and quantity of bedding material per animal class	
20	Manure management (iv)	months	Duration of slurry/solid manure storage	
21	Manure management (v)	categorical	Slurry tank management (stirred, covered)	
22	Manure management (vi)	%	% of manure exported	

2.4 Environmental impact indicators

Table 4 contains a list of suggested indicators for environmental impacts of MIFAS and the data these are based on.

Table 4. Indicators for environmental impacts and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	N- balance total farm, herd and field level	kg/ha	N input, t; N output, t; UAA, ha; herd size; calculated from data collected in 2.2 (Crop indicators) and 2.3 (Livestock indicators)	
2	P- balance total farm, herd and field level	kg/ha	P input, t; P output, t; UAA, ha; herd size; calculated from data collected in 2.2 (Crop indicators) and 2.3 (Livestock indicators)	
3	K- balance total farm, herd and field level	kg/ha	K input, t; K output, t; UAA, ha; herd size; calculated from data collected in 2.2 (Crop indicators) and 2.3 (Livestock indicators)	
4	CH_4 emissions from enteric fermentation per livestock unit	t/LU	Diet composition (sufficient for estimation of GE-intake; on annual basis); (number of LU collected under "livestock")	Digestibility of diet to be calculated from database if needed for Tier 2 approach
5	CH_4 emissions from enteric fermentation per N output unit of livestock	t/t	none (calculated from enteric CH_4 above & N-output from livestock indicators)	
6	CH_4 emissions from manure management per livestock unit	t/LU	type of manure system; length of storage (months), diet composition for the period of housing (sufficient for estimation of organic matter digestibility or NE/GE and volatile solids); (number of LU collected under "livestock")	
7	CH_4 emissions from manure management per N output unit of livestock	t/t	none (calculated from CH_4 from manure management above & N-output from livestock indicators)	
8	N_2O emissions per livestock unit	t/LU	Diet composition (sufficient for estimation of N-intake vs. N in products); (number of LU collected under "livestock")	N-digestibility to be calculated from database for estimation of N-excretion

Table 4 (contd.). Indicators for environmental impacts and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
9	N_2O emissions per N output unit of livestock	t/t	none (calculated from other data)	specified N_2O output per unit of crop production will be calculated from collected data
10	NH_3 emissions per livestock unit	t/LU	none; (manure system and diet composition from above; Tier 2 EMEP-guidelines; number of LU collected under "livestock")	
11	NH_3 emissions per N output unit of livestock	t/t	none (calculated from other data)	
12	Share of area in Natura 2000 network	ha/ha	Natura 2000 area, ha; (UAA, ha collected under "crop indicators")	
13	Share of area of natural habitat	m^2/m^2	Can be collected via GIS data from Google Earth; show farmer Google Earth image and ask him/her to indicate maintained natural habitat	
14	Share of area under agro-environmental measures	m^2/m^2	UAA, ha (collected under “crop indicators”); area under agro-environmental measures (if known); Otherwise, this can be collected via GIS data from Google Earth; show farmer Google Earth image and ask him/her to indicate area under agro-environmental measures	
15	Length of hedges per area	m/m^2	Can be collected via GIS data from Google Earth; show farmer Google Earth image and ask him/her to indicate hedges	Including type of plants forming hedges
16	Number of isolated trees per surface unit	n/m^2	Can be collected via GIS data from Google Earth; show farmer Google Earth image and ask him/her to indicate isolated trees	Including those recently planted
17	Riparian strips per surface unit	m/m^2	Can be collected via GIS data from Google Earth; show farmer Google Earth image and ask him/her to indicate riparian strips	

2.5 Economic indicators

Table 5 contains a list of suggested indicators for economic performance of MIFAS and the data these are based on.

Table 5. Indicators for economic performance and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	Revenue from outputs per expenses for inputs	€/€	Total revenue for outputs, €; total expenses for inputs, €; differentiated by crop and livestock	
2	Gross income per workforce unit	€/AWU	Gross income, €; labour, AWU	AWU = annual workforce unit
3	Subsidies fraction in total revenue	€/€	Subsidies, €; total revenue, €	
4	Net income per workforce unit	€/AWU	Net income, €; labour, AWU	AWU = annual workforce unit
5	Revenue per total asset unit	€/€	Optional: Total revenue for outputs, €; total assets, €	If this information appears to be too personal, use estimates from FADN data
6	Share of net worth in the total asset	€/€	Optional: Net worth, €; total assets, €	If this information appears to be too personal, use estimates from FADN data
7	Cash flow I per family workforce unit	€/AFU	Family labour, AFU; Optional: Cash flow, €;	AFU = annual family workforce unit; If information on cash flow appears to be too personal, use estimates from FADN data
8	Gross margin per ha (arable) or per LU, head or forage ha (livestock)	€/ha; €/LU	none; (calculated from total revenues & total expenses above; UAA collected under "crops"; LU collected under "livestock")	The income/costs need to be differentiated at the crop/livestock enterprise level to calculate the enterprise GMs.

2.6 Social indicators

Table 6 contains a list of suggested social indicators for MIFAS and the data these are based on.

Table 6. Indicators for social aspects and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	UAA per workforce unit	ha/AWU	None; calculated from other data; UAA collected under 2.2, Crop indicators; AWU collected under 2.5, Economic indicators	All family labour (e.g. spouse and children) shall be included here.
2	Livestock units per workforce unit	LU/AWU	None; calculated from other data; LU collected under 2.3, Livestock indicators; AWU collected under 2.5, Economic indicators	
3	Hired workforce per total workforce	hired AWU/total AWU	None; calculated from other data; AWU and AFU collected under 2.5, Economic indicators; Hired AWU = AWU - AFU	
4	Number of hours compared to statutory time as perceived by the farmer	categorical	Stated as full time, part time, or as a percentage of FT e.g. 100%.	
5	Free time	h/week	Number of hours of free time per week	
6	Number of weekends off in a year	n/year	Number of work-free weekends per year	
7	Number of days off for holiday in a year	n/year	Number of free days (for vacation) per year	
8	Workload of the farm as perceived by the farmer	Likert scale, 1-5	Perceived workload, 1= very low, 5 = extremely high	
9	Exposure to hazardous chemicals	Likert scale, 1-5	Perceived exposure, 1= very low, 5 = extremely high	
10	Concern about physical work	Likert scale, 1-5	Concern, 1= very low, 5 = extremely high	
11	Education indicator	h/year	Time spent in training per year	Asking this would need to be justified due to GDPR! This might be avoided by asking for number of trainings attended per year.
12	Employment	n	Number of permanent and seasonal jobs created on farm due to MIFAS	

Table 6 (contd.). Indicators for social aspects and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
13	Working atmosphere	Likert scale, 1-5	Perceived atmosphere, 1= very poor, 5 = extremely good	
14	Income as perceived by the farmer	Likert scale, 1-5	Perceived income, 1= very poor, 5 = extremely high	
15	Farm performance as perceived by the farmer	Likert scale, 1-5	Perceived performance, 1= very poor, 5 = extremely high	
16	Collaboration indicator: meetings	h/year	Time spent in collaboration meetings	
17	Collaboration indicator: assistance (active)	h/year	Time spent in helping others	
18	Collaboration indicator: assistance (receiving)	h/year	Time others help you	
19	Collaboration indicator: administration	h/year	Time spent in collaboration administration	
20	Economic viability in 10 years as perceived by the farmer	yes/no	Expectation whether farm will or will not be economically viable in 10 years	
21	Expectation about farm succession	categorical		
22	Overall farmer's satisfaction	Likert scale, 1-5	Overall satisfaction with current situation and situation in the near future, 1= very poor, 5 = extremely positive	
23	Income of spouse	% spouse working off farm	Proportion of spouse working off farm in % of a total workforce	

2.7 Indicators for position of farmers in value chain

Table 7 contains a list of suggested indicators which characterise the position of farmers in the value chain(s) and the data these are based on.

Table 7. Indicators for farm position in value chain and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	Power and Dependency Dyadic Relationship, by each farmer per buyer	Two* Likert scales	perceived buyer dependency, 1 = low, 5 = high; perceived supplier dependency, 1 = low, 5 = high	Each farmer gives their perception of their relations with each of their buyers for their products. Different dependencies determine strengths of negotiation positions, and hence captured value, of specific actors
2	Number of actors main product(s) is (are) sold to	n	Number of buyers (actors) the main product(s) is (are) being sold to	Number of buyers separately if several products are sold
3	Type of buyer for main product(s)	categorical	Type of buyer (actor) main product(s) is (are) being sold to	
4	Number of actors by-product(s) is (are) given away to	N	Number of actors the by-product(s) is (are) given away to	Number of buyers separately if several by- products
5	Type of actor for by-product(s)	categorical	Type of actor by-product(s) is (are) give away to	
6	Type of sale channel for main product(s)	categorical	Type of sale channel for main product(s) going to main actor(s) (buyer(s))	
7	On-Farm processing for main primary product(s)	yes/no	Is (are) saleable primary product(s) being processed into saleable product(s)?	
8	Value added by processing (only if processing takes place on farm)	€/unit (e.g. kg)	Value of saleable processed product - value of saleable primary product	
9	Perception of value-added processing	Likert scale	Do farmers feel that processing improves products' marketability with buyers?	
10	Number of partnerships	N	Number of other non-buyer actors involved in production, processing or marketing (e.g. cooperatives, inter-farmer relations such as input exchange, etc.)	Should be answered for each type of partnership defined by a transaction of a specific matter or land
11	Type of partner	categorical	Type of partners involved in partnership from above	

Table 7 (contd.). Indicators for farm position in value chain and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
12	Importance of the partnership for the farmer regarding substitutability	categorical	Subjective view of the farmer regarding the impact of the substitutability of the partnership from above (1=very substitutable; 4=very difficult to substitute)	What if the partnership stops, how much is it going to change/impact your farming practices/ organization?
14	At farm level: Extra costs due to MiFAS (compared to specialised system)	€/unit	Extra costs (fixed, variable) & risks (productions, ….) due to being a MIFAS compared to a specialised farm	If numbers are not possible, qualitative answers also suffice
15	At farm level: Reduced costs due to MiFAS (compared to specialised system)	€/unit	Reduced costs (fixed, variable) & risks (production, financial, ….) due to being a MIFAS compared to a specialised farm	If numbers are not possible, qualitative answers also suffice
16	At farm level: Additional revenues due to MiFAS (compared to specialised system)	€/unit	Additional revenues, such as price premium, due to being a MIFAS compared to a specialised farm	If numbers are not possible, qualitative answers also suffice
17	At farm level: Revenues forgone due to MiFAS (compared to specialised system)	€/unit	Revenues forgone, such as missing a volume bonus, due to being a MIFAS compared to a specialised farm	If numbers are not possible, qualitative answers also suffice

2.8 Efficiency indicators

Table 8 contains a list of suggested indicators for efficiency of MIFAS and the data these are based on.

Table 8. Efficiency indicators and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
1	DM-output crops per UAA	kg/ha	None; calculated from other data; UAA collected under 2.2, Crop indicators; AWU collected under 2.5, Economic indicators	
2	DM-output crops per workforce unit	kg/AWU	None; calculated from other data; crop output collected under 2.2, Crop indicators; AWU collected under 2.5, Economic indicators	
3	N-output crops per UAA	kg/ha	None; calculated from other data collected under 2.2, Crop indicators	
4	N-output crops per workforce unit	kg/AWU	None; calculated from other data collected under 2.2, Crop indicators and 2.5, Economic indicators	
5	N-output livestock per LU	kg N/n	None; calculated from other data collected under 2.3, Livestock indicators	
6	Total farm N-output per workforce unit	kg N/AWU	None; calculated from other data collected under 2.2, Crop indicators, 2.3, Livestock indicators and 2.5, Economic indicators	
7	N-output crops to livestock per workforce unit	kg N/AWU	None; calculated from other data collected under 2.2, Crop indicators, 2.3, Livestock indicators and 2.5, Economic indicators	
8	N-efficiency total farm	kg/kg	None; calculated from other data collected under 2.2, Crop indicators, and 2.3, Livestock indicators	
9	N-efficiency of plant production	kg/kg	None; calculated from other data collected under 2.2, Crop indicators	
10	N-efficiency of livestock production	kg/kg	None; calculated from other data collected under 2.3, Livestock indicators	
11	Thrifty use of non-renewable energy (NRE)	MJ/€ gross product	None; calculated from other data collected under 2.2, Crop indicators (management processes) and taken from data bases; data collected under 2.4, Environmental impact indicators, and 2.5, Economic indicators	

Table 8 (contd.). Efficiency indicators and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected	Comments
12	Productivity of NRE inputs	MJ from outputs / MJ NRE inputs	None; calculated from other data collected under 2.2, Crop indicators (management processes) and taken from data bases; data collected under 2.4, Environmental impact indicators, and 2.5, Economic indicators	
13	Economic efficiency (profitability)	€ outputs / € inputs	None; calculated from other data collected under 2.2, Crop indicators, 2.3, Livestock indicators, and 2.5, Economic indicators	
14	Total factor productivity	€/€	None; calculated from other data collected under 2.2, Crop indicators, 2.3, Livestock indicators, and 2.5, Economic indicators	
15	Technical efficiency	dimension-less	None; calculated from other data collected under 2.2, Crop indicators, and 2.3, Livestock indicators	From collected data production function will be computed, comparing actual and maximum production, actual and minimum input use.
16	Economic efficiency	dimension-less	None; calculated from other data collected under 2.2, Crop indicators, 2.3, Livestock indicators, and 2.5, Economic indicators	From collected data production function will be computed, comparing actual and maximum revenues, actual and minimum costs.

2.9 Resilience indicators

Table 9 contains a list of suggested indicators for resilience of MIFAS and the data these are based on.

Table 9. Resilience indicators and data needed at farm (MIFAS) level

No.	Indicator	Unit	Data to be collected[1]	Comments
1	Robustness (1)	Scale 1 - 7 & "Why so?"[2]	Perceived capacity of farm to return to current profitability after serious challenges	
2	Robustness (2)	Scale 1 - 7 & " Why so?"[2]	Perceived personal capacity of managing the farm to allow quick recovery from shocks	
3	Robustness (3)	Scale 1 - 7 & " Why so?"[2]	Perceived easiness to personally get back to normal after a setback	
4	Robustness (4)	Scale 1 - 7 & " Why so?"[2]	Perceived sufficiency of options to deal with severe shocks on the farm	
5	Adaptability (1)	Scale 1 - 7 & " Why so?"[2]	Perceived capacity of farm to adopt new activities, varieties, technologies in response to challenges	
6	Adaptability (2)	Scale 1 - 7 & " Why so?"[2]	Perceived personal capacity of adaptation to challenging situations	
7	Adaptability (3)	Scale 1 - 7 & " Why so?"[2]	Perceived ability to personally adapt in times of change	
8	Adaptability (4)	Scale 1 - 7 & " Why so?"[2]	Perceived inflexibility of farm, i.e., lack of adjustment if dealing with a changing environment	
9	Transformability (1)	Scale 1 - 7 & " Why so?"[2]	Perceived personal ability to make decisions that result in transformation	
10	Transformability (2)	Scale 1 - 7 & " Why so?"[2]	Perceived difficulty of farm reorganisation in response to drastical change of external circumstances	
11	Transformability (3)	Scale 1 - 7 & " Why so?"[2]	Perceived ability to drastically reorganise the farm in reaction to challenges	
12	Transformability (4)	Scale 1 - 7 & " Why so?"[2]	Perceived ability to make major transformative changes if needed	

[1]Based on: Slijper, T., Y. de Mey, P.M. Poortvliet, M.P.M. Meuwissen, 2020. From risk behaviour to perceived farm resilience: a Dutch case study. Ecology and Society 25(4):10.
[2]Open question.

3 Implementation & outlook

The selected data collection points and wide-ranging indicators presented in chapter 2 provide a basis for development of a data collection and reporting process, continued in Task 2.3, and linked to work in many other work packages. During this process, further refinement of the exact data requirements and style of data collection will be undertaken to enable the optimal combination of simplicity of use, whilst ensuring the highest data quality for use within the project.
Note that each MIFAS has its own specificities and that additional indicators may be necessary.