Farm sustainability data for better policy evaluation with FADN

Krijn Poppe and Hans Vrolijk (eds.)

WAGENINGEN UNIVERSITY & RESEARCH

FLINT

FARM SUSTAINABILITY DATA FOR BETTER POLICY EVALUATION WITH FADN

Krijn Poppe and Hans Vrolijk (eds.)

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 613800

December 2016

PROJECT CONSORTIUM:

1	Wageningen Economic Research (Wageningen University & Research)	Netherlands
2	Agrargazdasagi Kutato Intezet (Research Institute of Agricultural Economics)	Hungary
3	MTT Agrifood Research Finland	Finland
4	Instytut Ekomiki Rolnictwa I Gospodarki Zywnosciowej – IERIGZ	Poland
5	Instituto Navarro De Tecnologias e Infraestructuras Agrolimentarias	Spain
6	Leibniz Centre for Agricultural Landscape Research ZALF	Germany
7	The Agriculture and Food Development Authority of Ireland Teagasc	Ireland
8	Agricultural Ec. Res. Inst.– Hellenic Agricultural Organization - Demeter	Greece
9	INRA – Institut National de la Recherche Agronomique	France
10	CROP-R BV	Netherlands
11	University of Hohenheim	Germany

Disclaimer

The information presented in this report has been thoroughly researched and is believed to be accurate and correct. However, the authors cannot be held legally responsible for any errors. There are no warranties, expressed or implied, made with respect to the information provided. The authors will not be liable for any direct, indirect, special, incidental or consequential damages arising out of the use or inability to use the content of this publication.

Copyright

MORE INFORMATION:

Krijn Poppe MSc (coordinator) e-mail: krijn.poppe@wur.nl

Dr. Hans Vrolijk e-mail: hans.vrolijk@wur.nl

Wageningen Economic Research phone: +31 07 3358247

P.O. Box 29703

2502 LS The Hague

The Netherlands

www.flint-fp7.eu

This report can be downloaded for free at http://dx.doi.org/10.18174/414173 or at www.wur.eu/economic-research (under Wageningen Economic Research publications).

ISBN 978-94-6343-203-0

ABOUT THE FLINT PROJECT

FLINT delivers a data-infrastructure providing up to date information to policy-makers and the agro-food sector about farm level indicators on sustainability and other new relevant issues. FLINT establishes a pilot network of at least 1000 farms (representative of farm diversity at EU level, including the different administrative environments in the different MS) that is well suited for the gathering this kind of information.

Taking into account the sustainability performance of farms on a wide range of relevant topics will facilitate better decision making. These topics include (1) market stabilization; (2) income support; (3) environmental sustainability; (4) climate change adaptation and mitigation; (5) innovation; and (6) resource efficiency. The approach will explicitly consider the heterogeneity of the farming sector in the EU and its member states. In cooperation with the farming and agro-food sector, the feasibility of these indicators will be determined.

FLINT addresses the increasing needs for sustainability information of the national and international retail and agro-food sector. The Sustainable Agriculture Initiative Platform and the Sustainability Consortium -in which the agro-food sector actively participates - support the FLINT approach.

The lessons learned and recommendations from the empirical research conducted in 9 purposefully chosen MS is used to estimate and discuss effects in all 28 MS. This will be very helpful in case the European Commission should decide to upgrade the pilot network to an operational EU-wide system.

PREFACE

As the world and agriculture are changing, so is the Common Agricultural Policy. Changes in the last decades include attention to public values such as rural development and environmental issues. This raises new challenges for impact analysis of those policies, especially the access to relevant data of high quality.

The European Commission has recognised this challenge and issued a call in the Framework Programme 7 to come up with solutions for this challenge. A consortium of research institutes, universities and a software company in The Netherlands, Ireland, France, Spain, Greece, Hungary, Poland, Finland and Germany carried out the FLINT project to test a solution that involves Europe's Farm Accountancy Data Network. This report is the end report of the FLINT project. It contains a concrete plan to implement the results in the FADN for all 28 European countries.

We would like to take the opportunity to thank the more than 1100 farmers in the 9 member states for making their data available and testing our indicators. Their collaboration shows how farmers are dedicated to help the world to become more sustainable and improve their management by starting measuring these issues. We also thank the data collectors for their hard work to make this data collection a success.

In the Farm Accountancy Data Network we are indebted to the FADN unit in DG Agri as well as the representatives from the member states for their support and insights into what is feasible and not feasible in their country. Our proposal for implementation involves a challenging task for them in the next years, on which the sustainability of the FADN itself will depend. We are convinced that the transition to an even more relevant FADN is needed and can be done. We thank the staff of DG Research and DG Agriculture and Rural Development, and especially mr. Yves Plees and mr. Tassos Haniotis, for their guidance. Thanks also goes to the external Advisory Group of the project: mr. Peter Erik Ywema (SAI), mr. Koen Boone (TSC), mr. Nicolas Ferenczi (CopaCogeca), mr. Jean Michel Terres (EU-JRC), mr. Yves Plees (EU-DG-Agri) and mr. Jussi Lankoski (OECD).

This end report is based on the project deliverables, that have many project members as authors. These deliverables are available on the website of the project [www.flint-fp7.eu]. Where relevant, we have indicated with footnotes on which deliverable we base our text or even have copied parts of the text from the deliverable. In doing so we have refrained from following the normal practice to put these copied texts in hyphens and italics, to keep the report readable.

Scientific papers from the project have been published in a special issue of Studies in Agricultural Economics.

With this end report the project comes to a close, but we sincerely hope that it will be followed up by incorporating the results in the normal practice of FADN, to provide policy evaluators and academic research with better data for policy analysis and insights into the sustainability of farming.

December 2016,

The FLINT Consortium.

TABLE OF CONTENTS

AT A GLANCE

New societal challenges change policies

Common Agricultural Policy: new topics

- Cross-compliance
- Greening:
- Climate change
- Soil management
- Water
- Biodiversity
- Rural Development:
- Innovation

- Policies aim to influence decisions of farmers (towards public goals)
- Farmers' decisions have effects on income, productivity and sustainability (with trade-offs)
- Policy evaluation needs to analyse these decisions with an integrated data set

*1

*1

Farm Level Indicators for New Topics in policy evaluation

- To demonstrate the feasibility of collecting policy-relevant data in different administrative environments
- To demonstrate how indicators can be used to evaluate policies

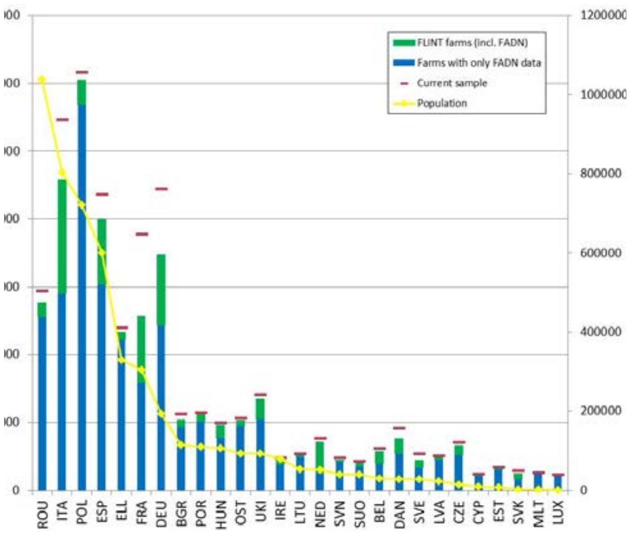
Sustainability data collected on 1100 farms in 9 MS.

Experiences of farmers and data collectors surveyed

On FADN farms a lot of data available on invoices, in industry schemes etc.

Proposal to adopt the FADN:

- Reduce FADN from 85,000 to 75,000, to
- Create subsample of 15,000 farms with sustainability data



Adaptation FADN via 2 actions:

* Formal change of FADN by adapting FADN regulations

* Project FLINT-2 Policy Research Infrastructure to make directly existing data available and help Member States to make the change

PART 1 – PROPOSAL TO ADAPT THE FADN

Societal challenges such as climate change, environmental pollution, reduced biodiversity, inequality between city and country side and within agriculture, as well as the need to feed the growing population have been translated by the European policy-makers in policies for a productive and sustainable agriculture. For farmers the Common Agricultural Policy (CAP), linked to other environmental policies through cross compliance, and with a pillar for rural development, has been renewed for the period 2014-2020 with new policy topics such as greening and innovation partnerships.

The European institutions, most of all DG Agriculture & Rural Development, have a need to monitor and evaluate this renewed CAP, also with an eye to renewal of the policy after 2020. This implies not only the need for statistics on the environment (the physical, ecological and the institutional, socio-economic environment) and productivity of agriculture. To evaluate the effectiveness and efficiency of the policy measures it is needed to understand how policies influence the behaviour of the farmers and the choices that they make in a trade-off between economic and different (sometimes contradictory) environmental goals.

The FLINT project has investigated what the best method is to collect sustainability data from farmers to make such policy evaluation possible. By collecting and analysing sustainability data on 1,100 farms in 9 member states in the framework of the Farm Accountancy Data Network (FADN), it was shown that such data collection explicitly considers the heterogeneity of the farming sector in the EU and makes a large variety of policy analyses possible. This data collection is possible in the different administrative environments that member states face or have chosen to organise the national FADN.

This leads us to the conclusion that the FADN should be adapted by including an FADN sub-sample of 15,000 farms in 28 member states, providing that this sub-sample is adequately selected (e.g. representativeness in terms of the various dimensions of sustainability). The sample allocation of these 15,000 farms should be based on an optimal allocation over the member states (Figure A) and would cost about 4.2m euros a year in data collection costs. At the same time the current FADN sample can be reduced from 85,000 to 75,000 farms to give the member states the possibility to keep the FADN costs within their current budget. This reduction will not have a big effect on income estimators at EU and member state level.

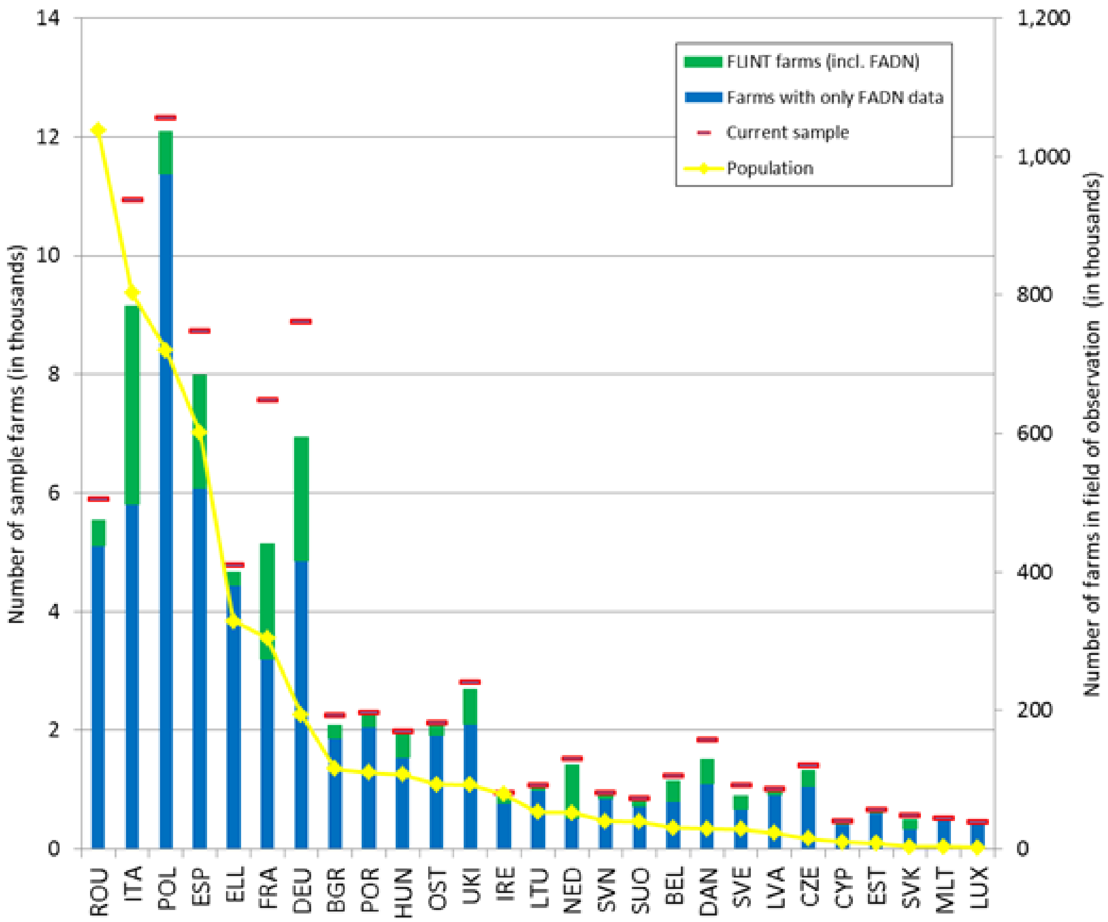


Figure A: Proposed distribution of FLINT farms and reduced size of FADN sample per member state (compared with current FADN sample and FADN population)

We recommend that the FADN committee, chaired by DG Agri, implements this change as soon as possible, building upon the results of the FLINT project, including its Farm Return and software. This is possible within the basic act of the FADN but needs adaptation of other Commission Regulations. As several member states have limited experience in collecting sustainability data in their FADN and some variables are sensitive in some countries, discussion on these regulations could take time. Also, as set-up costs of the subsample (software, instructions to accountants) asks for investments that are not easily compensated by a reduction of the current sample, there are arguments why DG Agri should provide some support in this change to speed up the process.

We therefore recommend DG Agri also start a 4-year project FLINT-2 that creates with the 28 national FADNs a Policy Research Infrastructure. This could start immediately and take in data that are already available in national FADNs for past years, including those from FLINT partners such as Hungary, Finland, Navarra (Spain) and Poland that decided to continue the data collection of some nationally relevant indicators after the FLINT project. In this way data would already be available for the evaluation of the current CAP in the winter of 2017/18. The project could help the member states that were not part of the FLINT pilot project to start up their activities based on the project budget and by making software available. In addition to DG Agri, other units of the Commission (e.g. JRC, DG Envi, DG Clima, European Environment Agency) could be interested and connected to such a project. The project could interact with developments in ICT and sustainability schemes in industry that make data digitally available and reduce administrative burdens.

PART 2 - ANALYSIS

1 INTRODUCTION

This report contains the final recommendations, and supporting evidence, to collect sustainability data in the framework of the Farm Accountancy Data Network (FADN). There is a growing need for data on the sustainability of agriculture, not only within the industry but especially also among researchers and policy-makers to monitor and evaluate the Common Agricultural Policy with its cross-compliance, greening and rural development measures.

The FLINT project (Farm Level Indicators for New Topics in policy evaluation) has investigated options to collect such data. In 9 member states, with different systems of data collection at farm level, it has collected and analysed sustainability data from 1,100 farms in the Farm Accountancy Data Network. More information on the project can be found on the website of the project (www.fp7-flint.eu). This includes background information, presentations and reports.

This report is the end-report of the project that makes recommendations to scale up the results of the project and include them in the FADN. To substantiate the recommendations given in part I of this report, Chapter 2 discusses in detail which data are needed for monitoring and evaluation of European agricultural policies. It shows how policy analysis might benefit from additional data with indicators on the sustainability performance of farms (profit, planet and people aspects). The analysis makes the point that although the environment and other public values are the objectives of the policy, governments target a change in farm management and that policy analysis requires an integrated data set at that level to understand choices by farmers with trade-offs between economic and (sometimes internally contradicting) environmental and social objectives. The chapter also explains how the data needed were translated into a survey.

Chapter 3 reports on the feasibility of the collection of sustainability data. The data defined in Chapter 2 were collected in 9 member states (Ireland, Netherlands, Germany, Poland, Finland, Hungary, Greece, Spain and France) on a total of 1,100 farms of different farm types, 100 more than planned. Experiences of participating farmers and data collectors have been surveyed and have been reported. Although some problems occurred, mainly due to the project and first-year character of FLINT, it is concluded that data collection is feasible, whatever the way the member state has organised its data collection.

Chapter 4 investigates options to upscale the results of the FLINT project from 9 to 28 member states and to create a representative panel with farm-level sustainability data. This leads to the conclusion that the most attractive option is to reduce the current FADN sample in order to accommodate a subsample with sustainability data. Chapter 5 provides our recommendations for future work on the implementation of these recommendations.

2 WHY POLICY-MAKERS NEED BETTER POLICY EVALUATION AND MORE DATA

2.1 New policy needs[1]

Policies change over time to adapt to new societal needs. This is also true for policies relating to agriculture. The FLINT project focuses on the CAP for the 2014-2020 period to identify and describe the policy evaluation needs, especially those policy evaluations that can be facilitated by farm-level indicators. Existing EU policy priorities that are relevant for our objective include:

- Rural Development,
- ICT for Competitiveness & Innovation,
- Key Enabling Technologies,
- Tourism,
- Animal Welfare,
- Animal Health, and
- Plant Health.

Of these, the Common Agricultural Policy (CAP) and more specifically the Rural Development Pillar with its six priorities is a highly relevant policy topic. Table 2.1 presents these rural development priorities, some other relevant policy priorities and examples of information needed to enable evaluation.

Table 2.1 Rural development priorities and other examples of farm level information needs for policy evaluation

Policy	Examples of information needs
RDP Priority 1: Fostering knowledge transfer in agriculture, forestry and rural areas	• Evidence of efforts to close the innovation gap between research and practice • Engagement in: European Innovation Partnerships (EIPs); co-operation activities; clusters or networks, and; operational groups • Incidence of trials and pilot projects to support innovation • Adoption of innovative actions • Measures to reduce risks and barriers • Increased profitability and competitiveness due to innovation • Social Return on Investment (SROI) • Co-operation operations continuing after RDP support • Agriculture holdings with RDP support for investments regarding modernisation • RDP support for business development plan for young farmers
RDP Priority 2: Enhancing the	• Economic performance of farms • Measurement of farm structures • Measurement of farm modernisation

1 This section is based on the following FLINT publications: Kelly et al. (2015); Poppe et al. (2016); Vrolijk (2016).

Policy	Examples of information needs
competitiveness of all types of agriculture and enhancing farm viability	• Degree of farm diversification • Profiles of age structures in the agricultural sector • Support for investment by young farmers
RDP Priority 3: Promoting food chain organisation and risk management in agriculture	• Participation in quality schemes for products and food • Local and regional branding of products • Participation and contribution to short supply chains (e.g. direct sales, local markets) • Participation in producer groups • Marketing of local produce • Targeting of knowledge, training and skills for new entrants and existing producers • Targeting of financial support to assist short supply chains • Use of LEADER to support local food sectors • Participation in risk prevention and management schemes • Knowledge and information on access to RDP finance instruments other than non-repayable grants • Use of RDP finance instruments other than non-repayable grants (e.g. revolving loan fund, venture capital fund, interest rate subsidy, guarantee fund, equity fund)
RDP Priority 4: Restoring, preserving and enhancing ecosystems dependent on agriculture and forestry	• Land cover • Less favoured areas • Farming intensity • Natura 2000 areas present around the farm • Farmland birds index • Conservation status of agricultural habitats (grassland) • High Nature Value farming • Protected forest • Water use and abstraction in agriculture • Water quality • Soil organic matter in arable land (current indicators are output of modelling exercise) • Soil erosion by water (current indicators are output of modelling exercise) • Proportion of farm area occupied by Natura 2000 • Proportion of farm area occupied by some other legislative designation for wildlife • Proportion of farm area occupied by semi-natural habitats • Presence on the farm of a species or habitat of high wildlife value • Participation in biodiversity measures of an agri-environment scheme • Participation in water quality measures of an agri-environment scheme • Participation in soil quality measures of an agri-environment scheme • Training in issues related to wildlife or habitat maintenance • Provision of advice related to wildlife or habitat maintenance • Training in issues related to water quality • Provision of advice related to water quality • Training in issues related to soil quality • Provision of advice related to soil quality
RDP Priority 5: Promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in agriculture, food and forestry sectors	• Share of irrigated land switching to more efficient irrigation system • Increase in efficiency of water use in agriculture in RDP supported projects (m^3 water used/standard output/) • Increase in efficiency of energy use in agriculture and food-processing in RDP supported projects (output/MJ energy used) • Total investment in renewable energy production (euros) • Renewable energy produced from supported projects (tonnes of oil equivalent) • Livestock units concerned by investments in livestock management in

Policy	Examples of information needs
	view of reducing the N_2O, methane and ammonia emissions • Share of agricultural land under management contracts targeting reduction of N_2O, methane and ammonia emissions • Reduced emissions of methane and nitrous oxide (measured in CO_2 equivalent) • Reduced emissions of ammonia from agriculture (tonnes) • Share of agricultural and forest land under management contracts contributing to carbon conservation and sequestration
RDP Priority 6: Promoting social inclusion, poverty reduction and economic development in rural areas	• Jobs created in supported projects • Share of rural population covered by Local Action Groups (LAG) funded through the RDP • Rural population benefiting from improved services / infrastructures supported under the RDP • Jobs created in supported projects (LEADER) • Rural population benefiting from new or improved services / infrastructures (ICT)
ICT for Competitiveness and Innovation and Key Enabling Technologies	• Adoption of ICT to improve farm business • Farm-level adoption of key enabling technologies
Tourism	• Farm income generated from tourism • Proportion of farm labour dedicated to agri-tourism • Investment in agri-tourism • Membership of agri-tourism certification scheme, co-operative, LAG or LEADER project
Animal Welfare	• Use of RDPs to support investment and aid adaptation to higher standards in the farming sector, as well as to reward practices that go beyond minimum standards • Farmers' awareness of animal welfare programmes • Adherence to animal welfare rules on the farm, during transport and at time of slaughter or killing (with specific rules for laying hens, calves, pigs and broilers) • Participation in RDPs to support investment and aid adaptation to higher animal welfare standards in the farming sector • Participation in activities to inform consumers about animal welfare standards and influence consumers' purchasing decisions
EU Animal Health Strategy (AHS)	• Farm-level incidence of disease outbreaks • Farm-level investment in precautionary measures for biosecurity for animal health • Participation in an eradication programme for named diseases (listed in AHS) • Participation in electronic identification schemes for traceability of live animals (to replace paper certification) • Receipt of effective training to be able to identify the signs of disease at an early stage • Receipt of information/training to improve farm-level surveillance of disease
Plant Health	• Inspection of pesticides application equipment in use – All pesticides application equipment will have to be inspected at least once by 2016 to grant a proper efficient use of any plant protection product • Adherence to EU plant health rules • Actions to prevent incidence of plant pests and diseases • Incidence of alien invasive species • Support for surveillance and control systems for plant pests and diseases

Source: FLINT project, based on analysis of Commission documents.

Government policies in the EU have to be assessed ex-ante, mid-term and ex-post with an impact assessment and monitored during their existence (Kirkpatrick and Parker, 2007). These assessments and monitoring should not only consider the target variables of the policy, but all other effects that could throw a light on the effectiveness and efficiency of the policy, including data on different target groups of the policy. Such data can come from different statistics and be combined with up-to-data techniques from econometrics and statistics (such as imputation methods). However to understand the decision making of the policy's target groups it is recommended to collect different variables on the same farms and not introduce a data bias by artificially linking data from different sources.

Most[2], if not all, of the topics and indicators discussed above can be framed in the Triple P approach of Profit, People and Planet to describe sustainability (Elkington 1997). This approach has been used by various frameworks, approaches, methods and indicators to appraise how much farms and firms in the food production chain contribute to sustainability. FAO has combined many of those in the SAFA-tool. Data needs on new policy topics are therefore interpreted as needs on sustainability data of farming and farms.

Diffusion of these indicator frameworks is in its early stages and data gathering is at best at a small scale in projects or some national FADNs. Industry standards such as the Sustainable Agriculture Initiative (SAI) and The Sustainability Consortium (TSC) are used to develop food safety and tracing- and tracking systems (such as GlobalGap and many other schemes) towards sustainability frameworks. In practice, the data collection at farm level of sustainability indicators is in its infancy. One of the early refinements was the emerging of nutrient accounting systems for livestock and crop farms in some parts of Europe (Breembroek et al., 1996).

There are clear gaps between the policy priorities and the existing data infrastructure required to develop metrics for policy evaluation at farm level concerning the sustainability issues that are now part of European policies. The farm-level data from the existing FADN relates to farm economics. Topics with no or very limited coverage in the FADN relate only to the environmental, animal welfare, technology and innovation topics. These areas are particularly important for future policy evaluation. Some of the major changes to the CAP include the Greening policy and increased support from Rural Development for various environmental and social public goods. It is important to effectively discern the effects of these specific policy instruments to allow for policy evaluation. This would require considerable disaggregation of data to allow analyses to discern such effects. Other issues identified relate to the representativeness of topics of both international and national policies and the representativeness of farm types.

2.2 Examples of better policy evaluation[3]

The FLINT project has demonstrated with a number of examples how policy evaluation could be improved with access to better data. In this section we provide some examples of policy-

[2] The text on sustainability frameworks has been adapted from a report by the EIP Agricultural Productivity and Sustainability on Benchmarking (EIP, 2016) that discusses in more detail the need to adopt sustainability indicators in benchmarking for farmers.

[3] This section is partly based on the following FLINT documents: Brennan et al. (2016a); Van Asseldonk et al. (2016), O'Donoghue et al. (2016), Van der Meulen et al. (2016), Latruffe et al. (2016a), Saint-Cyr et al. (2016), Herrera et al. (2016b), Kis-Csatari and Kesthelyi (2016a), Brennan et al. (2016b), Lynch et al. (2016), Buckley et al. (2016), Latruffe et al. (2016d), Herrera et al. (2016c), Uthes (2016), Eguinoa and Intxaurrandieta (2016); Hoste and Vrolijk (2017).

relevant analyses that we carried out with the FLINT data and national FADN data that already incorporates data on new policy topics.

Monitoring

A first example of the type of policy-relevant data the FLINT project gathered is given in Table 2.2 with results on dairy farms in 6 countries. The first rows of the table contain conventional FADN data on number of cows, subsidies, turnover and income data. Besides these profit-indicators the table then shows data on planet and people indicators. The estimated greenhouse gas emissions seem to be relatively high per cow (not corrected for milk yields) in Spain, the Netherlands and Ireland, and lower in Finland and Poland. The data confirm that dairy farms in the Netherlands have relatively high nitrate balance surpluses. FLINT also collected data on the use of advisory services, an important aspect in the rural development programme. It turns out that dairy farmers in Finland and Ireland have fewer contacts with advisors than in the other countries. Social indicators are represented in Table 2.2. with data on job satisfaction and quality of life opinions of farmers. Spanish, Polish and to a lesser extent French dairy farmers are less satisfied than the dairy farmers in the other 3 countries.

Table 2.2. Sustainability data (median values) from dairy farms in six countries (Spain, Finland, France, Ireland, Netherlands and Poland).

Variable	Unit	ES	FI	FR	IE	NL	PL
Dairy cows	Heads	74.4	42.8	50.0	75.0	99.2	22.4
Gross farm income	Euro	78,630	113,319	58,943	82,901	117,555	22,511
Farm net value added	Euro	38,999	47,680	28,611	70,587	70,044	18,567
Farm net income	Euro	27,205	33,057	12,643	61,299	18,692	16,719
GHG emission	tonnes CO_2 eq.	585.7	335.1	NA	624.0	597.3	130.8
GHG/cow	tonnes CO_2 per cow	7.88	7.84	NA	8.32	6.02	5.84
N-balance	kg N per ha	431.1	162.4	NA	323.1	408.5	127.9
NUE	output/input	6.2	6.6	NA	4.7	6.8	7.3
Advisory contacts	Number	25.0	13.0	21.0	11.0	24.5	21.0
Job satisfaction	max 10	6.5	8.0	7.0	8.0	8.0	6.0
Quality of life	max 10	5.9	8.0	6.2	7.8	7.2	6.0
Pesticides		2.1	0.4	1.6	NA	0.8	0.7

Similar data could be provided for other types of farming that the FLINT project considered, such as in Table 2.3 for arable farming. This table shows the land fragmentation in Greece: parcels (fields) are relatively small in this country. Greek farms also show a low level of crop diversity (a greening objective in the new CAP). Arable farmers in Greece and Spain are more than in the other countries involved in contract-farming. However, arable farms differ between these two countries in their contacts with advisory services: these are twice as high in Greece as in Spain. The data on environmental performance show that Dutch arable farmers have, like their dairy colleagues, a high surplus on nitrate. Nutrient efficiency, relating the output to the input, seems however not be so bad, compared to other countries.

Table 2.3. Sustainability data (median values) from arable farms in six countries (Spain, France, Greece, Hungary, Netherlands and Poland)

Variable	*Unit*	*ES*	*FR*	*GR*	*HU*	*NL*	*PL*
Utilised agr. Area	ha	110	116	22	150	66	42
Gross farm income	euro	30,559	27,845	-631	64,738	127,345	19,935
Farm net value added	euro	17,554	-2,646	-1,616	61,467	96,702	11,258
Farm net income	euro	-549	-21,262	-5,580	26,467	61,688	9,689
Average Parcel size	ares	225	546	67	955	419	406
Share under contract	%	5.00	2.50	5.00	2.00	3.00	3.50
Crop diversity	number	3.2	3.5	2.0	3.8	4.5	3.5
Advisory contacts	number	18.0	24.0	35.0	25.0	28.0	21.0
GHG emission	tonnes $C0_2$ eq.	0.8	NA	0.2	4.9	0.6	0.9
N-balance	kg N/ha	102.3	NA	160.7	89.1	482.9	155.0
Pesticides		2.7	1.5	8.7	0.9	6.2	1.4
Job satisfaction	(max 10)	8.0	8.0	8.0	8.0	8.0	7.0
Quality of life	(max 10)	8.2	7.6	7.0	7.3	7.8	6.4

The conclusions from these two tables concerning differences between member states should be interpreted with care. These results are based on relatively small groups of farms (although more than 25 farms), which are not necessarily representative for the whole country. More work on harmonisation of indicators is probably needed to substantiate conclusions that could reset policies.

What the two tables do make clear is that data on indicators for new policy topics can be collected and potentially provide interesting material to monitor aspects of the Common Agricultural Policy.

Policy analysis on environmental issues

The full potential of using the FADN for policy analysis in the area of environmental issues, can be shown by using the FLINT methodology on data from two countries that have already gathered some of the sustainability data for a longer time in their national FADN. A study was carried out that uses national extensions of the EU Farm Accountancy Data Network to derive nationally representative nitrogen use efficiency indicators for specialist dairy farms in the Republic of Ireland and the Netherlands between 2006 and 2014. Details are reported in Buckley et al. (2017). These countries are of particular interest as dairy production is an important sector in both countries and milk production has grown in these two Member States following the removal of the EU milk quota regime in 2015. Results indicate relatively similar N balances per hectare across both countries with the Netherlands returning significantly higher N use efficiency and lower N surplus per kg of milk solids produced. Over time there are improvements in nutrient use across both countries, due to efficiency gains. The analysis also highlights differences between a grazing system and a more high input orientated system that illustrates the need for the development of a life-cycle analysis approach to fully capture the full-scale environmental efficiency of differing systems of milk production.

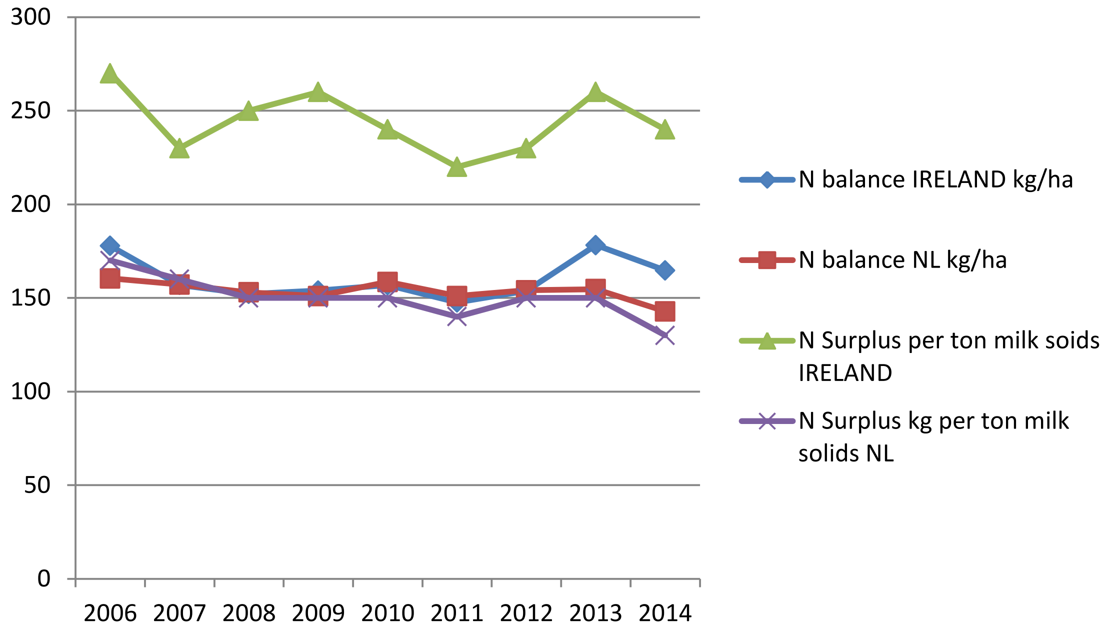


Figure 2.1. Nitrogen balance in kg/ha and nitrogen surplus per tonne of milk solids for the Republic of Ireland and the Netherlands (source: Buckley et al., 2017)

Another example of a policy analysis is the greening measures in the CAP for grassland. 'Greening' measures were introduced as part of the 2013 CAP reforms to promote environmentally beneficial farming practices. In particular, permanent grassland must be maintained, in the expectation that it will provide carbon sequestration and benefit local biodiversity. However, there is little relevant data beyond the areas currently managed as permanent pasture, despite important differences in the states of permanent grassland. In the FLINT project, a set of novel indicators was developed to address this information gap. These include the proportion of permanent grassland that is managed intensively or extensively (> or <50 kg N/ha per year respectively), the proportion of permanent grassland managed extensively (and with designated nature protection), and the total farm area covered by semi-natural habitats. The results show considerable variation in the way permanent grassland is managed between countries and between systems. Figure 2.2 shows that permanent grassland in the FLINT sample is not only farmed by dairy and beef or mixed farms.

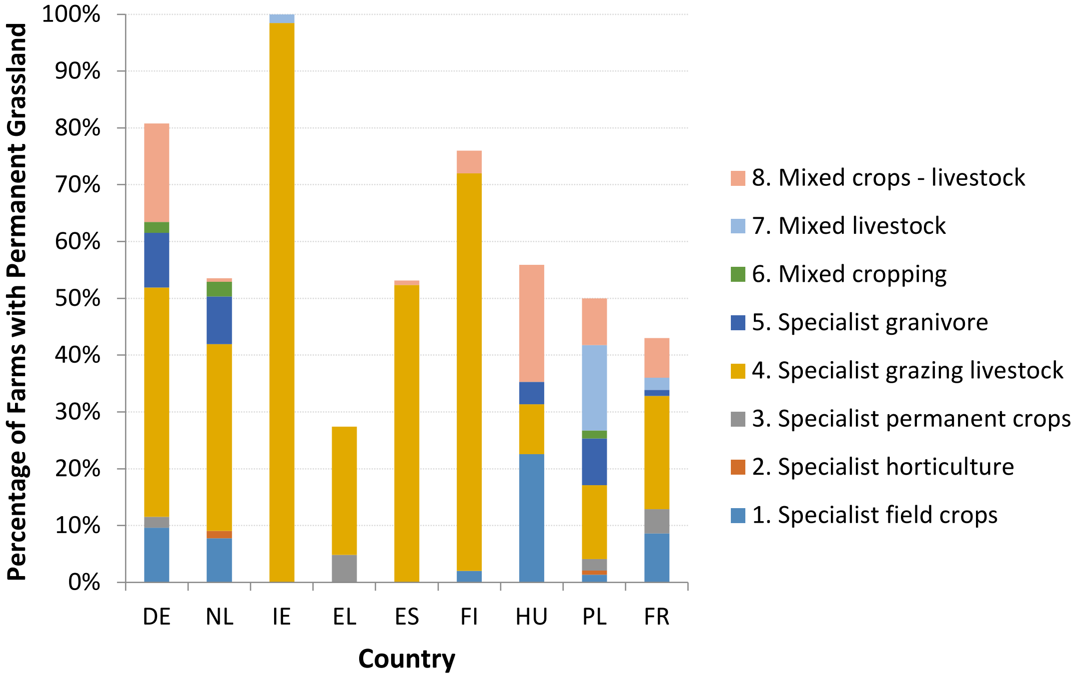


Figure 2.2. Percentage of farms from the FLINT sample containing permanent grassland, including distribution across different farm types (source: Lynch et al., 2016)

The proportion of permanent grassland which was managed intensively (>50 kg ha-1 per annum of nitrogen fertiliser, indicator E.1.1) varied significantly between countries, according to the dominant types of agriculture in the farms surveyed. In Ireland, most of the sample consisted of intensive grazing livestock farms, compared with, for example, Hungary, where many arable farms contained areas of permanent grassland, but livestock production was not a major farm output, and they were not highly stocked or intensively managed. The second permanent grassland indicator, E.1.2, shows the counterpart to this, namely the proportion of permanent grassland managed extensively (<50 kg ha-1 per annum of nitrogen fertiliser).

The final permanent grassland based indicator, E.1.3, is the proportion of permanent grassland managed extensively which also has some form of nature protection. The values for this indicator are quite low for most countries, with only Hungary showing a significant proportion of grassland with designated natural habitat protection. It is likely that these values reflect the choice of farms and selection strategy for the sample. This result could be explored further in future work, with member state specific nature designations likely driving these differences, either in terms of the habitats which are covered by legislation, and/or the economic incentives for farmers to maintain or create these habitats (for more details on this analysis see Lynch et al., 2016).

Policy evaluation on risk, farm entrance and the use of advisory services

Another topic that is very relevant in the current discussions on the (future of the) CAP is the role of the government in risk management of farmers. Given the increased attention to risk management in the Common Agricultural Policy, it is important to monitor and evaluate the adoption rates and their determinants over time. FLINT data (for more analysis, see Van Asseldonk et al., 2016) confirms that adoption rates of risk management instruments such as insurance contracts, price contracts, off-farm income, other risk reduction measures and other gainful activities vary significantly across EU member states and farming types (Tables 2.4 and 2.5). Econometric analysis indicates that larger farms adopted more often crop insurance, occupational accident insurance, price contracts and diversification but were less likely to adopt credit avoidance and off-farm employment (at a significance level of 1%).

Table 2.4: Insurance adoption (%) and number of observations (n) per Member State (i.e., coverage for crop, livestock, building and occupational accident) (source: van Asseldonk, 2016)

Member State	Crop insurance		Livestock insurance		Building insurance		Occupational accident insurance	
	Adoption (%)	n	Adoption (%)	N	Adoption (%)	n	Adoption (%)	n
Finland	0	50	90	49	100	50	96	50
Germany	61	52	51	35	88	52	77	52
Greece	90	124	93	30	0	124	100	124
Hungary	34	102	11	64	39	102	13	102
Ireland	0	64	11	64	86	50	56	64
Netherlands	35	155	56	82	95	155	55	155
Poland	41	146	9	87	97	146	82	146
Spain	50	128	95	69	54	128	64	128

Table 2.5. Adoption of some other risk management strategies (%) and number of observations (n) per Member State. (source: van Asseldonk, 2016)

Member State	Divers-ification	On-farm proces-sing/ sales	Off-farm invest-ment	Credit avoid-ance	Hed-ging	Finan-cial reser-ves	Off-farm employ-ment	Other gainful activities	n
Finland	40	18	26	66	4	36	44	32	50
Germany	54	17	19	46	0	64	60	64	52
Greece	90	18	2	69	0	68	23	13	124
Hungary	38	8	6	40	4	38	43	16	102
Ireland	30	0	14	53	3	50	53	2	64
Netherlands	33	10	8	16	2	14	51	46	155
Poland	62	7	2	45	3	40	26	14	146
Spain	28	13	2	59	0	9	23	12	128

Another very relevant policy topic is the fact that the farming age profile for many European countries is rapidly rising and EU programmes such as the Young Farmer Scheme aim to redress this balance. Descriptive results of the FADN and FLINT data (see Brennan et al. (2016)) confirm the issue of an aging farming population, with mean farmer's ages of between 43 and 55, and highlight that 96% of farmers sampled would not qualify for the Young Farmers Scheme. An analysis on the Irish data suggests a significant relationship between indicators of economic, environmental and social sustainability and the age of the farmer. For each additional year of farmer age, declines can be seen in output per hectare, gross margin per hectare, family farm income and farm viability. As the farmer ages, declines can be seen in environmental impacts as well. This is likely to be due to the fact that younger farmers farm more intensive, and as a result they have a greater GHG output per ha than their less intensive counterparts and it is probable that due to increased efficiencies their GHG emission per kg of output is lower than that of older farmers. Younger farmers appear to be more socially sustainable. Older farmers are more likely to live in a vulnerable household and live in isolation and are less likely to have attained agricultural education. The data also suggest that the age at which the farmer becomes the decision maker matters in terms of viability and household sustainability. The older the farmer is when he/she establishes themselves as a decision maker, it is less likely that the farm will be sustainable and the more likely they are to live in a vulnerable household: successful farmers start relatively young and have time to build up their enterprise. Such results highlight the importance of programmes such as the Young Farmer Scheme.

The last topic we use as an example for the usefulness of sustainability data, is the use of advisory services by farmers. This is relevant not only because it can be subsidised in the rural development programme of the CAP, but it also plays a role in more bottom-up innovation processes. With FLINT data it is possible to investigate the use of extension services by farm households; exploring the type of extension service engaged with; the degree of engagement; and the type of information sought. In countries such as Ireland, Spain and Poland, public extension services provide the most frequent interaction with farming households; whereas in the Netherlands, Greece, Finland and Hungary private advisory services are most commonly used. This represents the different institutional (and policy) frameworks across Europe for agricultural knowledge and innovation systems (Figure 2.3)(Knierim et al., 2015).

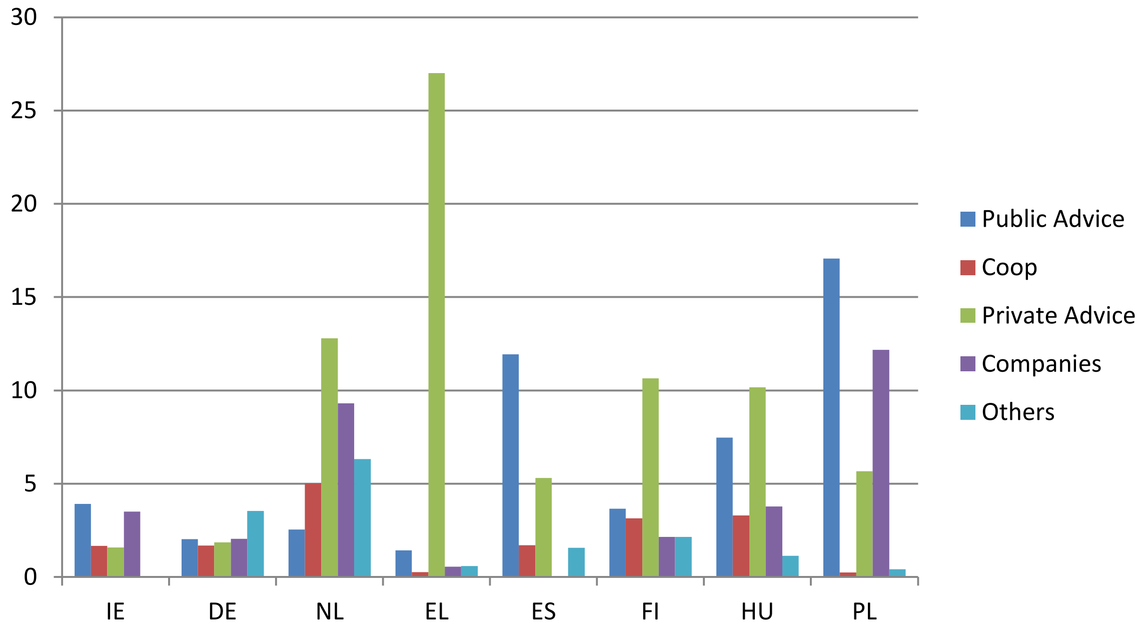


Figure 2.3: Mean number of engagements in 2015 with each advisory service per country (source: Brennan et al. (2016b))

Results of our analysis (see Brennan et al. (2016b)) indicate that the extent to which households engage with extension services has implications for the sustainability at the farm-level. An analysis with the data for Ireland (using 872 farms from the national FADN) indicates that participation in extension programmes has a positive impact on economic indicators, with all suggesting positive outcomes. Family farm income in particular is significant, with those who participate in extension programmes experiencing on average 6,469 euros in additional farm income per labour unit (Table 2.6). The environmental indicators suggest that those who participate in extension programmes have the poorest performance in terms of greenhouse gas emissions and risk of loss of nutrients to water (nitrogen per ha), though this result is statistically insignificant. The results for the social indicators signify that those who participate in extension schemes are less likely to suffer from household vulnerability and isolation (though these results are statistically insignificant) and more likely to have undertaken agricultural training. On average, farmers who participate in extension schemes work 88.5 more hours per annum than those who do not.

Table 2.6: Irish FADN extension coefficients for each regression with sustainability indicator as the dependent variable (source: Brennan et al., 2016b)

Indicators	*Extension*	*SE*	*R-squared*	*Observations*
Economic				
Output per ha	129.1**	55.41	0.634	872
Gross margin per ha	79.16**	33.33	0.649	872
Family farm income per labour unit	6,469***	1872.00	0.295	872
Viability	0.058*	0.034	0.268	872
Market orientation	0.0155**	0.01	0.608	872
Environmental				
GHG per ha	0.141	0.13	0.65	872
Nitrogen per ha	5.24	3.56	0.552	872
Social				
Household vulnerability	-0.053	0.04	0.139	872
Agricultural training	0.080**	0.03	0.189	872
Isolation	-0.000	0.03	0.037	872
Hours worked	88.51*	50.37	0.228	871

Robust standard errors reported for OLS
*** p<0.01, ** p<0.05, * p<0.1

Latruffe et al. (2016a) assessed the trade-offs between economic, environmental and social sustainability using a variety of indicators. Within each type of farming, farms were statistically grouped into clusters of different economic sustainability based on several economic indicators available in FADN (such as output, costs, farm value added). The environmental sustainability (in terms of GHG, N balance and EFA) and social sustainability (in terms of farmers' quality of life, stress and social engagement) were then compared across clusters. Finally, the characteristics of the best performing clusters were identified.

Results indicate that there are trade-offs between economic sustainability and environmental sustainability, as well as within environmental sustainability (depending on the indicators), in the sense that indicators are positively correlated for some farm types and negatively for others. By contrast, no trade-offs were identified between economic performance and social performance defined by the three above-mentioned indicators. High social sustainability is either not related significantly to high economic performance or is related to it in a positive way.

These examples show that having data on individual farms that describe environmental, economic and social indicators is very important to investigate relations and trade-offs. It is not just having data on risk management, or young farmers or environmental performance that is interesting for monitoring and policy evaluation. In that case different samples on different topics could be set up, although that would not necessarily be very efficient (but it would distribute the higher administrative burden among farmers). Most important for understanding the management and behaviour of farmers in policy analysis is to have information on all relevant aspects. We come back to that in Section 2.4, but first discuss which data could be useful for future policy monitoring and analysis.

2.3 Set of indicators needed[4]

The examples in the previous section show that it is beneficial for policy evaluation to have access to more data on the micro level to monitor in detail what is happening on the farm. As these are examples, the FLINT project has analysed in more detail which indicators are needed. The theoretical framework for proposing the final list of indicators is based on the components of an agricultural information system (Figure 2.4).

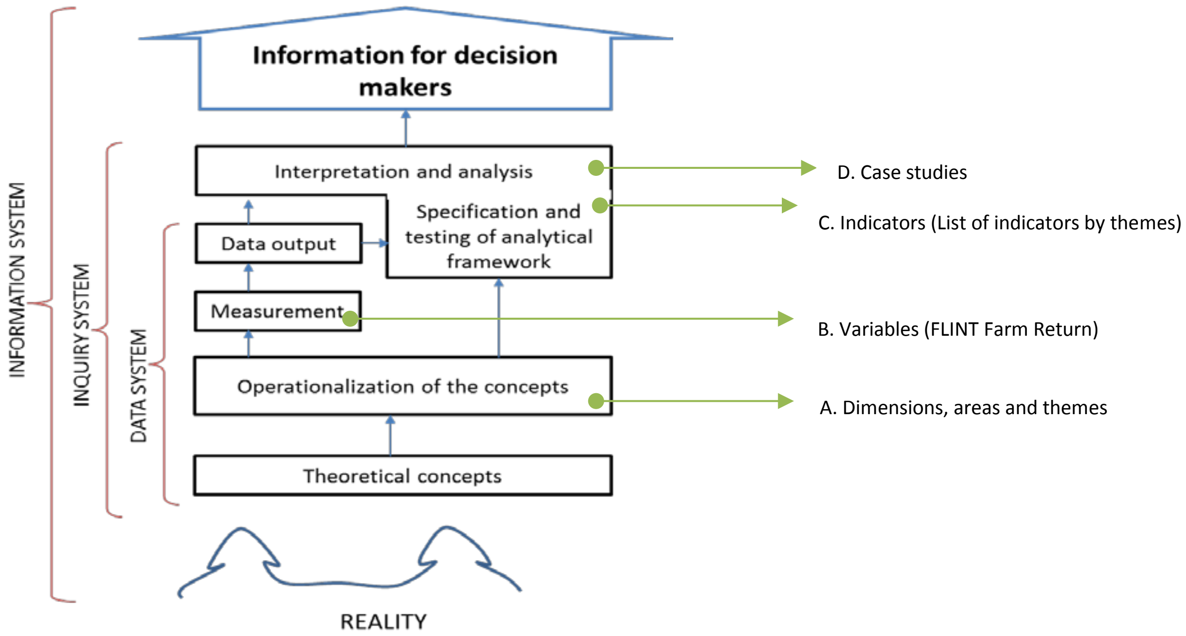


Figure 2.4. An Agricultural Information System Concept and elements to consider in the selection of FLINT final set of indicators needed.

Source: Adapted from Bonnen (1975).

To define the final set of indicators needed, the four elements of the information system have been considered:

A. Concepts and themes (dimensions, areas, and themes) that have been selected according to policy priorities, literature reviews, stakeholders' perception and discussed along the project.
B. Experiences in measurement and the output data obtained (of variables) have been evaluated. The result is a list of variables which could be collected with at least a minimum level of quality?
C. The specification of the analytical framework has taken place through literature reviews and discussions about indicators. Evaluation of the analysis and interpretation of indicators has been conducted. The result is the selection of indicators by theme to be calculated and reported.

4 This section is partly based on the FLINT documents Latruffe et al. (2016e), Herrera et al. (2016a)

D. Interpretation and analysis has also been conducted to test if better information for decision makers is generated (case studies). Some examples of this were described in the previous section of this report.

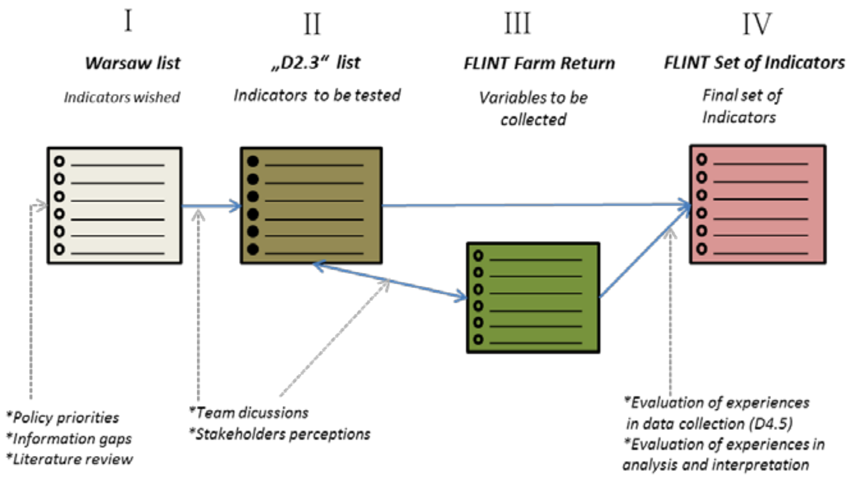


Figure 2.5 Steps taken to define the FLINT set of indicators (source: authors own compilation)

The working process of defining the set of indicators can be described as a suite of defining and selecting concepts, indicators, variables and measurement instruments. Several steps were taken to define the FLINT set of indicators (Figure 2.5). The first list ('*Warsaw list')* was the result of the analysis of the policy priorities (see Section 2.1 above), analysis of information gaps and a comprehensive literature review of sustainability farm level indicators. Experiences from member states that already collect sustainability indicators were also reviewed. The list was structured according to the three sustainability dimensions: environment, social and economics. This 'ideal' list was reduced to a list of indicators with the most essential indicators for policy analysis, taking also into account the feasibility of data collection. This list of indicators describes 33 topics, grouped in 11 themes ('*D2.3 List*', Table 2.7). The list has been translated into a manual for data collection *('the FLINT Farm Return')*.

Table 2.7. FLINT set of indicators

	Area	Themes	Indicators
Environmental	1. Land Management	E1: Greening: permanent grassland E2: Greening: Ecological Focus Areas E3: Semi-natural farmland areas EI5: Land fragmentation (Efficiency field parcel)	E_1_1; E_1_2; E_1_3; E_2_1; E_2_2; E_3_1; EI_5_1; EI_5_10; EI_5_11; EI_5_2; EI_5_3; EI_5_4; EI_5_5; EI_5_6; EI_5_7; EI_5_8; EI_5_9
	2 Soil	E6: Soil organic matter in arable land E11: Farm management to reduce soil erosion	E_6_1; E_6_9; E_10_1; E_10_2; E_11_1; E_11_2; E_11_3; E_11_4; E_11_5; E_11_6; E_11_7; E_11_8
	3 Pesticides	E4: Pesticide usage (pesticide risk score)	E_4_1

	4 Nutrient Balance	E5: Nutrient balance (N, P) E10: Farm management to reduce nitrate leaching E12: Use of legumes	E_5_1; E_5_2; E_5_3; E_10_3; E_10_4;
	5 Energy	E7 : Indirect energy usage E8 : Direct energy usage E9: On-farm renewable energy production	E_7_1; E_7_2; E8; E9
	6 GHG Emissions	E13 GHG Emission per ha E14 GHG emissions per product E15: Carbon sequestering land uses	E_14_1
	7 Water	E16: Water usage and storage E17: Irrigation practices	E_16_1; E_16_2; E_16_3; E_16_4; E_16_5; E_17_1; E_17_3; E_17_4; E_17_5
	8 Biodiversity	E18 Crop species diversity	E_18_1
Social	1 Information and Knowledge	S1 : Advisory services S2 : Education and training S3: Ownership management	S_1_1; S_1_2_1; S_1_2_2; S_1_2_3; S_1_2_4; S_1_2_5; S_1_2_6; S_1_2_7; S_1_2_8; S_1_4; S_2_1; S_2_2; S_2_3; S_2_4; S_2_5; S_3_6; S_3_7
	2. Community engagement?	S4: Social engagement/participation S7: Social diversification: image of farmers/agriculture in local communities	S_4_1; S_4_2; S_4_3; S_4_4; S_4_5; S_7_1; S_7_2
	3. Working Conditions	S5: Employment and working conditions	S_5_1; S_5_13; S_5_14; S_5_15; S_5_16; S_5_17; S_5_18; S_5_19; S_5_2; S_5_20; S_5_21; S_5_22; S_5_23; S_5_24; S_5_25; S_5_27; S_5_28; S_5_29; S_5_3; S_5_30; S_5_4; S_5_5; S_5_6; S_5_7; S_5_8; S_5_9
	4 Quality of Life	S6: Quality of life/decision making	S_6_1;S_6_10;S_6_2; S_6_3; S_6_4; S_6_5; S_6_6; S_6_7; S_6_8; S_6_9
Economic	1 Market access?	EI2: Producing under a label or brand EI3: Types of market outlet	EI_2_1; EI_2_2; EI_2_3; EI_2_4; EI_2_5; EI_2_6; EI_2_7; EI_3_1; EI_3_2; EI_3_3; EI_3_4
	2 Risk Reduction	EI7: Insurance EI8: Share of output under contract with fixed price delivery contracts	EI_7_1; EI_7_2; EI_7_3; EI_7_4; EI_7_5; EI_8_1; EI_8_14; EI_8_2; EI_8_3; EI_8_4

		EI9: Non-agricultural activities	EI_8_5; EI_8_6; EI_8_7 ;EI_9_1; EI_9_10; EI_9_2; EI_9_3; EI_9_4; EI_9_5; EI_9_6 ;EI_9_7; EI_9_8 ;EI_9_9
Innovation	1 Innovation	EI1: Innovation EI6 : Modernisation of the farm investment	EI_1_1; EI_1_2; EI_1_3; EI_1_4; EI_6_1; EI_6_2; EI_6_3; EI_6_4; EI_6_5

A detailed description of concepts, indicators, variables and calculations is provided in Annex II.

2.4 Integrated data collection needed[5]

The examples in section 2.2 show that it is beneficial for policy evaluation to have access to more data on the micro level to monitor what is happening on the farm, with a full list of the desired indicators discussed in the previous section. The problem is that those data are not available, at least not in an integrated form. For the examples in section 2.2 they have exclusively been collected by the FLINT project, with the addition of some FADN data that are only nationally available.

The FLINT project therefore addressed the question whether there is a need to collect all relevant data from the same farms, or whether the policy evaluation could be based on alternative data sources. One alternative is to infer some of the data needed from current available data. For instance the amount of money paid for fertilisers, as documented in the FADN, could be used as an estimation for the quantity of fertilisers (by using price statistics to convert monetary values to quantities) and this as a proxy for the environmental pressure of the farm system. That would essentially mean that no new data has to be collected, but new data (interpretations) can be derived from existing ones. Another alternative is to combine data collected from different farms, e.g. environmental data collected on one farm and financial data on another farm. The advantages of such a solution are that some of this data is already available (e.g. Eurostat statistics and FADN) or - when this is not the case - that the administrative burden of collecting such data could be spread over different farms (but probably lead to higher costs of data collection).

Policy-makers have to evaluate the trade-offs between different policy objectives, e.g. farm income, different environmental impacts and food security (production levels). With policy measures they try to influence the decision of a farmer in such a way that the outcome of the decision would be different from a situation without a policy. In policy evaluations, researchers try to compare these two situations: with and without a policy, in order to estimate the effectiveness of a policy (and the money spent on it). This asks for detailed data on the behaviour of the farmer and how his/her decision affects the policy objectives. It means that policy researchers are more interested in those relationships between policy, management and the exact relation between inputs, outputs and income, than in the statistical data on use of inputs or of income as such.

5 This section is partly based on the FLINT documents Vrolijk et al. (2016); Latruffe et al. (2016d); Saint-Cyr et al. (2016)

The FLINT project tried to assess the need of having the data collected on one farm, compared to estimating the data by imputing data from other sources or assuming that financial data is a good estimator for volume data. For this purpose a number of policy analyses was not only carried out with the integrated data collected in FLINT (the baseline of this comparison) but also with data that were imputed from other farms where FLINT collected data (to mimic the situation that incomplete data are gathered on different farms and then combined) and on the current available data from FADN.

A first example is related to data on land fragmentation (for details of this analysis see: Saint-Cyr et al. (2016)). Land fragmentation (LF) of the field pattern is a structural characteristic of holdings which has to be taken into account when investigating the drivers of farm performance. Difference in LF may be a source of difference in productivity or efficiency among farms which may appear as equivalent on other grounds. Not taking LF into account would lead to spuriously attribute its impact either to the farmers' ability or to other variables of interest such as public support.

However, it has been difficult so far to precisely assess this relationship on a large scale because there does not exist to date a single database which would allow to measure, at the same time and for the same farm, both performance and fragmentation indicators at the individual level. Latruffe and Piet (2014) combined accountancy data with data from the Land Parcel Identification Systems (LPIS), enforced by the European Council Regulation No 1593/2000. As, due to confidentiality reasons, farms are not recorded with the same identifier in both databases, the authors had to use the assumption that the land fragmentation of a farm is positively correlated with that of the municipality where it is located.

The FLINT data with a small set of LF-related variables (surveyed in the FLINT project) may look simplified with respect to the precise information of the LPIS, but together with the information regarding the farm's UAA already available in the FADN, they nonetheless allow deriving effective LF indicators and make a comparison over member states possible (the LPIS is not harmonised over member states).

The exploratory exercise shows that (1) a wide variety of situations with respect to farm LF across EU member states and farming types exists; (2) LF seems to be only loosely related to working conditions and quality of life indicators for the studied sample and (3) LF into account does change the results obtained when analysing the links between agricultural subsidies and farm technical, economic and environmental performance. When subsidies are considered as a whole, most of their impact seems to come from the interaction with the average distance of farm plots, an effect which is not captured when LF is not taken into account. This seems to be also true as far as decoupled payments are concerned while the impacts of other types of subsidies appear to be more direct, i.e., disconnected from the level of LF.

In this analysis it was also investigated if imputing data (through the mean) to replace missing values in a larger sample constitute an improvement. Results show otherwise, as imputation often leads to degrading the explanatory power of the model and blur the results regarding the relationships between the dependent variable and the chosen covariates. This strongly advocates for gathering data as exhaustively and precisely for the same farms and at the same time.

A second example in which we investigated the added value of all data gathered on one farm above a policy analysis with imputed data or a smaller data set, deals with technical efficiency, environmental outputs and the role of subsidies (for more details, see Latruffe et al., 2016d). Farm technical efficiency is a global productivity indicator in the sense that it considers all outputs produced and all inputs used by the farms. The Common Agricultural Policy (CAP) aims at promoting farm competitiveness, and hence a legitimate question is whether the CAP subsidies received by farms contribute to enhance their technical efficiency. Studies investigating the effect of subsidies on technical efficiency so far have considered only marketed outputs, that is to say, food (and fibre and feed) sold and generating revenue. Non-marketed outputs such as environmental and social outputs are not considered, as such data are not recorded in the FADN. With FLINT data it is possible to incorporate environmental outputs in the calculation of technical efficiency and analyse the effect of CAP subsidies on technical efficiency. Three environmental outputs have been considered: greenhouse gas emissions, nitrogen balance and Ecological Focus areas.

The results show that the effect of subsidies on farms' technical efficiency changes when environmental outputs are taken into account in the efficiency calculation. Some effects that are not significant on the classic technical efficiency (i.e. without environmental outputs) become significantly negative or positive effects when environmental outputs are accounted for; some effects that are significantly negative or positive on the classic technical efficiency become non-significant effects when environmental outputs are accounted for; some effects that are significantly negative on the classic technical efficiency become significant positive effects when environmental outputs are accounted for.

Some of these changes in effects' signs and significance are also observed when using data-sets with imputed data (where missing data have been imputed by the means) and with reduced data (where one farm was full removed from all efficiency calculations as soon as it had missing information on some input or some output). Hence, the treatment for missing data may bring changes in conclusions and policy recommendations, and the sample considered for policy evaluation should be well thought when environmental outputs are collected.

In summary, results indicate that the effect of subsidies on farm technical efficiency changes when environmental outputs (namely greenhouse gas emissions, nitrogen balance and ecological focus areas) are taken into account in the efficiency calculation. Accounting for environmental outputs may thus change policy recommendations, and it is important to account for such outputs so that farms producing such outputs are not penalised in the calculation of technical efficiency. Evaluations of policies that aim to improve efficiency should therefore be based on a full set of data in relation to the management decisions of the farmer.

2.5 Conclusions

In this chapter we have analysed the developments in the Common Agricultural Policy and related policies (via cross-compliance or otherwise) and can conclude that there are many new topics that require micro-data for monitoring and evaluating the effectiveness and efficiency of the policies. As shown by a number of examples in which we used the new data that we collected, there is a need to have data describing different aspects of environmental, economic and social sustainability on the same farm. This is because policies target farm management that affect these aspects and its trade-offs or jointness. We showed that imputation methods can be useful, but they are less precise and hence best of all the data is gathered on the same farms.

We have defined new indicators for 11 new policy topics, split into 33 indicator themes. The next chapter investigates the feasibility of collecting these data.

3 FEASIBILITY OF DATA COLLECTION

Given the need for the data discussed in Chapter 2, this chapter focuses on the feasibility to collect this data. We first look which data is already available at farm level, given the administration that farmers have for their management, for tax accounting and for compliance auditing in private certification schemes for food safety and environmental claims. We then describe the data collection that the FLINT project carried out on more than 1,000 farms in 9 European countries. Subsequently our experiences in data collection are reported, in which special attention is paid to the views of the participating farmers and the data collectors. Next our experiences in data management are described and we end with a conclusion on the feasibility.

3.1 Availability of data at farm level[6]

As in many other contexts, sustainability has become a general principle for the assessment of agricultural activity. At national level administrations have already recognised the importance of growing needs of reliable data on economic, social and environmental dimensions of sustainability. In the past few years, efforts have been made to improve the volume, range and quality of data collection on farm level but most of these concentrate either on only one dimension (often the environmental dimension) or specific themes within a dimension, for instance greenhouse gas emissions or biodiversity within the environmental dimension (Binder et al., 2010; Bockstaller et al., 2006; Meier et al., 2015). The coverage of all these attempts (due to the small sample size) was not satisfactory enough and did not make it possible for decision makers to use these information as an input for the design of sound and well-established policy measures.

Some of the data collected within the framework of FLINT project are already available at national level. For national purposes farm accountancy data networks have been improved and adapted to suit the changing needs of national users. Six out of nine of the member states involved in the FLINT project indicated that data related to agricultural machinery and building, livestock and crop production were already available and four out of nine FLINT partners collected information on manure, slurry and energy consumption previously (Table 3.1). On sensitive and subjective topics such as working conditions and quality of life no data is available.

6 This section is partly based on the FLINT documents: Kis Csatári and Keszthelyi (2016b), Poppe et al. (2016)

Table 3.1: Share of already existing data

Theme / indicators	Share of already existing data	Share of personal interview needed	Theme / indicators	Share of already existing data	Share of personal interview needed
Information and Knowledge	⊙	●	Marketing contracts	○	●
Quality Of Life	○	●	Risk reduction	⊙	●
Innovation	○	●	Pesticide usage	⊙	●
Machinery and buildings	◉	◉	Livestock (quantity)	◉	⊙
Label	⊙	●	Crops (quantity)	◉	⊙
Market outlet	⊙	●	Purchased feedingstuff	⊙	◉
Greening	⊙	●	Purchased seed	⊙	◉
Nitrate leaching reduction	○	●	Manure	◉	◉
Soil erosion	○	◉	Slurry	⊙	◉
Land fragmentation	○	◉	Energy	◉	◉
Soil organic matter	○	●	Water	⊙	●
Insurance	○	●			

0% ○ ⊙ ⊙ ⊙ ◉ ◉ ◉ ● ● ● 100%

Source: Online survey (FLINT project)

There are differences between farms in the types of data that are available at farm level. Farmers with management software, tax accounting obligations or sales under certification schemes such as GlobalG.A.P. or Organic farming have large amounts of data available. Other farmers are not involved in such systems.

Also the agri-food sector responds to these new needs. The UN Global Compact[7] principles and the Sustainable Development Goals highlight directions to pursue on sustainable development that relate to, among others, food security, resource efficiency and environmental impacts in agriculture (Griggs et al., 2013). Food and beverages processing companies often express their

7 www.unglobalcompact.org

commitment to improve on these internationally-recognised goals and principles in their corporate social responsibility report. Reporting guidelines set by organisations such as the Global Reporting Initiative provide direction to what indicators could be included, and which data are needed to report against these indicators (Vigneau et al., 2015). Another example where there is a farm-level data need is for certifications schemes such as Global G.A.P.[8] or the Irish *Bord Bia* Quality Assurance Schemes[9]. Data assembling is often in place, or linked with farm management systems. Alongside standards and certifications that are being developed to measure sustainability performance, there are also sector-based initiatives that pursue alignment across initiatives such as the Sustainable Agriculture Initiative (SAI) Platform[10]. The SAI Platform works on tools and guidance that enhances the support of both global and local sustainable practices and sourcing. Another more sector-specific example is the Dairy Sustainability Framework (DSF)[11]. The DSF is a programme from the Global Dairy Agenda for Action (GDAA) that aims for aligning and connecting sustainability initiatives in the dairy supply chain.

At a national level, there are several initiatives to develop empirical indicator frameworks which are directly linked to data collection to capture the sustainability performance of farms at farm level (Boone and Dolman, 2010; Dillon et al., 2010; Platteau et al., 2014). Although these initiatives are successful in measuring (certain aspects) of farm-level sustainability, a current limitation is that the measurement and data collection are not harmonised among countries. This lack of harmonisation and especially the fact that this information is only available for a limited set of countries hampers its use in EU policy evaluation.

3.2 Data collection in the FLINT project[12]

Due to the agricultural sector specificities, developing and implementing an integrated data collection which is harmonised in the EU remains a major challenge. Whilst the world increasingly relies on the creative economy to drive sustainable growth, EU-wide statistics provide an incomplete picture of sustainability. This makes it difficult to consider appropriate policies (European Commission, 2012).

To provide an assessment of the feasibility of collecting farm level data for the selected indicators, the existing FADN data infrastructure was used. The responsibility for FADN data collection rests with the Liaison Agencies, often together with agricultural research institutes. These either employ their own staff to visit the sample farms and to collect the data, or they contract this work out to accountants, universities, farmers' cooperatives or other organisations (Chapter 4 provides more background to this situation). This implies that there are differences between countries how the roles of liaison agency, national FADN management and on-farm data collection are allocated to organisations. The organisation of FADN data collection in the member states involved in the FLINT project is given in Table 3.2. The member states use different methods to collect data for FADN, covering a spectrum that ranges from, at one end, those that make use of existing tax and other administrative data, through those that draw information from existing farm accounts in various ways, to at the other extreme where data are

[8] www.globalgap.org/uk_en
[9] www.bordbia.ie/industry/farmers/quality/pages/qualityassuranceschemes.aspx
[10] www.saiplatform.org
[11] dairysustainabilityframework.org
[12] This section is partly based on the FLINT documents: Vrolijk et al. (2016), Kis Csatári and Keszthelyi (2016b).

collected by farm visits (Agra CEAS Consulting 2007, Hill 2012). Therefore, the situations in the countries involved are more or less representative for all 28 member states of the EU.

Table 3.2: Organisation of FADN data collection for countries in the FLINT project

Country	*Liaison agency (FADN)*	*How are the data collected (FADN)?*
France	Ministry of Agriculture	Partly by Regional LAO employees, partly by private firms
Ireland	Research Institute	Partly by LAO employees
Spain	Ministry of Agriculture	Partly by Regional LAO employees, partly by private firms
Poland	Research Institute	By accountancy offices which are agricultural advisory centres and legal entities of the NUTS 2 (*voivodship*) local governments
Greece	Ministry of Agriculture	By state employees at the Prefectures, belonging to the Ministry of Interior
Germany	Ministry of Agriculture	Partly by Regional LAO employees, partly by private firms
Hungary	Research Institute	Outsourced to private firms (with more or less data treatment and controls at LAO level)
Netherlands	Research Institute	Partly by LAO employees, partly by private firms
Finland	Research Institute	Outsourced to private firms (with more or less data treatment and controls at LAO level)

Note: LAO = Liaison Agency Office

Source: EU DG-AGRI FADN Committee RICC 1605

Depending on the consortium partner's legal status and relationship with the Liaison Agency of the given country, the data collection methodologies that were applied by the member states for FLINT can be separated into two main types (Figure 3.1). In case of Ireland, Poland, Finland, Hungary and the Netherlands Liaison Agencies and/or other bodies responsible for completing the FADN Farm return were involved in the FLINT data collection. In this case the FLINT data collection procedure followed the protocol as in general for the FADN within the framework of a separate agreement. In case of Greece, France, Germany and Spain the FLINT data collection was separate from FADN data collection.

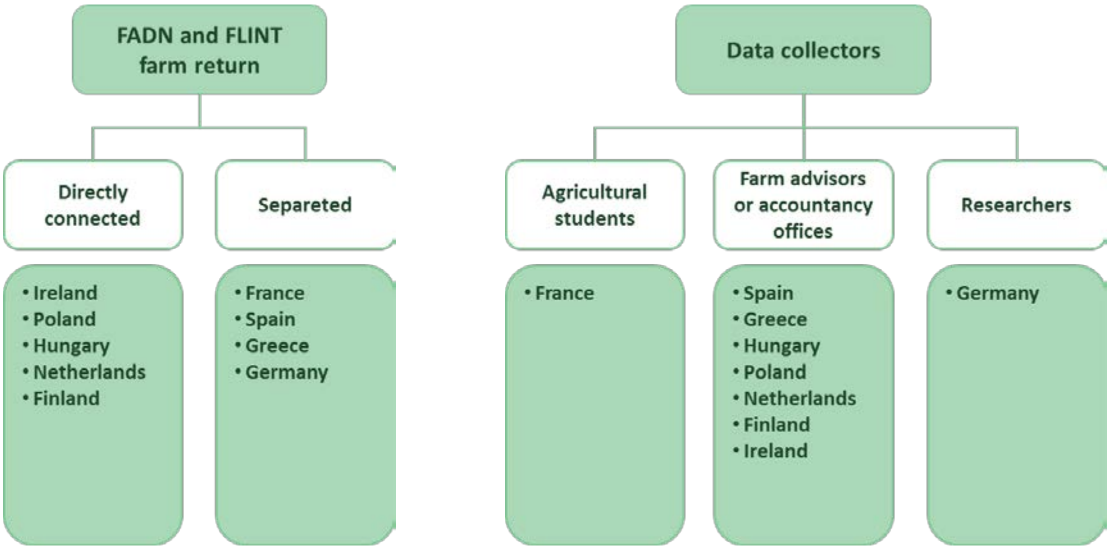


Figure 3.1: FLINT data collection

Source: Online survey

The data collection methods were pretested to identify potential problems with the survey items as well as the data collection protocols. The pre-test involved data collection from a small number of farmers. Based on the feedback from data-collectors and farmers, the FLINT farm return was improved, definitions and explanations were clarified.

In total 1,000 pilot farms were selected. In the determination of the selection plan the size, the type of the farm, certain policy objectives (Nature 2000 and High Nature value areas) and the different administrative environment of the member states were also taken into account. The number of sample farms and the year of data collection by member states can be seen in Table 3.3.

Table 3.3: Sample size (according to selection plan) and the year of data collection

	FRA	*IRE*	*ESP*	*POL*	*ELL*	*DEU*	*HUN*	*NED*	*FIN*
Sample farms for FLINT	150	65	165	140	110	95	100	150	50
Accounting year	2014	2015	2015	2015	2015	2014/ 2015*	2015	2015	2015

*(from 1 July to 30 June)
Source: Online survey

The Community FADN Farm Return covers a period of twelve consecutive months. Member states have accounting years starting on different dates. In Germany the accounting year runs from 1 July to 30 June and the FLINT data collection follows the same period of time. In France, FADN data referring to accounting year 2014 were available for the French consortium partner (INRA) therefore FLINT data relate to this period, as well.

The data collection covered 33 topics in 11 themes which serve the data need for the calculation of almost 180 sustainability indicators. For this the indicators were translated into the need for raw data items that could be taken from invoices and other paper worked or could be collected during a farm visit. This led to 1,060 new data items to be collected overall, which means approximately 300-400 new data per farm (Figure 3.2). In line with the normal FADN practices, these items were grouped in 10 tables ('the FLINT Farm Return').

Data definition and manual

A document was prepared with definitions of each of the variables. In line with the FADN Farm Return, this document was called the FLINT Farm Return. For practical reasons the required data were rearranged into ten tables and structured and described according to the EU FADN standards. This way the data collection could be better integrated in the national FADN systems and more important it allowed the use of the current data checking infrastructure (RICA-1) of DG Agri to check the FLINT data. FLINT data were crosschecked with FADN data at farm level to enhance data quality.

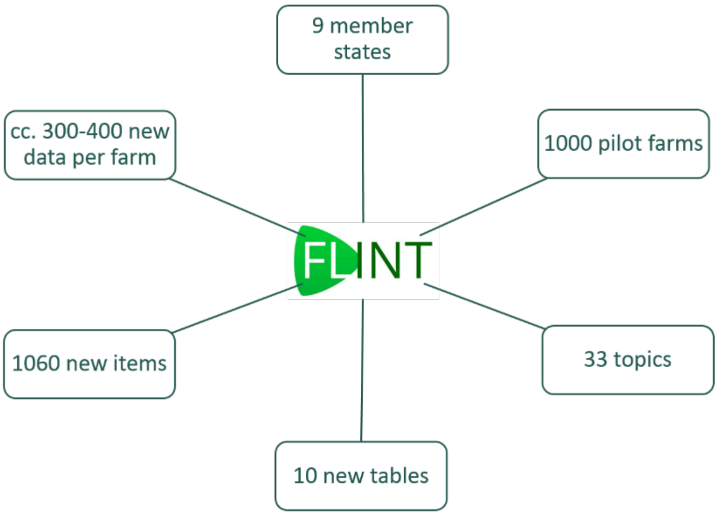


Figure 3.2: FLINT data collection in numbers

Data were collected and recorded by trained data collectors, except in Germany where due to the special administrative circumstances data were self-reported by farmers (with assistance provided by researchers). In France the data collection was made by agricultural students, and in the rest of the countries it was made by farm advisors and accountancy offices (Table 3.4). When data collection was made by experienced data collectors the training of data collectors took less time than for example in France where agricultural students were involved without experience in data collection.

Table 3.4: Data collection in the FLINT project.

Country	**Number of farms**		**Integration with FADN**	**Data collected by**	**Methods of data collection**
	Selection plan	**Data collected**			
Type 1: own staff data collection					
Greece	110	124	Separate	Researchers	Farm visit
Ireland	65	64	Integrated	FADN data collectors	Farm visit
Netherlands	150	155	Integrated	FADN Data collectors	Other sources and farm visit
Poland	140	146	Integrated	FADN data collectors (farm advisors)	Farm visit and other sources
Spain	165	165	Separate	FADN Advisors and FADN accounting office	Farm visit and other sources
Type 2: Outsourced data collection					
Type 2a: Ministry supervision (regular FADN in FLINT by research Institute)					
France	150	297	Separate	Students	Farm visit
Germany	95	52	Separate	Researchers	Mail questionnaire
Type 2b: Research institute supervision					
Finland	50	49	Integrated	FADN Accounting offices	Farm visit
Hungary	100	102	Integrated	FADN Accounting offices	Farm visit

Source: own compilation

FLINT data was collected in different ways. Some of the partners integrated the data collection in their normal processes and tools. A wide range of tools is used by agricultural agencies in Europe to collect and store information at farm level (e.g. the information on invoices, the use of Electronic Data Interchange messages etc.). A common data collection tool (based on Excel to avoid internet constraints) was developed in FLINT for the partners who could not easily adapt their own data collection software. The data was transferred from the spreadsheets or databases to the central database of the project (see Section 3.3).

3.3 Experiences in data collection[13]

In general, the FLINT project showed positive experiences of collecting sustainability data, furthermore the project showed that farmers are willing to make the data available. Nevertheless the FLINT project was challenged by some difficulties and learnt valuable lessons for future continuation of such data gathering.

A major challenge for the project was to organise the data collection in those cases where the FLINT consortium partner was not the Liaison Agency, or where the FADN data are retrieved by the Liaison Agency from commercial tax accounting offices. The FLINT project was partly designed to investigate such problems and to overcome them. We therefor pay explicit attention to them here.

All the Liaison Agencies had a positive attitude to the FLINT project and provided assistance for recruiting farms and transmitting FADN data. Nevertheless some legal problems were encountered. In Germany, the addresses of FADN farms are only known by the private book-keeping offices that forward the collected data, anonymously, to the regional agricultural authorities, and from there the data goes to the Federal ministry and finally to the Liaison Agency. Thus, all public levels, including the Liaison Agency, work only with anonymous FADN data. The bookkeeping offices have no interest in disclosing the farm addresses, even if they were released from privacy obligations, as they fear they lose clients, which would jeopardise their business as well as the normal FADN data collection. As a supportive action the Ministries from the three Bundesländer involved in FLINT encouraged selected bookkeeping offices that were known for their cooperation willingness to distribute letters to farmers in which the farmers were invited to contact the consortium partner ZALF if they were interested in participating in the FLINT survey. Letter invitations are less successful than direct contacts, explaining the low response rate in Germany. The only way to overcome this situation would be that data collections such as in FLINT would be in the self-interest of the federal agricultural ministry, BMEL. Then BMEL could take legal and administrative actions to change and extend the current FADN organisation towards collecting sustainability data.

In France the Liaison Agency was able to provide the FLINT team of INRA with the contact details of FADN farmers, and this made it possible to organise a FLINT data collection process by sending students to the farms for data collection. This made it possible to test a solution where collection of FLINT data is not done by the staff or commercial accountants that normally visit the farm for data gathering, but via an additional, separate process. It should however be kept in mind that such a way of data collection (through students) would not be used by the Liaison Agency if similar data collection would become compulsory for member states. Hence, the case of France should not be fully regarded as a successful test for the reality, as it would not be replicated as such in the reality in the future. The cost in reality may be higher than when the interviews are outsourced to agricultural students; the quality and quantity of data collected may be different; etc.

Another problem occurring in France is data protection. Due to the separate data collection in France, the project resulted in two databases with individual data: an FADN database and a FLINT database. Legal arrangements (with the French Data Protection Authority, governing data matching and data exchanges) had to be made to link the data, but also to transfer them to RICA(1) infrastructure for data testing and to the other FLINT partners for analysis. Again preluding our conclusions later in this report, this problem is due to the project-structure of

[13] This section is partly based on the FLINT documents: Vrolijk et al. (2016), Kis Csatári and Keszthelyi (2016b).

FLINT and would not occur if the data was collected as one FADN data set under the authority of the Liaison agency, even if parts of the dataset are collected by different persons. This also holds for a similar challenge in a country such as Spain where the project was dependent on the national liaison agency to send the FADN data of the farms involved in FLINT to Brussels prior to the normal delivery at the end of the year.

The experience of data collectors was monitored throughout the data collection period. Based on their feedback, data availability was assessed for the nine member states with a five-point Likert scale with categories 1 'poor' to 5 'excellent'. The Likert scale of data availability was analysed (Figure 3.3). This feedback, from the data collectors in different administrative environments in nine member states shows that the data availability was the most problematic in case of data referring to Water and Land Management. Data collectors faced many difficulties in gathering information about the source and the usage of water. It can be generally stated that there are few farms which have a water meter and the water consumption from different irrigation channels can be established only by rough estimation. Six out of 9 member states involved in the FLINT project indicated that the data availability in case of Land Management is not satisfactory. Questions connected to greening (Ecological Focus Area), nitrate leaching reduction and soil erosion were not easy to interpret by farmers and this fact significantly influenced the data availability as well. For example, in some countries, the EFA categories used in FLINT differed from the EFA categories farmers use in their direct payments application forms. In other cases, for example pesticide usage, the results show large national differences. Where the data have been already collected for national purposes (Netherlands), the information requested was completely achievable. But in other cases (Greece, Finland, Hungary) the calculation of pesticide usage from parcel level sprayings to total amounts was experienced as difficult and data collection required extra effort, while in Germany the experiences were good.

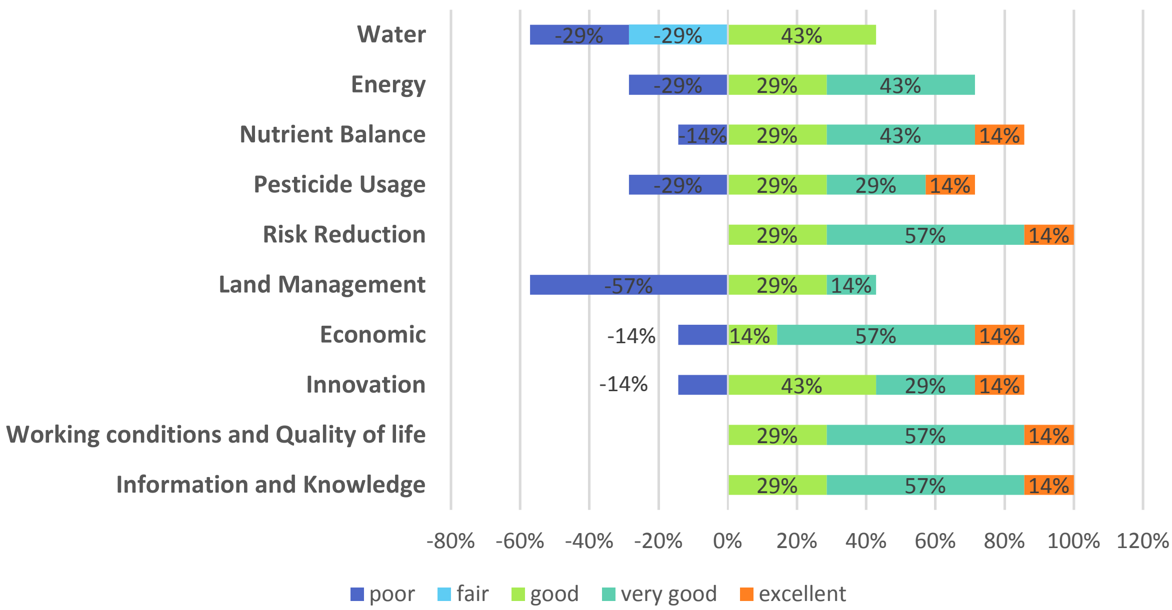


Figure 3.3: Assessment of data availability at the farm

Source: Online survey of data collectors

Data collectors gave feedback on the feasibility of the survey. Questions referred to the following: feasibility, complexity, data quality, structure of the tables, accuracy and comprehensibility of wording. For the assessment of the feasibility of the FLINT data collection, a five-point Likert scale was used with categories 1 ('poor') to 5 ('excellent'). Item responses were aggregated and a score for the group of items was created (Figure 3.4).

It can be concluded from the responses that the most problematic points with regard to feasibility were Land management and Innovation. The question about soil erosion was very difficult to understand by many farmers and in most cases it was also very difficult to estimate the area associated with erosion risk. National distinctions made the determination of permanent grassland difficult; for instance there is no 'natural' permanent grassland in Finland. In 6 out of 9 of the member states there are doubts concerning the data quality of information on land management, because the definitions and descriptions were hard to interpret by the farmers and therefore the data collection is based on rough estimations. At the time of data collection the farmers were still not familiar with the definition of Ecological Focus Area, which makes the level of uncertainty higher. Another problem in France and Germany was that the FLINT land management data information could not be cross-checked with area figures from FADN during data collection, because the FADN data was provided after the FLINT collection had been carried out. Also, there was a mismatch between the year the EFA area referred to (calendar year 2015) and the year of the FADN data in these two countries (2014/15).

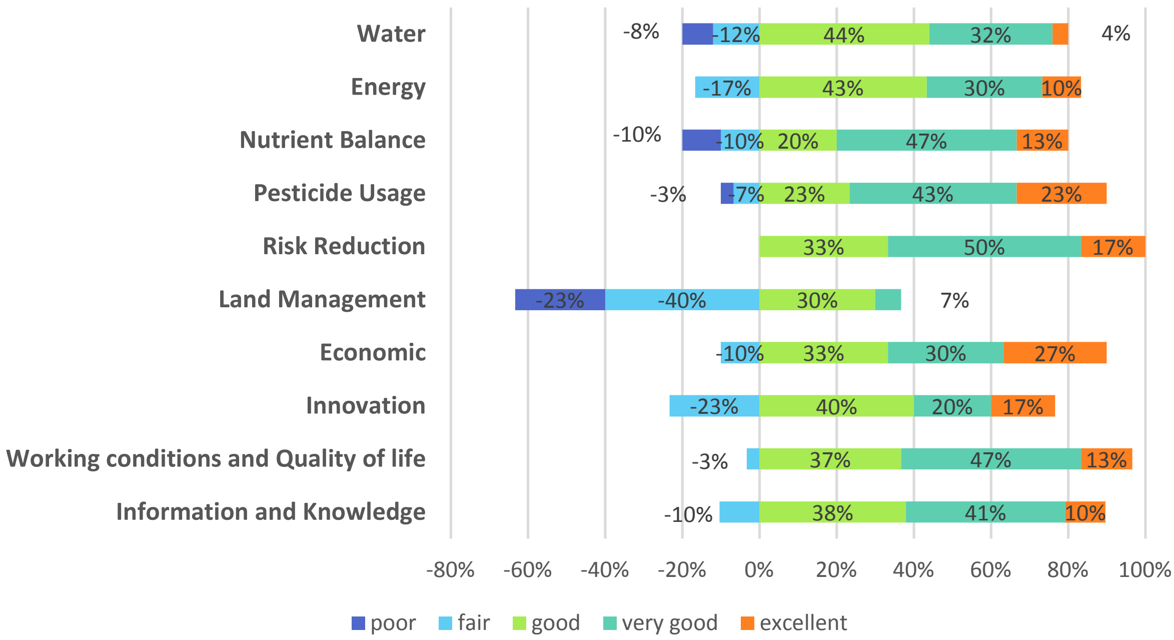


Figure 3.4: Feasibility of data collection

Source: Online survey

Cost of data collection

Collecting FLINT data in national farm accounts surveys will require adjustments in the systems. While we conclude that the costs of adaptation will be specific to each Member State, some general principles are evident. Although extending the collection of any type of data to the member states that do not currently collect it would incur costs, these would be marginal to the basic data collection infrastructure already in place (Bradly and Hill, 2015). During FLINT data collection, consortium partners had to face initial costs (such as training of data collectors, developing and installing IT infrastructure, etc.), which occur only in the first year and will incorporate into general FADN data collection costs if the European Commission decides to turn the pilot network to an operational EU-wide system.

To determine the additional cost of FLINT data collection, consortium partners and data collectors were asked to provide input in the online questionnaire. The survey covered the time required for the data collection by type of farming, the incentive scheme used to gain the data from the farmers and a cost estimation.

Based on the responses there was no special incentive in eight out of nine member states to persuade the farmers to take part in the FLINT project. Where data collection was made by FADN data collectors (Finland, Netherland, Hungary, Spain) good relationship between data collectors and farmers encouraged participation. Farmers were informed about the aim of the data collection and they will get a report at the end of the project. German farms received a financial incentive (150-500 euros per farm) as compensation for the time and effort needed to participate in the FLINT survey as well as a benchmarking report based on the indicator results of the project.

All the actors gave an estimation of the time required for collecting the data per farm, which contains detailed information on time needed for preparatory work, farm visit, completion, delivery and control of the data (Figure 3.5).

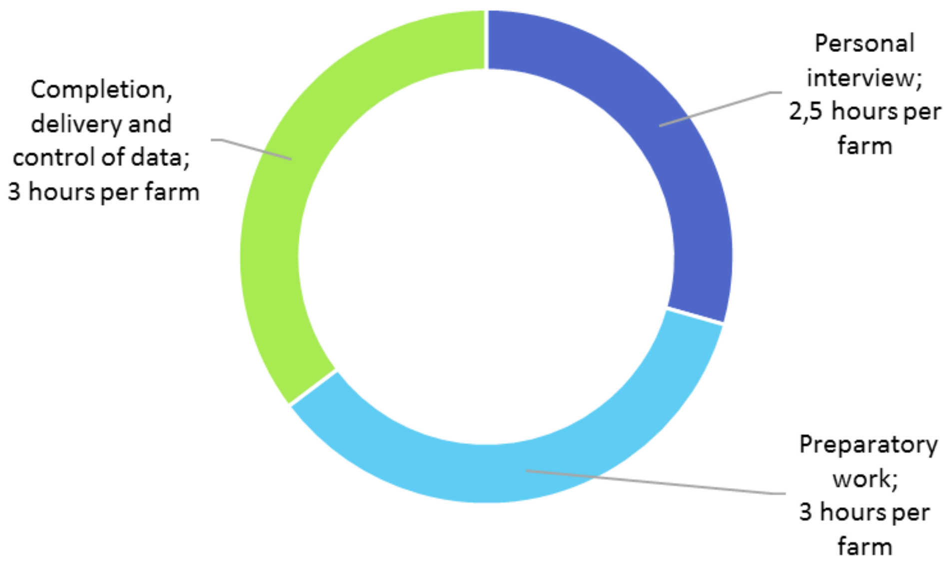


Figure 3.5: Time required for data collection per farm

Source: Online survey of data collectors

There is substantial variation among member states concerning the amount of time needed to collect the data. The results are influenced by the applied data collection methodology, the extent to which FLINT data was already part of the national FADN systems, the number of FLINT indicator themes that were collected, as well as the type and the size of a given farm. The average time required for data collection and data processing (including validation) is almost nine hours which vary from five to fifteen hours depending on the above mentioned circumstances.

Despite the fact that FLINT data collection was based on the FADN data collection methodology, the whole data collection procedure had to be established from the beginning. A new farm return was implemented, data collectors had to be trained and new or adapted IT infrastructure was installed for data recording, validation and storage. In case of those member states (Ireland, Finland, Netherlands, Hungary, Poland), where the FADN data collection is flexible and the system can easily adopt changes, the initial set-up costs were relatively low and existing resources were more effectively used. Initial costs, which incur only in the first year, distort the estimation of cost of data collection.

The total expenditure of data collection is not directly comparable between member states. In Germany the farmers self-reported their data and they received 150-500 euros per farm, but the data recording into the official FLINT spreadsheet was made by researchers. Poland spent 100 euros per completed questionnaire, but this figure does not contain the cost of data entry. In Spain, Hungary and Finland on average 300 euros per Farm Return were paid for the data collection (the cost of recording included). The other additional costs, such as recruiting of farms, training of data collectors, validation of data, application of new IT solutions vary from member state to member state, depending on the administrative environment and existing infrastructure in which FLINT data collection was integrated.

3.4 Experiences in data management[14]

Data collection is one thing, organizing it in a common harmonised European database is another. Where this is probably not a big issue for adding variables to the normal FADN system (although that is not free of cost), it turned out to be a complicated process on a project basis, notwithstanding the good collaboration with the liaison offices and the FADN Unit in DG Agri.

To check the collected data on potential errors and inconsistencies, and in line with the normal FADN procedures, 200 coherence tests were developed and modelled in the XML language. It was planned and agreed with the FADN unit in DG Agri to use their test server (an environment for testing FADN data) to test the FLINT data, this also allowed the running of integrated tests (running FLINT tests which are partly based on data in FADN). With hindsight it turned out that 2015 was an unfortunate year, as this was also a year of change for the normal FADN system with a high workload for the FADN unit. This created the risk that the FLINT testing procedure via the FADN unit in Brussels would not be available in time and therefore an alternative was considered.

Within the FLINT project, and the FLINT IT infrastructure built at INRA in Toulouse (ODR), another testing procedure was developed. A testing engine was developed at Wageningen Economic Research in The Hague. The advantage is that this software is now built from scratch and seems to be considerably faster than the older, and often changed, software at the FADN unit in Brussels (process time of checking is 90 seconds for testing 100 farms in the new software against several minutes per farm in the older software). Wageningen Economic Research has offered the FADN community to maintain this software together as a collaborative open source software. The Hungarian partner AKI made its software to calculate standard results (that mimics the DG Agri software) available for the project. In this way it was possible to calculate standard results without the need to further burden the FADN unit of DG Agri.

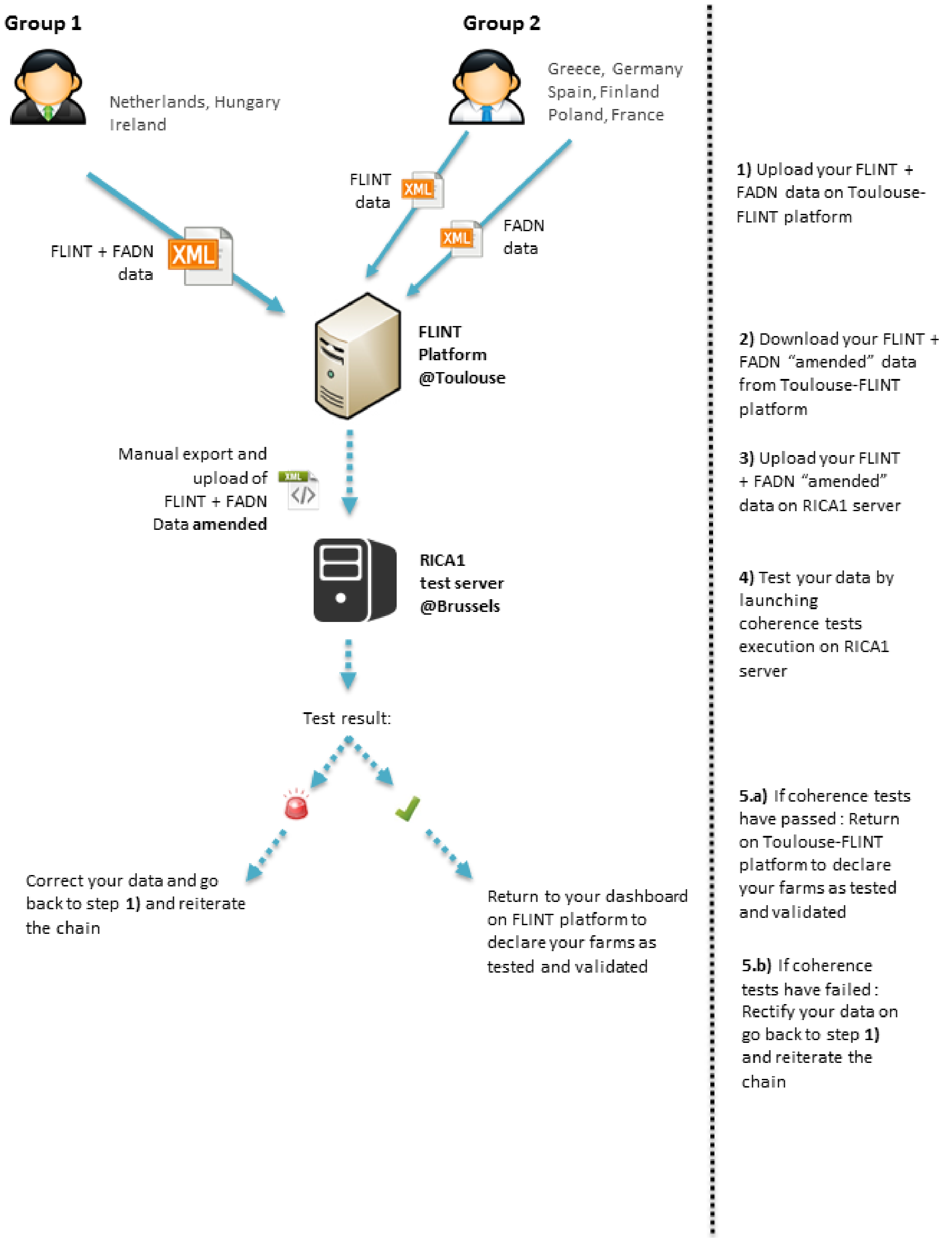
To manage the data, a dedicated platform with tools for all partners was developed. This platform is a web server with restricted access (login and password) that allows each partner to upload their farms, to merge FLINT and FADN data, and export the farm sample (all FLINT countries) in the appropriate format to run coherence tests on the RICA1 server. Before uploading the farm data, each partner had to sign an electronic declaration of honour. This

[14] This section is partly based on the FLINT documents: Kis Csatári and Keszthelyi (2016c), Cahuzac E. and Garcia, B. (2017)

ensured that the partner had fulfilled all the necessary conditions set by his/her country, concerning the protection of personal data and that the FLINT consortium is not responsible in case of failure of this obligation.

Additionally the platform enables the computation of all the indicators defined at farm level. Each indicator has been defined and then translated in a SQL language formula for calculation. All the individual data (FLINT + FADN), indicators and metadata can be downloaded (in different formats) by each partner for the use in data analysis and reporting.

Figure 3.6: Workflow diagram per country



3.5 Conclusions

The FLINT pilot project in nine countries including 1,000 farms has shown that in general it is feasible to collect this type of sustainability data on new policy topics. In the end the project collected data on 1,100 farms. The findings show that sustainability data can be collected independently of whether the data are collected by own staff or outsourced to a third party. What does make a difference is the relationship between the farmer and the FADN system and especially the FADN data collectors. The built-up trust is an important factor in the willingness of farmers to share the FADN data but also the additional FLINT data.

Problems that were encountered in the project were due the project structure and first-year effects. This includes access to farmers (in Germany where addresses are only available to the bodies involved in the FADN data collection), some lack of standardisation due to the fact that not all farm level issues were foreseen in the pre-testing, and IT-problems also due to the changes in RICA-1 in 2015. Some problems encountered were due to the fact that it was the first year in which data were collected and for instance software or instructions were not yet optimal. These issues were not unexpected. As one partner from Hungary stated: it was much more difficult to set up the FADN in this country than to add the FLINT variables to an existing structure.

As a few member states collect some of the FLINT data already for many years, this conclusion might be expected. However, FLINT has demonstrated that it is also possible to collect the data in countries such as France, Spain, Poland, Hungary, Greece and Germany with quite different circumstances and data collections systems. We think that this conclusion is also valid if we take in account that in this pilot the data collectors and farmers were in some cases selected with a potential bias and not taken randomly from the FADN.

For future data collection some indicators (and the variables behind them) might be adjusted. In case the FLINT data are organised in a separate process by specialists (like in France and Greece) some variables need to be collected at the same time of FADN, e.g. sub-categories of areas such as extensive grassland, in order to avoid inconsistencies between the sum of sub-categories and the full variable collected in FADN (Latruffe et al. , 2016b).

It also turned out that full harmonisation is not easy. There were some problems with some variables in some countries. In some countries some topics were very sensitive. For instance questions on water use were difficult in Hungary (due to a practice of unauthorised water pumping) and the Netherlands (where some farmers were afraid of a future quota or tax). Questions on the future take-over of the farm were experienced as quite normal in the Netherlands but very sensitive in Ireland where they were only answered under four eyes.

The use of the data and indicators showed that such missing data may limit the analyses. One possibility is to impute missing data with some information, such as the mean of the sample or the value of the nearest neighbour. However, it has been shown in some case study deliverables (Latruffe et al., 2016a and Saint-Cyr, 2016), that imputation decreases the significance of the relationships investigated. Thus, efforts should be made to collect as much information as possible, and that improved design of some of the questions in the farm return could help (Latruffe et al., 2016b).

As some data are not available in some cases, it is important to disentangle missing values from zero values. In FADN, and then in the 'FLINT dataset', zero values are not recorded as such; instead, empty cells, and hence missing values (i.e. NAs – Not Available), have a double meaning. For some variables it is possible to assume without too much error that all empty cells can be transformed into 0 (zero) values. In the 'FADN dataset' this is for example the case of the specific crop areas or numbers of livestock heads. As these variables are accountancy-related, it is less likely that the farmers were against recording the data or that the value has been removed due to inconsistencies. This is however more problematic for information that is not related to accountancy (or other related type of information e.g. invoices). One specific example is the different EFA elements. It may have been difficult for farmers to give a precise value of some elements and they may have preferred to keep silent. In this case, attributing a value 0 to them implies that we underestimate the extent of EFA and hence of their environmental sustainability compared to similar farmers who would have provided the information. A clearer distinction between zero and not available is therefore useful for these data items (Latruffe et al., 2016b).

Using FADN to collect sustainability data provides the opportunity to make use of the existing quality mechanisms. This does not only concern the quality of the collected data but also the quality of the processes (Ehling and Körner, 2007). The collection of sustainability data would benefit from existing quality processes ranging from the definition of the selection plan and the evaluation of the sample to work flows, instructions and training sessions for data collectors. The quality can also benefit through the strong linkage between the collection of environmental and social data in combination with the economic data.

Collecting more data does increase the complexity of data collection. The step from collecting economic data to sustainability data might seem substantial, but analysing the data gathering reveals that the main step is mainly from systematically recording the financial economic aspect of the flows going in and out of the farms to also record the relevant physical/material aspects of these same flows. Often the same source documents can be used. If a farmer buys pesticides, fertilisers, petrol etc. the data collector / accountant records the financial amounts from the invoice. On the same invoice there is (in most cases) also information on the physical flows, such as quantity and product name of pesticides, quantity and NPK content of fertilisers, quantity and type of energy source etc. If a data collector is well instructed to not only record the financial amounts but also the important physical attributes on the same invoice, a major step has been made in collecting data needed to calculate indicators of the environmental aspects of sustainability performance (e.g. use of active substances of pesticides, N-balance at farm gate, GHG emissions etc.).

Utilising this connection between financial and physical flows provides large advantages for the quality of the collected data, the completeness of the collected data, and the burden on farmers. The quality can be enhanced by the opportunities of cross-checking financial and physical flows. The completeness is better assured because the information is based on systematic recording and less emphasis is put on farmer recollection. Ssekiboobo and Zake (2016) show that direct estimations from farmers over (or under) estimate variables such as production when compared to the results of a systematic recording. The administrative burden of farmers is relatively small because the information which can be collected from invoices or other documents does not have to be asked from the farmer.

4 OPTIONS TO ADAPT THE FADN

In Chapter 2 we showed that the monitoring and evaluation of policies would benefit from more data on the sustainability of agricultural production, in addition to current productivity and income data and we showed that collecting these data in an integrated way on farms would be the most attractive option. The main reason for that is that policy-makers and researchers want to understand the decision making of farmers in how they manage trade-offs and jointness of productivity, sustainability and economic well-being under different technological options and policies.

In Chapter 3 we concluded that it is feasible to collect sustainability data in the scope of FADN. Extending this data collection from the pilot to the EU level is a promising option as FADN is the only well-established farm level data collection system on the performance of farms in Europe. Some have argued that a separate data network for environmental (and social) data would be an attractive alternative. Taking the example of environmental data we summarise the advantages and disadvantages of integrating environmental issues in FADN or setting up a separate environmental data network in Table 4.1.

Table 4.1: Collecting sustainability data in FADN or a separate environmental network.

Integrated data collection FADN + FLINT data	**Separate network for environmental variables**
(+) Jointness and trade-off between objectives / indicators	(-) No or weak link with economic performance and farm management
(+) Allows integrated policy analysis	(-) No direct link with policies, policy measure more difficult to evaluate
(+) Use of existing procedures and quality mechanisms	(-) Needs to be established (requires time and resources)
(-) Increased complexity of data collection	(+) Possibility to optimise design for specific variables
(-) Possible need to reconsider field of observation	(+) Optimised design results in more reliable estimates
(-) Wide variety of objectives complicates sample design	(+) Burden can be distributed among farmers
(-) Need for re-adjusting current systems and working processes	

Source: Vrolijk et al., 2016

To assess the farm management decisions under different policy options, the imputation of data from a specialised environmental network into the current FADN data or from other sources such as environmental statistics is needed. Such an imputation however would lead to less reliable estimates of behaviour and the impact of a policy change.

In Chapter 3 we tested the integrated data collection on FADN farms and concluded that this is in general an option that is feasible. Most problems encountered were linked to the fact that data collection was done in a project and not yet integrated in normal FADN data flows and liaison agencies.

A survey conducted by the FLINT project shows that 70 percent of the member states make use of administrative sources for the compilation of FADN. Bottlenecks experienced are legal restrictions in combining data sources and the identification of the (same) farm in different systems.

The fact that many data are available on the farm on invoices and other documents is a big advantage in using the FADN to collect such data and leads to an administrative burden that is (in total) much less than setting up an additional panel. It also contributes to data quality as checks can be made on implicit prices when quantities and financial flows are recorded. Some farmers do have a lot of sustainability data available, as they report to food processors in sustainability schemes. We assume that such schemes will become even more prevalent in the years to come (see e.g. Fresco and Poppe, 2016). Developments in ICT will lead to e-invoicing in the years to come and there have already been pleas from farmers (EIP 2016 Benchmarking report) and app-builders (EIP, 2016 Data driven business models) to move as fast as possible to a paperless food chain to reduce typing in of data that are already in a computer elsewhere and to make such data available for farm management.

The Netherlands is one of the few countries that has already a more extensive re-use of data from not only administrative but also from commercial information flows (ECA, 2016; Hill *et al.*, 2016). The farmer interacts with all kind of private and governmental organisations and for the compilation of the farm accounts the data collector uses information from these information flows (Figure 4.1). Access to these information flows is dependent on the explicit permission of the farmer.

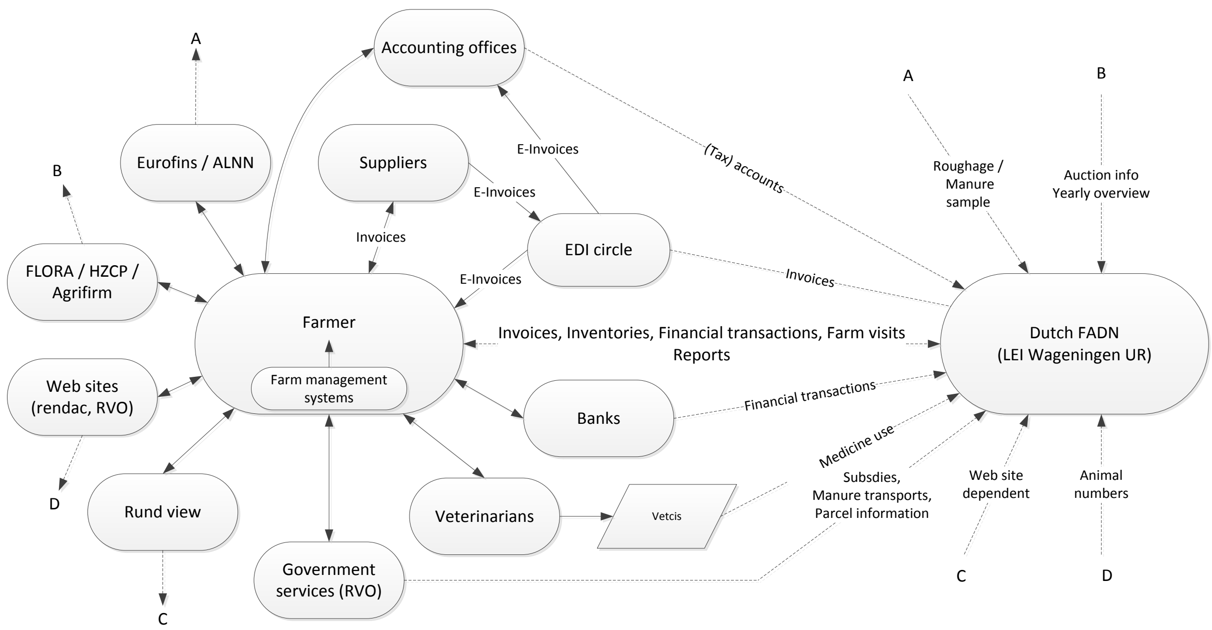


Figure 4.1: Use of data sources from the network of a farmer to compile accounts (case of the Netherlands).

Source: Vrolijk and Poppe (2016)

Given these developments, there are options to upscale the FLINT pilot to a larger scale in the FADN system to provide policy-makers and policy researchers with the data they need for the impact analysis of agricultural and environmental policies. Taking that conclusion as a point of departure this chapter looks how this data collection in the FADN could be organised and financed.

4.1 Legal issues

The legislation establishing FADN is Council Regulation 79/65/EEC of 15 June 1965. This legislation has since been modified and expanded into the FADN's basic act currently into force: Council Regulation (EC) No 1217/2009 of 30 November 2009. This sets up a network for the collection of accountancy data on the incomes and business operation of agricultural holdings in the European Community.

Article 1 of this basic act links the FADN with the needs of the Common Agricultural Policy and defines as its purpose to collect the accountancy data needed for, in particular: (a) an annual determination of incomes on agricultural holdings coming within the field of the survey; and (b) a business analysis of agricultural holdings.

Article 2 defines 'accountancy data' as any technical, financial or economic data relating to an agricultural holding derived from accounts consisting of entries made systematically and regularly throughout the accounting year.

The basic act makes a difference between the purpose of the annual determination of income (in Chapter 2) and the business analysis of agricultural holdings (in Chapter 3). Originally this second purpose in Chapter 3 was written to be able to analyse specific types of production (crops, animals) on mixed farms ('analytical accounting') or to carry out a more detailed specific analysis on a group of farms. In Article 13 under this chapter it is stated that the farm return shall include the accountancy data required under Article 8(2) and all such further accountancy items and details as each particular analysis may require.

Our interpretation of this basic act is that this would make it possible to collect the FLINT sustainability data within the purpose that the basic act of FADN has set out. A lot of the indicators are based on technical data derived from accounts. Meeting environmental and social standards is currently a normal business practice that influence farm management, and environmental accounting is a well-known business practice. To understand farm behaviour and responses to policies, data on environmental and social issues (and certainly those linked to the CAP's greening and cross-compliance rules) is needed in the same way as the current FADN collects data on the elevation of the farm or the age of the farmer. Chapter 3 on business analysis makes it possible to run a special analysis such as the FLINT sustainability analysis on a subset of farms.

That is not to say that sooner or later it would be clearer to state the purpose of sustainability analysis more explicit in the basic text of the FADN. But for the moment it is sufficient to conclude that current law already makes an expansion in this direction possible.

From our pilot we learnt that also in the future it is important to respect the different circumstances in the member states and to be flexible in how the data should be collected, as long as the data delivered to the FADN is harmonised. Although we have given arguments above for collecting the data in the same procedure as the conventional FADN data, this is not always a realistic option. Using specialised data collectors can be attractive, especially if data for FADN are a by-product from tax accounts (see next section). For instance in our pilot in France we used students to collect the data, and a discussion with the French FADN Liaison Office taught us that one option for France could be to ask government staff that collects Farm Structure Survey (FSS) data on a sample basis to also collect the FLINT data (in addition to the tax accounts of those farms that are bought from accounting offices, as the FADN (RICA) panel is fully linked to this FSS-sample).

Another issue in adding the sustainability data to FADN is the fact that some data are not very relevant or are too sensitive to be collected in a certain country. A country could be given a derogation for a certain variable, but that could be a problematic solution. The data collection then ends up quickly with the smallest common denominator. In 2000 the Ricastings project (Abitabile et al., 2000) advocated such a flexible approach and take all data that member states had available. At that time this was not implemented, priority was given to a more classic ICT approach. Although it is feasible from an ICT point of view, in legal terms such a level of freedom is perhaps still challenging.

All in all, we conclude that from a legal point of view there is no problem to include the FLINT sustainability indicators in the FADN. The way we defined the indicators in Farm Return tables and variables, and documented definitions, this could be done relatively easy. Table 4.2 lists the new tables. Nevertheless the procedure would take some years to reach agreement and have data delivered to the database in Brussels. We come back to that aspect later on. The inclusion of this list of tables does not mean that all indicators can be copied too. In Chapter 2 we reported some problems with some indicators. Several of these were country-specific (e.g. water in Hungary) and could be countered by some flexibility in (not) gathering some data in some countries or farm types. For land management we assume that by now farmers are more familiar with the concept of Ecological Focus Areas in the CAP as they were during the FLINT project. Some indicators for soil management and erosion should be reviewed as they were difficult to collect, but seem to be important for policy analysis in at least some regions.

Table 4.2: List of tables from the FLINT project to be integrated in the FADN Farm Return

Table	**Topic**
Z1	Information and Knowledge
Z2	Working Conditions and Quality Of Life
Z3	Innovation
Z4	Economic situation
Z5	Land Management
Z6	Risk Reduction
Z7	Pesticide Usage
Z8	Nutrient Balance
Z9	Energy
Z10	Water

4.2 Organisational aspects of data collection

The organisational structure of FADN differs strongly in different EU member states and this influences the flexibility in adapting the FADN to include sustainability data. When describing the functioning of an FADN system a number of roles at national level should be distinguished, namely the client that finances the FADN, the liaison agency and the data collection. These different roles can be conducted by one organisation or can be placed in different organisations. In all countries the client is the responsible Ministry, in most cases the Ministry of Agriculture. The Ministry has the formal obligation to comply with the *acquis communautaire*, of which the FADN is an integral part. The ministry can also be the liaison agency, but also a governmental or private organisation (i.e. a research institute) can be appointed to fulfil the FADN obligations and to coordinate data collection. The personnel of the liaison agency can collect the data or the data collection can be delegated to another organisation (i.e. accounting office or advisory service). Furthermore there are some supporting tasks which can be outsourced (for example IT support by a software company, or statistical support by a national Statistical Office). Different organisational combinations of data collection and liaison agency can be observed in one or more EU member states (Table 4.3). Several countries use more than one organisation in the data collection.

Table 4.3: Different organisational settings of FADN in the European Union

Liaison Agency:	**Data collection by:**		
	Own liaison agency staff	**Accounting offices**	**Advisory service**
Ministry	Luxemburg, UK, Estonia, Cyprus, Bulgaria, Belgium, Portugal, Malta, Greece	UK, Slovenia, France, Czech Republic, Estonia, Belgium, Portugal, Spain	Estonia, Rumania
Research institute	Ireland, The Netherlands, Slovakia	Germany, Austria, Hungary, The Netherlands	Latvia, Finland, Poland, Italy, Lithuania, Slovakia
Statistical office	Sweden	Denmark	Sweden
Advisory service			Croatia

Source: own compilation adapted from Vrolijk et al. (2016)

Poppe (1997, 2002) defines a typology of FADN systems labelled type Y and type X. A crucial distinction between the types is whether the information collection is primarily dedicated to the FADN task or that existing (accounting data) is re-used to fulfil the FADN data needs. In type Y, FADN data collection is done by the FADN liaison agency. Liaison agency staff collects the data for FADN purposes. Data collection for the primary purpose at hand, in this case FADN, is defined as primary data collection (Green *et al*., 1988). This makes it a relatively expensive way to collect FADN data because the whole system is set up and maintained for fulfilling the FADN requirements. A major advantage is that it is more flexible to adapt to new information needs. It is easier to instruct and adapt the working flow of own staff to collect additional data elements. This makes it much more cost efficient to make changes in the data collection. It is a system with relatively high fixed and low marginal costs for data collection.

In type X, data are provided by (fiscal) accountants. The data which is used to compile the farm accounts are re-used for FADN tax accounts. There is still some additional work needed to make the fiscal accounts suitable for FADN purposes (mainly on the valuation and depreciation of assets), but in general it is relatively cheap because the cost of bookkeeping is already covered by farmers. Although type X is therefore relatively cheap, at the same time it is more difficult to make changes in the data collection. Accountants have their own way of working to compile the tax accounts and it is more difficult to adapt their working procedures for just a small group of their clients who participate in FADN, and collecting sustainability data is normally beyond their expertise. Such a system has relatively lower fixed costs but a high marginal cost and much resistance for additional data. Type Y or X strongly determines the flexibility of the data collection and therefore the opportunities and limitations for collecting sustainability in the scope of FADN.

We take these organisational issues in consideration in the next section, when we estimate the costs of data collection.

4.3 Cost of data collection

Adding the FLINT data to the FADN of course adds a cost. Estimating these costs is not a trivial issue. Estimating the costs of FADN is already a challenge. Bradley and Hill (2015) have tried to make an inventory of the costs of FADN in Europe. To make the costs more comparable they have adjusted the estimates by the average wage level in countries (Eurostat figures).

In the FLINT project a short survey was distributed. The survey asked for the hours and budget per FADN farm and an estimate of the required number of hours to collect the FLINT data. In order to cross check the data and to be able to impute a value in case of missing values countries were categorised in three example situations (Table 4.4 column 2). Column 3 of Table 4.4 gives the number of hours per FADN farm (if the data was missing in the FLINT survey an estimate was made based on the Bradley and Hill report). Based on these data the costs for collecting data on one FADN farm can be calculated (column 4, missing values based on Bradley and Hill). The hours per farm to collect the FLINT data (column 5) are the indications by the FADN committee members for their country. Missing values were imputed by the average of hours (column 5) belonging to the same example situation (column 2). Also outliers were corrected by the research team (in italics). Based on these assumptions the costs for adding the FLINT sustainability data were calculated.

The results reflect a range of local circumstances. Bradley and Hill conclude that the amounts differ due to differences in wage levels and due to differences in the scope of data collection. However, there are also other factors, such as whether the costs only include direct labour costs or a full commercial rate (including overhead costs and a profit margin); the quality of the data; special costs (e.g. the inclusion of costs of big ICT projects that once every ten or 15 years reorganise the software and working methods); and a possible lack of resources in some countries. The assumption is that these factors also affect the estimation of costs for the collection of FLINT data and therefore that data collection costs per hour and the required number of extra hours provide an acceptable basis for estimating the FLINT data collection costs.

Table 4.4: Costs of FADN and FLINT data collection in Europe (euros per farm, values that were somehow corrected or imputed by the FLINT research team are in italics)

Country (1)	***Example reflecting situation * (2)***	***Hours per FADN farm (3)***	***Data collection cost per hour (4)***	***Hours per farm for FLINT data (5)***	***Current costs FADN farm (6)***	***Estimated costs FADN farm + FLINT data***	
						In euros (7)	**Increase in % (8)**
Austria	2	*16.8*	46	10	1,360	1,819	34%
Belgium	2	56	36	12	2,000	2,429	21%
Bulgaria	2	15	14	10	209	348	67%
Croatia	2	15	9	10	130	217	67%
Cyprus	3	7	36	8	250	536	114%

Czech Rep.	2	30	12	*9*	370	481	30%
Denmark	1	*6*	60	5	400	699	75%
Estonia	2	*28.8*	14	*9*	314	439	40%
Finland	2	25	40	7	1,000	1,280	28%
France	3	4	52	*12*	500	1,119	124%
Germany	3	*8*	46	*12*	600	1,157	93%
Greece	3	24	53	*12*	1,273	1,910	50%
Hungary	2	6	11	6	500	566	13%
Ireland	1	24	42	2.5	1,000	1,104	10%
Italia	1	15	20	8	300	460	53%
Latvia	3	*12*	23	*12*	270	540	100%
Lithuania	2	8	31	5	250	406	62%
Luxembourg	2	50	40	15	2,000	2,600	30%
Malta	2	4	25	*9*	100	325	225%
Netherlands	1	54	56	6	3,000	3,333	11%
Poland	2	32.2	20	10	656	860	31%
Portugal	2	37.5	13	*9*	500	620	24%
Romania	3	4	7	12	100	179	79%
Slovakia	2	20	17	10	340	510	50%
Slovenia	3	15	23	*12*	263	542	106%
Spain	3	10	32	6	500	691	38%
Sweden	2	9	56	12	800	1477	85%
UK	2	*44*	45	*9*	2,000	2,409	20%

Source: Survey among FADN managers

* (1) Netherlands/Ireland: already much data available, FLINT data gathered in same process as FADN; (2) Poland/Hungary: not much data available, FLINT data gathered in same process as FADN and (3) France/Greece: not much data available, FLINT data gathered in a separate farm visit.

The estimates in Table 4.4 show a large range: from countries such as Ireland (+10%) and the Netherlands (+11%) to France (+124%) and Malta (+225%). One explanation is that some of the countries gather already several data items from the FLINT data set for national purposes, but do not yet make them available to the EU FADN. Another is that some of the data-heavy FLINT farm return topics are not relevant in some countries, thus reducing the data collection burden (e.g. hardly any pesticides on crops in the Irish FADN sample where livestock dominates).

Another is that countries with relatively low extra costs see options to integrate the data collection in the current process, where others are not able to do that or have to pay the full cost of such an adaption, as the current costs are relatively low as the FADN data are a by-product of tax accounting. This implies that the differences in costs between countries are lower in the desored situation where FADN data are supplemented by FLINT data then in the current situation with only FADN data: the burden is on those with currently relatively low costs.

Of course this analysis has to be treated with caution. Costs of the FADN are hard to estimate and the costs of extra FLINT data are much based on expectations of the FADN managers who not yet have experience with gathering those data. The costs from member states in the FLINT project are probably too high in the long run as these are the costs from the first year, not yet taking learning effects and optimal software solutions and working procedures into consideration. On the other hand, the costs exclude set up costs in software, training, and extra overheads.

On average (weighted with the number of farms per member state) the costs of adding the FLINT sustainability data to the FADN imply an increase from 750 euros per holding to 1,040 euros (+ 38%).

4.4 Options for scaling up

Given the budget reductions that governments face, it is probably unrealistic to add the FLINT data collection to the full FADN sample of 85,000 farms and increase the budget costs by about 40%. We therefore explore a number of alternatives.

The first alternative discussed is to reduce the frequency of some of the variables. Some of the FLINT data are perhaps not needed every year and could be collected in certain years (e.g. ask for data on social indicators only every three years). This could also apply to the current FADN data (e.g. ask for the composition of the work force only every four years). The ARMS survey of the USDA-ERS (which is more or less similar to the FADN) applies this method by for instance having more detailed data collection on a certain crop in a certain year to understand production practices and cost prices. However ARMS is a much more centralised system than FADN whose EU database is essentially taken from 28 FADN national data collection systems. Although FADN managers see some possibilities to apply such flexibility, taking into account extra work in changing software and instructions for data collectors, this option will not release enough budget to collect sustainability data on e.g. 10,000 farms in Europe. Therefore this option is not advised as the solution (but could be taken into account if the FLINT sustainability data are incorporated in the FADN Farm Return).

A second option is to collect the new FLINT variables on a subsample of FADN farms. This alternative is attractive as it involves and teaches other member states to scale up from the current pilot in only 9 countries. However it does not solve the budget issue, new funds are needed for this extension. Another disadvantage is that the FADN managers have to run two systems: the old FADN data collection and the new FADN-FLINT data collection. In cases where the FLINT data would be collected in a separate process (e.g. such as in the French example during the pilot) this is not so complicated, but countries with a very integrated data collection method need to have quite flexible software systems.

To overcome the budget problem of this option, there are two pathways, that both are interesting to pursue. One is to find extra money with the European Commission to set this up quickly for e.g. the next five years. The Commission has an urgent need to have access to the FLINT data for the impact evaluation of the current CAP and ex-ante assessment of the CAP-post-2020. Some of this data is to some extent already available in some member states. By acting fast (perhaps in collaboration with the JRC and the Environmental Agency) via a project structure instead of FADN legislation, the FLINT project could be continued in 2017 data gathering for as many countries as feasible. The FADN committee itself has then more time to work on the inclusion of this data in the normal FADN and after e.g. 5 years the project structure could be abandoned. We label this option as '*FLINT-2 Policy Research Infrastructure*'.

The other pathway to solve the budget issue is to cut the number of farms in the FADN so that the data collection in a subsample could be paid from the current budget (mostly paid by the member states). We label this option as '*FADN subsample*'.

Taking this pathway one step further is to reduce the FADN sample in such a way that the FLINT data is collected on every FADN farm, in other words collect all the information on as much FADN farms as possible. The idea behind this solution is that the FADN managers do not have to run different data collection procedures on different farms, which is especially attractive for those who have an integrated data collection of both types of data. Second advantage is at the research side: with a subpanel researchers will be tempted to use the FLINT data from the subsample for imputation at the full FADN set or will only use the subsample for most of the research, making the other data less valuable. Both developments suggest that having the same data on all farms is an attractive option, probably to be reached in a couple of years by upscaling the collection of FLINT data and let a substantial number of farmers leave the conventional FADN. We label this option '*Full FADN*'. The disadvantage of this option is that the FADN becomes less representative at a regional level for certain farm types. That is probably not a big concern at the EU level, but it might be problematic in some countries, especially some federal countries where the data play an important role in regional policy making.

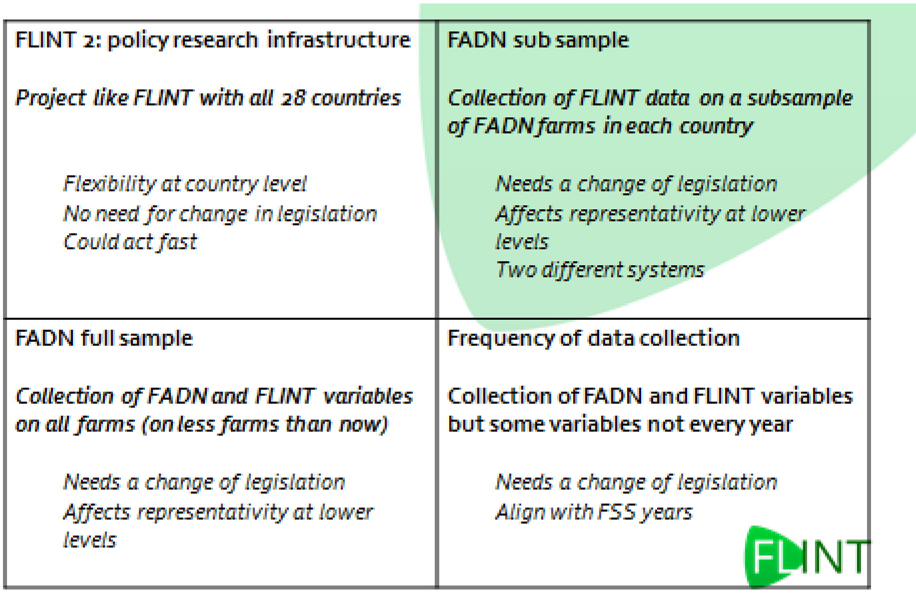


Figure 4.2: Promising scenarios for a future data infrastructure

Figure 4.2 provides an overview of the four options discussed above. From our Community of Practice with the FADN-managers (in workshops with the FADN committee and more informal in the Pacioli-workshops) and from meetings with a number of ministries, we can conclude that there is a wide support for the need for sustainability information, there is a broad recognition of the advantages of an integrated data set with economic, environmental and social indicators and most of the indicators specified in FLINT are considered relevant.

Despite this, there are still different thoughts on the best way to collect these data. Some ministries strongly support the idea of collecting this data in the scope of FADN and see FADN as the only feasible approach, some other countries (especially those with a long history of data collection by accounting offices) doubt whether FADN is the right place and is flexible enough to include sustainability data. A further analysis of this choice asks for a calculation on how many farms data should be collected in the different options.

4.5 Number of farms for three options

FADN is often claimed to be designed to be representative for economic issues (Oenema et al., 2011; Koester and Loy, 2016). Although this claim is often not made more precise, a few aspects should be distinguished. These are the demarcation of the field of observation and the sample design of the FADN. With respect to the demarcation of the field of survey, FADN is aimed at covering commercial farms, namely those that produce for the market and are larger than a certain minimum economic size (EU, 2010). This threshold differs between countries to reflect the different agricultural structures and different economic situations in countries.

Farms smaller than the threshold are not included in FADN but do have an impact on the environment and the social dimensions of rural areas, especially in those regions with a large number of small and/or semi-subsistence farms (Tocco et al., 2014; Tudor, 2015). Here it is important to be aware of the fact that FADN is designed as a tool to monitor and evaluate the CAP, which is mainly targeted at and affects commercial farms. Collecting sustainability data on FADN farms does not provide data on very small farms, but does provide the opportunity to evaluate the impacts of the CAP on economic, social and environmental objectives. If the CAP would be focused on smaller farms, changing the field of observation of FADN should be considered, irrespective whether sustainability data is collected or not. In the FLINT project we tried to collect data on farms just below the threshold in some countries, but this proved to be very difficult as such farms do often not have basic data for accounting available and are not very interested in improving farm practices and learn from the feedback of FADN data.

At a regional level the FADN sample is stratified based on two dimensions: economic size and type of farming. Both dimensions are based on the concept of Standard Output (SO) which is a standardised measure for the expected output of a farm based on the agricultural activities on the farm. The sample allocation (how many farms to include in each strata) is based on different allocation methods, such as proportional or optimal allocation (Vrolijk, 2002). Although SO is defined as an economic indicator to be able to sum different agricultural activities to establish the size of the farm, the practical impact of this choice is very limited. Also for collecting data on environmental and social issues, type of farming and size of farming would be important stratification variables. Owing to the very strong correlation between physical size and economic size (especially within a type of farming) the resulting sample structure is likely to be very similar. What could be different is the exact allocation of the sample size to the different strata. In case of applying proportional allocation the result would be the same. In case of optimal allocation, the sample size within each stratum can differ based on the choice of the variable to define the homogeneity of farms in a stratum[15]. A sample fully dedicated to GHG emissions or soil would

[15] In case sustainability data would be collected in a separate environmental network, the quality of environmental estimates would improve in terms of a reduced variance of the estimates, because the sample can be designed to minimise this variance for the specific environmental variable. A major disadvantage of a separate environmental network is the loss of a direct link with policy measures. Policy measures do not directly affect the environment. Policy measures affect decision makers (in this case farmers) and the behaviour and the change in behaviour of farmers can lead to different farm management decisions and farming practices and these affect the environment. To understand and evaluate the impact

be more (statistical) efficient for that specific purpose but each of these objectives would lead to different allocation of the sample capacity. Given the wide range of indicators on greening a more multi-purpose panel is required. The subsequent experiences with the use of this panel could results in changes in the panel design.

Another aspect of the stratification of FADN is that it is carried out in a harmonised way, but at a member state level. The European FADN is a federation of national FADNs and there is no procedure that stratifies the sample at a European level resulting in an optimal allocation of farms to the member states (and regions). As most of the costs of the sample are born by the individual member states, a European optimal allocation would be difficult to implement, as national budgets cannot easily be shifted.

This however creates a new question for collecting the sustainability data in an FADN subsample or in FLINT-2 Policy Research Infrastructure: should the number of farms with sustainability data be optimised over the European Union, or in relation to the national FADN (e.g. 20% of its sample farms)? And should also the different costs in the member states be taken into account?

For the options of the FADN Subsample and the FLINT-2 Policy Research Infrastructure, as defined above, the number of farms has to be chosen as a balance between costs and the preciseness of the information we accept. Table 4.5 contains the results of calculations with the FLINT data on the preciseness of estimates for different subsamples. The calculations assume that the variability found for FLINT indicators in 9 countries can be used as an indication for the EU-28. In the bottom rows of the table the coefficient of variance for some income indicators has been calculated for the FLINT and the FADN sample as a reference. The calculation is based on the full samples of FLINT and FADN, without taking prior stratification into account. The relative standard error (standard error of estimation divided by the mean of the variable) was used as the coefficient of variance would be constant over different sizes of the sample. Data have been calculated on the basis of 1-year results, although policy evaluations often are based on data for several years (either by doing the same calculations for several years, or even better by using panel data techniques).

Table 4.5: Relative standard errors for variables in different sample sizes.

Data set	*Indicator*	*Number of farms*	*Relative standard error (current for the FLINT/FADN sample, simulated for other sample sizes)*							
	Sample size		Current	5,000	10,000	15,000	20,000	30,000	40,000	50,000
FLINT	GHG emission	1,102	0.144	0.054	0.038	0.031	0.027	0.022	0.019	0.017
FLINT	Crop diversity	1,102	0.018	0.008	0.006	0.005	0.004	0.003	0.003	0.003
FLINT	Pesticide use	1,102	0.248	0.092	0.065	0.053	0.046	0.038	0.033	0.029
FLINT	N-balance	1,102	0.404	0.152	0.108	0.088	0.076	0.062	0.054	0.048
FLINT	NUE	1,102	0.942	0.352	0.249	0.203	0.176	0.144	0.124	0.111
FLINT	Innovation	1,102	0.035	0.017	0.012	0.010	0.008	0.007	0.006	0.005
FLINT	Succession	1,102	0.062	0.011	0.008	0.007	0.006	0.005	0.004	0.004

of policy measures it is therefore necessary to understand the structure and the farm practices of individual farms. These farm structures and farm practices are recorded in the current FADN.

FLINT	Parcel size	1,102	0.076	0.035	0.025	0.020	0.017	0.014	0.012	0.011
FLINT	Age machinery	1,102	0.015	0.007	0.005	0.004	0.004	0.003	0.003	0.002
FLINT	Insured categories	1,102	0.009	0.004	0.003	0.003	0.002	0.002	0.002	0.001
FLINT	Share under contract	1,102	0.015	0.005	0.004	0.003	0.003	0.002	0.002	0.002
FLINT	Other income sources	1,102	0.057	0.027	0.019	0.016	0.013	0.011	0.010	0.008
FLINT	Advisory contacts	1,102	0.039	0.018	0.013	0.010	0.009	0.007	0.006	0.006
FLINT	Social engagement	1,102	0.018	0.009	0.006	0.005	0.004	0.003	0.003	0.003
FLINT	Weekly working hours	1,102	0.012	0.005	0.004	0.003	0.002	0.002	0.002	0.002
FLINT	Holidays	1,102	0.053	0.024	0.017	0.014	0.012	0.010	0.009	0.008
FLINT	Job satisfaction	1,102	0.007	0.003	0.002	0.002	0.002	0.001	0.001	0.001
FLINT	Social diversification	1,102	0.026	0.012	0.009	0.007	0.006	0.005	0.004	0.004
FLINT	Utilised agr. Area	1,102	0.104	0.049	0.034	0.028	0.024	0.020	0.017	0.015
FLINT	Gross farm income	1,102	0.093	0.044	0.031	0.025	0.022	0.018	0.015	0.014
FLINT	Farm net value added	1,102	0.107	0.050	0.036	0.029	0.025	0.021	0.018	0.016
FLINT	Farm net income	1,102	0.268	0.126	0.089	0.073	0.063	0.051	0.044	0.040
FADN	Gross farm income	85,087	0.009	0.037	0.026	0.021	0.019	0.015	0.013	0.012
FADN	Farm net value added	85,087	0.010	0.040	0.028	0.023	0.020	0.016	0.014	0.013
FADN	Farm net income	85,087	0.010	0.043	0.030	0.025	0.021	0.017	0.015	0.013

The table suggests that the FADN sample shows a decline to a relative standard error for the main income indicators below 3% with a sample size of 10,000 farms, and below 2% with a sample of 30,000 farms. The same variables measured in the FLINT data set of 1,100 farms show more or less the same outcome, giving some confidence that the FLINT data set can be used to support decisions on sample size.

Table 4.5 suggests that the relative standard errors are relatively small for social indicators. For the indicator on greenhouse gasses the standard error is in line with the main income variables, but for pesticides use and nitrogen balances and nitrogen use efficiency they are higher.

Based on this calculation we suggest a sample size for the first 5 years in these two options of the FADN-subsample and the FLINT-2 Policy Research Infrastructure project of 15,000. That guarantees a relative standard error below 3%, and makes it possible to publish results for the most important farm types in the individual member states (see below). Concerning the choice of a number of farms per member state (proportional to its current sample, or optimal from an EU perspective) we argue that the latter is most attractive with the subsample approach as it would not lead to a loss of precision at EU level. This is also to contrast with the third option where the FLINT sustainability data are collected for all FADN farms.

The distribution over the member states of these 15,000 farms is given in Table 4.6. Combining that with the estimation of cost for data collection in Table 4.4 gives for the option FADN Subsample the reduction needed in the FADN sample to collect this data within the current budget.

Table 4.6: Number of FADN farms per member state and with FLINT data collection for a subsample in the option FADN subsample (excluding Croatia, for which basis (2013) data were not yet available)

Country	*Current FADN sample*	*Sample for FLINT data*	*Increase in cost (in %)*	*Required reduction in FADN*	*Adjusted FADN sample*	*% FLINT farms*
BEL	1,228	360	0.06	77	1,151	31%
BGR	2,239	229	0.07	152	2,087	11%
CYP	469	23	0.06	26	443	5%
CZE	1,401	274	0.06	82	1,319	21%
DAN	1,827	421	0.17	314	1,513	28%
DEU	8,880	2,089	0.22	1,939	6,941	30%
ELL	4,777	227	0.02	114	4,663	5%
ESP	8,716	1,907	0.08	729	7,987	24%
EST	660	41	0.02	16	644	6%
FRA	7,552	1,946	0.32	2,409	5,143	38%
HUN	1,972	380	0.03	50	1,922	20%
IRE	938	150	0.02	16	922	16%
ITA	10,929	3,342	0.16	1,782	9,147	37%
LTU	1,067	50	0.03	31	1,036	5%
LUX	444	9	0.01	3	441	2%
LVA	998	43	0.04	43	955	5%
MLT	507	3	0.01	8	499	1%
NED	1,513	899	0.07	100	1,413	64%
OST	2,119	161	0.03	54	2,065	8%
POL	12,321	718	0.02	223	12,098	6%
POR	2,285	192	0.02	46	2,239	9%
ROU	5,881	430	0.06	340	5,541	8%
SUO	846	106	0.04	30	816	13%

SVE	1,070	216	0.17	182	888	24%
SVK	563	150	0.13	75	488	31%
SVN	944	48	0.05	50	894	5%
UKI	2,805	588	0.04	120	2,685	22%
Total EU	84,951	15,000		9,011	75,940	20%

The calculations show that collecting the FLINT sustainability data on 15,000 farms would demand a reduction of less than 10,000 FADN farms, bringing the sample down from 85,000 to 75,000 farms. At EU level that is not a big loss in precision of the income estimators (Table 4.7). The FLINT sustainability data would then be gathered on 20% of the farms.

Table 4.7: Effect of the reduction of the FADN sample to 75 thousand farms on the precision of the income indicators (measured in the relative standard error)

	Sample size		*Relative standard error*					
			Gross farm income		Farm net value added		Farm net income	
	Current	Reduced	Current	Reduced	Current	Reduced	Current	Reduced
BEL	1,228	1,151	0.09	0.10	0.11	0.11	0.15	0.16
BGR	2,239	2,087	0.02	0.02	0.02	0.02	0.06	0.07
CYP	469	443	0.26	0.27	0.32	0.33	0.43	0.45
CZE	1,401	1,319	0.03	0.03	0.03	0.03	0.07	0.07
DAN	1,827	1,513	0.08	0.09	0.09	0.10	0.33	0.37
DEU	8,880	6,941	0.07	0.08	0.08	0.09	0.12	0.14
ELL	4,777	4,663	0.11	0.11	0.13	0.13	0.16	0.16
ESP	8,716	7,987	0.07	0.08	0.08	0.08	0.10	0.11
EST	660	644	0.04	0.04	0.05	0.05	0.13	0.13
FRA	7,552	5,143	0.11	0.13	0.14	0.17	0.23	0.28
HUN	1,972	1,922	0.04	0.04	0.05	0.05	0.08	0.08
IRE	938	922	0.05	0.05	0.05	0.06	0.07	0.07
ITA	10,929	9,147	0.09	0.10	0.10	0.11	0.12	0.13
LTU	1,067	1,036	0.03	0.03	0.04	0.04	0.05	0.05
LUX	444	441	0.09	0.09	0.13	0.13	0.18	0.18
LVA	998	955	0.05	0.05	0.06	0.06	0.11	0.11
MLT	507	499	0.09	0.09	0.10	0.10	0.11	0.12
NED	1,513	1,413	0.06	0.07	0.08	0.08	0.16	0.17
OST	2,119	2,065	0.08	0.08	0.11	0.11	0.12	0.12
POL	12,321	12,098	0.04	0.04	0.05	0.05	0.06	0.06
POR	2285	2,239	0.14	0.14	0.17	0.17	0.19	0.19
ROU	5881	5,541	0.01	0.01	0.01	0.01	0.01	0.01
SUO	846	816	0.08	0.08	0.13	0.13	0.20	0.20
SVE	1,070	888	0.09	0.10	0.12	0.13	0.32	0.35
SVK	563	488	0.13	0.14	0.17	0.19	-1.40	-1.53
SVN	944	894	0.09	0.10	0.18	0.18	0.22	0.23
UKI	2,805	2,685	0.10	0.10	0.12	0.12	0.19	0.19
Total	84,951	75,940						

The percentage FADN farms that provide FLINT data differs strongly between member states (Table 4.6). In some countries it is only 5% (Slovenia, Latvia, Lithuania, Greece and Cyprus), in others it is over 30% (Belgium, Germany, France, Italy, Slovakia) and tops in the Netherlands with two-thirds of the FADN farms. These differences are mainly the result of two factors: the optimal allocation over member states and the costs of collecting the FLINT sustainability data. Especially the effect of optimal allocation should not be underestimated. For instance Luxembourg collects FADN data on 450 farms, for national and European purposes, but an optimal allocation of an EU sample of 85,000 farms would ask Luxembourg to keep records on only 75 farms. An extreme at the other side would be the Netherlands that in an optimal allocation for the EU should have 4,500 FADN farms instead of only 1,500.

Luxembourg, Malta and Cyprus have a very low number of farms as a result of this calculation, which should probably be set to at least 25 farms.

A similar calculation has been carried out for the option *Full FADN*. In this case the number of farms in the FADN decreases per member state, based on the estimation of the costs of collecting FADN data in that particular member state in Table 4.4. This has to be interpreted as a very tentative estimation, as for some member states the learning effects might be much larger than currently thought of. Table 4.8 suggests that in this option the FADN sample will have to be reduced with one third, from 85,000 to 55,000 farms. This reduction would be rather low in countries such as Belgium (- 18%) and Hungary (- 12%), but very high in for instance France (- 55%). This is a direct result of the differences between the countries in costs for collecting FLINT sustainability data compared to the current level of costs of FADN data.

Table 4.8: Number of FADN farms per member state in 2015 and with FLINT data collection for all sample farms in the option Full FADN.

Country	*Current sample*	*Increase in cost per farm (%)*	*Reduction needed in number of farms*	*Adjusted FADN + FLINT sample*
BEL	1,228	21.5	217	1,011
BGR	2,239	66.5	894	1,345
CYP	469	114.4	250	219
CZE	1,401	30.0	323	1,078
DAN	1,827	74.8	782	1,045
DEU	8,880	92.8	4,275	4,605
ELL	4,777	50.0	1,593	3,184
ESP	8,716	38.2	2,409	6,307
EST	660	39.6	187	473
FRA	7,552	123.8	4,178	3,374
HUN	1,972	13.2	230	1,742
IRE	938	10.4	88	850
ITA	10,929	53.3	3,801	7,128
LTU	1,067	62.4	410	657
LUX	444	30.0	102	342
LVA	998	100.0	499	499

MLT	507	225.0	351	156
NED	1,513	11.1	151	1,362
OST	2,119	33.8	535	1,584
POL	12,321	31.1	2,923	9,398
POR	2,285	24.0	442	1,843
ROU	5,881	79.0	2,596	3,285
SUO	846	28.0	185	661
SVE	1,070	84.6	490	580
SVK	563	50.0	188	375
SVN	944	105.9	486	458
UKI	2,805	20.5	476	2,329
Total EU	84,951		29,062	55,889

On EU level the reduction of the sample by one third would not lead to a big loss in the precision of the estimations for e.g. farm family income or net value added (per ha). The main income indicators would see a marginal loss in precision: the standard error of estimates of these indicators drops from 1% to 1.3%. However at member state level the effect would be much bigger, and in some large member states such as France or Germany the results for certain farm types in certain regions might lose quite some reliability.

4.6 Selection plans

In this section we develop selection plans for the three options that were discussed in the previous section. We argued already that the inclusion of the FLINT sustainability indicators do not need a change in the variables used for stratification. Also for collecting data on environmental and social issues, the type of farming and size of farming (the current variables) would be important stratification variables. Owing to the very strong correlation between physical size and economic size (especially within a type of farming) the resulting sample structure is likely to be very similar. The exact allocation of the sample size to the different strata could be different if a method for optimal allocation is used with a different choice of the variable to define the homogeneity of farms in a stratum. Given the wide difference between the optimal allocation from an EU point of view and the actual allocation based on preferences in the member states, this seems to be a point of minor importance.

Table 4.9 provides the optimal allocation per member state over the 8 different types of farming that are used as a standard in FADN. These percentages give an indication on how the FLINT farms should be allocated in a sample of 15,000 farms as an FADN-subsample and as a FLINT-2 policy research infrastructure project. In the option of the Full FADN it seems to be logic to follow the current allocation that member states use.

Table 4.9: Optimal allocation of sample farms over the member states and main types of farming

Country	Population	Optimum sample	Sample fraction per farm type							
			1	2	3	4	5	6	7	8
BEL	30,456	1,908	9%	13%	5%	31%	23%	1%	7%	12%
BGR	115,650	1,135	49%	10%	3%	19%	8%	4%	0%	8%
CYP	10,209	175	14%	10%	10%	42%	10%	13%	0%	1%
CZE	14,856	842	36%	5%	3%	21%	5%	1%	4%	25%
DAN	29,044	1,660	16%	5%	4%	31%	31%	3%	1%	9%
DEU	193,867	9,526	18%	7%	5%	37%	16%	1%	5%	11%
ELL	328,985	1,904	24%	14%	29%	15%	3%	8%	0%	7%
ESP	601,208	13,014	15%	10%	24%	24%	19%	3%	2%	4%
EST	8,090	201	34%	5%	0%	43%	6%	0%	1%	10%
FRA	304,539	12,443	21%	4%	21%	27%	11%	2%	4%	10%
HUN	107,241	1,526	48%	6%	5%	9%	13%	4%	1%	13%
IRE	78,954	1,241	12%	0%	0%	85%	0%	0%	0%	3%
ITA	802,922	15,271	20%	8%	32%	24%	7%	5%	1%	3%
LTU	52,926	310	40%	2%	1%	32%	5%	2%	1%	17%
LUX	1,607	73	3%	0%	7%	77%	4%	0%	4%	7%
LVA	22,682	252	39%	2%	0%	35%	5%	2%	3%	15%
MLT	3,034	30	7%	27%	7%	23%	23%	10%	3%	3%
NED	52,201	4,595	8%	30%	3%	38%	16%	1%	3%	2%
OST	92,989	1,340	10%	0%	14%	39%	25%	3%	3%	6%
POL	720,630	5,475	20%	7%	3%	19%	17%	3%	10%	21%
POR	109,921	1,483	12%	8%	19%	40%	6%	6%	1%	8%
ROU	1,038,322	3,040	21%	2%	3%	38%	4%	1%	13%	18%
SUO	39,353	901	15%	14%	0%	54%	10%	1%	0%	4%
SVE	28,053	1,331	19%	3%	0%	58%	8%	0%	1%	12%
SVK	3,393	340	43%	1%	2%	26%	2%	4%	3%	20%
SVN	39,952	396	4%	2%	7%	58%	11%	3%	5%	12%
UKI	92,341	4,539	28%	3%	1%	52%	7%	1%	1%	7%
Total EU	4,923,425	84,951	19%	8%	15%	31%	12%	3%	3%	8%

4.7 Conclusion

The analysis in this chapter leads us to the conclusion that adapting the FADN to include the collection of FLINT sustainability indicators is a realistic option. There are no legal barriers in the basic act of FADN to do so, and the most relevant FLINT tables with variables for the Farm Return could easily be added to the current Farm Return.

Collecting some of the current FADN and some of the FLINT data in specific years (e.g. the years that a Farm Structure Survey (FSS) is carried out) can be attractive for indicators that do not vary a lot from year to year, e.g. if they are not very much influenced by weather, yield and price fluctuations. However many environmental data fluctuate with weather, prices and yields and the data from one year could bias the analysis. The gains from such an approach are also not big enough to finance the collection of sustainability data on 10,000 to 15,000 farms.

That leaves three options. A Full FADN in which the FLINT sustainability data are collected on all FADN farms, without increasing the current budget would lead to a reduction of the FADN sample with a third, from 85,000 to 55,000 farms. Although this would not jeopardise the income estimation at EU level, it would lead to considerable changes of the FADN panel in some countries such as France, Germany and Sweden. Such countries would most likely be confronted with unreliable estimates for some farm types at regional level. Our estimations of the reduction in the sample needed are quite unsure as they very much depend on the estimation of the FADN managers and the FLINT project team on the costs that member states would have in collecting the data. Learning effects and future developments in ICT are hard to quantify. That makes this option less attractive than the other two to upscale the FLINT project results.

Upscaling the FLINT project results could better be done to a sample of 15,000 farms for 28 member states. If that sample would be optimally allocated over the member states and farm types this would guarantee a relative standard error below 3%, and makes it possible to publish results for the most important farm types in the individual member states.

There are two options to start with this sample of 15,000 farms. One option would do that as a FLINT-2 Policy Research Infrastructure project, with extra funding. The other option is to include it in the FADN and the current FADN budget. That would imply a reduction of 10,000 farms, bringing the FADN sample back to 75,000 farms. Also this reduction would be unevenly distributed over the member states.

5 FUTURE DEVELOPMENT

The analysis presented in the previous chapters lead us to the conclusion that the results of the FLINT project can be upscaled to improve the evaluation of the current and future CAP. The most realistic option to realise this is an FADN sub-sample of 15,000 farms in 28 member states. This is a strong recommendation from a research project towards a decision that is of course also political. It is based on the analysis of the current EU policies, the good practice of the EU to perform ex-ante impact evaluations (Kirkpatrick, 2007) and the demonstration in the FLINT project that data can be gathered. And it is confirmed by the strong interest of DG-Agriculture and Rural Development in this project and suggestions to be able to use the results in the mid-term review of the current CAP.

There are two options to realise this upscaling that could and should be started in parallel. One is to formally expand the FADN with this data in a subsample, and at the same time reduce the current FADN sample from 85,000 to 75,000 farms to give the member states the possibility to keep the FADN costs within their current budget.

The problem with this option is that it will take time to change the legislation, agree on the set of data that has to be collected (e.g. some of the countries not in the FLINT project will question the relevance or definition of certain indicators for their country) and to get started. In several member states time is needed to discuss consequences with accounting offices and software suppliers, and to adapt contracts. This means it would take a few years before the European Commission has access to the micro-level sustainability data for policy analysis. Even if the FADN committee would agree in 2017 on introducing the FADN subsample, this most optimistic planning would at the earliest bring in data on 2018 at the end of 2019 to be available as a first-year dataset for policy analysis in 2020. That is certainly too late for the current mid-term evaluation of the CAP and most likely also too late for the ex-ante evaluation of the CAP-post-2020.

We therefore propose to start in parallel with a project FLINT-2 that creates with the 28 national FADNs a Policy Research Infrastructure. This could start immediately and take in data that is already available in national FADNs for past years (e.g. Ireland and the Netherlands), including those from FLINT partners such as Hungary, Finland, Navarra (Spain) and Poland that decided to continue the data collection of some nationally relevant indicators. The project could immediately start to help the member states that were not part of the FLINT pilot project to start up their activities based on the project budget and by making software available. In addition to DG Agri other units of the Commission (e.g. JRC, DG Envi, DG Clima, European Environment Agency) could be interested and more easily connected to such a project.

These recommended options are discussed in more detail in the next sections. This is followed by a couple of suggestions for further work on indicators, ICT and collaboration with industry.

5.1 Plan for execution to create a FADN subsample

We recommend the FADN committee, chaired by DG Agri, to discuss this report and its recommendations in 2017 and start working on adapting the FADN legislation to include a sub-sample of 15,000 farms that provide some sustainability data as defined in this project. The allocation of these 15,000 farms is shown in Table 5.1. At the same time the current FADN sample should be reduced.

Table 5.1: Proposal for a reduced FADN of 75,000 farms with a subsample of 15,000 farms for sustainability data based on optimal allocation of subsample farms over the member states and main types of farming

Coun-try	FADN field of survey	FADN sample - total	of which sub-sample	fraction of the subsample per farm type							
				1	2	3	4	5	6	7	8
BEL	30,456	1,151	360	9%	13%	5%	31%	23%	1%	7%	12%
BGR	115,650	2,087	230	49%	10%	3%	19%	8%	4%	0%	8%
CYP	10,209	443	25	14%	10%	10%	42%	10%	13%	0%	1%
CRO	89,300	4,000	150	To be calculated when data becomes available							
CZE	14,856	1,319	370	36%	5%	3%	21%	5%	1%	4%	25%
DAN	29,044	1,513	420	16%	5%	4%	31%	31%	3%	1%	9%
DEU	193,867	6,941	1,900	18%	7%	5%	37%	16%	1%	5%	11%
ELL	328,985	4,663	230	24%	14%	29%	15%	3%	8%	0%	7%
ESP	601,208	7,987	1,900	15%	10%	24%	24%	19%	3%	2%	4%
EST	8,090	644	40	34%	5%	0%	43%	6%	0%	1%	10%
FRA	304,539	5,143	1,900	21%	4%	21%	27%	11%	2%	4%	10%
HUN	107,241	1,922	380	48%	6%	5%	9%	13%	4%	1%	13%
IRE	78,954	922	150	12%	0%	0%	85%	0%	0%	0%	3%
ITA	802,922	9,147	3,285	20%	8%	32%	24%	7%	5%	1%	3%
LTU	52,926	1,036	50	40%	2%	1%	32%	5%	2%	1%	17%
LUX	1,607	441	25	3%	0%	7%	77%	4%	0%	4%	7%
LVA	22,682	955	40	39%	2%	0%	35%	5%	2%	3%	15%
MLT	3,034	499	25	7%	27%	7%	23%	23%	10%	3%	3%
NED	52,201	1,413	900	8%	30%	3%	38%	16%	1%	3%	2%
OST	92,989	2,065	160	10%	0%	14%	39%	25%	3%	3%	6%
POL	720,630	12,098	720	20%	7%	3%	19%	17%	3%	10%	21%
POR	109,921	2,239	190	12%	8%	19%	40%	6%	6%	1%	8%
ROU	1038,322	5,541	430	21%	2%	3%	38%	4%	1%	13%	18%
SUO	39,353	816	110	15%	14%	0%	54%	10%	1%	0%	4%
SVE	28,053	888	220	19%	3%	0%	58%	8%	0%	1%	12%
SVK	3,393	488	150	43%	1%	2%	26%	2%	4%	3%	20%
SVN	39,952	894	50	4%	2%	7%	58%	11%	3%	5%	12%
UKI	92,341	2,685	590	28%	3%	1%	52%	7%	1%	1%	7%
Total EU	4,923,425	75,940	15,000	19%	8%	15%	31%	12%	3%	3%	8%

The timetable for moving from the current FADN to the renewed FADN with this subsample is given in Table 5.2. It assumes that legislation could be adapted in the winter of 2017/18 and that data collection could start in all member states on the accounting year 2019. This process can be supported by providing data from some of the FLINT partners (that collect the data already for national purposes) at an earlier stage, to test FADN (RICA-1) software.

Table 5.2: Timetable for creating the subsample in FADN

year	*Action*
2017	Discuss this report in FADN committee and adopt recommendations Adapt FADN legislation: number of holdings in FADN sample and subsample; new tables in Farm Return for subsample Optional: decide to collect some data from current form and FLINT indicators only in the years that an FSS is organised
2018	Finalise selection plans Change contracts with (or instructions to) accounting offices Adapt software in member states and at DG Agri, including auditing programs (RICA-1); pre-test with data from one of the FLINT partners
2019	First year of data collection Finalise adaptation of software with DG Agri
2020	Upload data from member states to FADN website at DG Agri
2021	Publish data from subsample on FADN Website and make it available for policy research

A fall back option for the Commission is to start in the accounting year 2020 or to make the proposal to adapt the FADN a part of the legislative proposal to change the CAP for the period after 2020 in a package deal with the member states. Renewing the CAP with cross-compliance, greening and other options could go hand in hand with an obligation for the member states to monitor that not only with the Common Monitoring and Evaluation Framework (CMEF) but also (for the current pillar 1) with the FADN subsample as defined in Table 5.1.

5.2 Plan for a FLINT-2 Policy Research Infrastructure project

As argued in the introduction of this chapter, the option to adapt the FADN legislation to include a sub-sample of farms that provide sustainability data does not solve the immediate data needs of DG Agri for the evaluation of the current CAP or the ex-ante evaluation of proposals for the CAP-post-2020. This is a pity as a lot of data is available, also on past years, in some of the member states. There is also a risk that some member states will block the development of the FADN as advocated in Section 5.1.

We therefore recommend DG Agri to launch a project (call) that establishes for the time being a 'policy research infrastructure' in which some sustainability data as defined in FLINT are collected on 15,000 FADN farms in the 28 member states. Such a project would have three advantages. First, it brings in data that is already available in some of the member states, even for previous years up to 2017 which could help DG Agri (and its contractors) to improve its policy analysis. That would improve the impact analysis of the current CAP and show the diversity in farms in the uptake of measures such as greening etc. and see which measures work (and which ones not). Second, such a project would be much more flexible in making data from member states available than the FADN subsample based on legislation. In a project it is much easier to take on board what is available and to make exceptions if a certain indicator is relevant for a country but very hard to collect in the national context. A flexible ICT system (as advocated for FADN in the RICASTINGS project, Abitabile et al., 2000) supports that. In the legislative framework of FADN that can be arranged with exceptions and derogations but it quickly leads to agree on the lowest common denominator of data to be gathered. Third such a project could be useful to support the member states in setting up the subsample, especially for those countries that were not part of the FLINT project. At the same time it puts some pressure on them to make progress with the official FADN subsample as discussed in the previous section.

Table 5.3 gives a tentative list of deliverables for a project FLINT-2 Policy Research Infrastructure. The call for such a project could be launched by DG Agri in the spring of 2017, with bids evaluated before the summer. That would make it possible to do the first policy analysis in the project already after the summer break of 2017, based on the FLINT data and other data from the member states that are already available (including those from member states not present in the FLINT-consortium). Data gathering in many countries could start in 2018, making the data available in time for the ex-ante evaluation of the CAP-post-2020. The project could also develop the software needed for managing the sustainability data. The test-engine developed in the FLINT project could be made available and managed as open source and additional software could be developed in a similar way. A budget of 7.5m euros a year would probably be large enough to realise the sample of 15,000 farms[16].

Table 5.3: Main deliverables for a project FLINT-2 Policy Research Infrastructure.

Time	*Deliverable*
August 1, 2017	Signed contract for the project
November 1, 2017	Report with first analysis of CAP with FLINT data and some national FADN sustainability data
January 1, 2018	Selection plans and instructions (with best practices) for data collection in FADN Subsample available to start data collection in 2018 in 28 member states
March 1, 2018	Database available with relevant data from member states (FLINT and others) from 2010-2016 (including FLINT data)
July 1, 2018	2nd Report with analysis of CAP with FLINT data and national FADN sustainability data. Data in aggregated form available on website
October 1, 2018	Selection reports on start-up data collection in FADN subsample in 28 member states
	Software with tests available for auditing sustainability and conventional FADN data (RICA-1) in open source approach
December 15, 2018	Database available with relevant data from member states (FLINT and others) from 2017
July 1, 2019	3rd Report with analysis of CAP with FLINT data and national FADN sustainability data on 2017. Data in aggregated form available on website
December 15, 2019	Database available with relevant data from all 28 member states from 2018
July 1, 2020	4th Report with analysis of CAP, focus on ex-ante evaluation CAP-post 2020 with for the first time data from all member states, on 2018. Data in aggregated form available on website
December 15, 2020	Database available with relevant data from all 28 member states from 2019; end of project.

[16] Based on the estimation in Chapter 4, the data collection for 15,000 farms would cost about 4.2m euros. This excludes overheads and set-up costs and contains a very low fee for countries who collect this data anyway. There are also costs to make data from previous years available. In addition there are costs for work packages on ICT and missions to the member states to support the set-up of their data collection. In larger (federated) member states this could involve substantial work. In addition a work package on carrying out analysis with the data should be planned, to support policy evaluation in DG Agri as well as that the use of data provides necessary feedback on data collection.

Alternatively we recommend the European research institutes (or liaison offices) that are active in the FADN data collection create a coalition of the willing and pool the sustainability data that they have available. Such a pooled data set would directly have value for their own research and would be beneficial in working in projects that the European Commission contracts out. On the longer term such an action could lead to a more formal Research Infrastructure, recognised in the Horizon2020 ESFRI (European Strategic Forum on Research Infrastructures) facility.

5.3 Future work on indicator development and standardisation

Besides the recommendations in the previous sections to scale up the results of the FLINT project within the FADN community, we have a couple of recommendations for future work in research and innovation that builds upon the FLINT results. The first is to keep working on the development of sustainability indicators and their standardisation. There are a number of reasons for that. First, the FLINT project does not claim that its decisions on indicator definitions cannot be challenged from a scientific or practical point of view. We had to take practical decisions for the 9 member states involved, and applying the methodology to other countries and sectors with new practical experiences could lead to new insights.

A more important reason for this plea to work on indicator development is that we concentrated in the environmental indicators on soil, water, air, and biodiversity and in the social indicators on those related to people and human capital. We think that more work could be done on these issues, especially soil (where experts have no clear conclusions on good indicators but where sustainability issues are clearly on the table), climate change and biodiversity themes. Introduction in agriculture of new concepts such as the bio-economy and circular economy will lead to new issues and indicators. The issue of climate change, adaption as well as mitigation, will probably play a big role in the CAP-post-2020 and ask for policy evaluation (Fresco and Poppe, 2016). In the social domain we for the moment deliberately left out ethical issues such as animal welfare.

Standardisation of indicators should be done in collaboration with statistical agencies that collect some of the sustainability data for statistics. In some cases the statistics could be based on FADN data, reducing the administrative burden for farmers and costs for the government.

5.4 Future work on integration with industry schemes

Several industry schemes oblige farmers to collect sustainability data, as discussed in Chapter 2. Researchers active around the FADN should liaise with these schemes. First, as these schemes and their indicators are a reality, they influence farm behaviour and perhaps even more than policies do. This means that researchers who want to explain farm behaviour and the effect of policies on this behaviour and through this on the environment, need insight into the indicators that industry uses to influence farm management. Indicators in the FADN should therefore be based as much as possible on what is used in the industry. Second, the harmonisation between industry indicators and those used in FADN and policy evaluation is beneficial for the cost of data collection. Farmers will make data more easily available if that data is already in their management software for the industry schemes. It reduces administrative burdens if farmers can supply the same data to the FADN as to industry. Third, the world becomes less complicated and policies more successful if incentives from policies and industry towards farmers are harmonised. This is not to say that industry indicators are all correct and complete. In some cases the indicators can be made more scientifically sound or new ones can be included in industry schemes after a test in the FADN for new sustainability topics.

5.5 Future work on ICT aspects

In the introduction of Chapter 4 we described how many member states use administrative data in compiling their FADN data set and how some have started to re-use commercial data that comes from invoices and other transaction data in a digital form. Costs of the FADN could be lowered substantially in the coming years if such a development would take off. And farmers themselves would benefit most of all.

A recent EIP Focus Group on Benchmarking (2016) concluded that data sharing is an important theme for innovation:

> *''Farmers, like most people, do not like to enter data into devices that are already available somewhere else. Unfortunately, the current situation is far from an ideal situation of nonrepudiation of data input. Agri-businesses, such as sellers of farm inputs and buyers of farm produce send ten thousands of paper invoices and other documents per year to farmers (one of the characteristics of agriculture is that farmers do not send invoices on their sales, but their buyers do, as this is more efficient). Farmers then have to type such data in their farm management information systems or accounting software (or have to pay their accountant to do that). This is often restricted to the most needed data (e.g., financial data) where other data on the documents (on volumes of input and output or on quality indicators of the produce) is ignored, although this would be useful for indicators on productivity and especially sustainability.*
>
> *In the next years, this practice should evolve towards digital exchange with EDI (Electronic Data Interchange) messages. [..] Novel more pro-active government approaches by public authorities could play a key role to promote EDI approaches and benchmarking sustainability. The Focus group discussions mentioned the blockchain technology as a possible solution, guaranteeing the ownership of data for the farmer and as such creating trust in a common interoperable system which holds data that farmers may not want to share with all actors. Standardisation organisations like AgGateway Europe or national ones could help in providing EDI-standards (many of them already available as UN/CEFACT standards).''*

Such principles as Single Entry and Digital by Default could help the agricultural sector and the food chain in managing its paper work and administrative burden. Researchers involved in the FADN should actively investigate and develop such innovations. The EIP Focus Group on Benchmarking also suggested that averages from the FADN, currently published on websites, should actively be used to provide benchmarks by linking this data to the IACS data. This could help to improve productivity and sustainability.

References

Abitabile, C., Beers, G., Bonati, G., Bont, de K., Del'Homme, B., Larsson, G., Linden, H. and Poppe, K.J. (1999). RICASTINGS: The implications of a new farm return on a renewed FADN. Agricultural Economics Research Institute, Report LEI 99.06. The Hague.

Agra CEAS Consulting (2007) Feasibility Study on the Implementation of Income of Agricultural Households Sector (IAHS) Statistics. Final Report for European Commission (Eurostat).

Bockstaller, C., G. Gaillard, D. Baumgartner, R. Freiermuth-Knuchel, M. Reinsch, R. Brauner and E. Unterseher (2006). 'Abschlussbericht zum Projekt 04 - 'Comete' 2002-2005: Betriebliches Umweltmanagement in der Landwirtschaft. Vergleich der Methoden INDIGO, KUL/USL, REPRO, SALCA', Colmar, Grenzüberschreitendes Institut zur rentablen umweltgerechten Landbewirtschaftung (ITADA).

Binder, C. R., Feola, G., & Steinberger, J. K. (2010). Considering the normative, systemic and procedural dimensions in indicator-based sustainability assessments in agriculture. Environmental Impact Assessment Review, 30(2), 71–81.

Bonnen, J. (1975): Improving Information on Agriculture and Rural Life. American Journal of Agricultural Economics, 57(5), 753-763.

Boone, J.A. and Dolman, M.A. (2010): Monitoring sustainability of Dutch agriculture. Paper presented at the Fifth International Conference on Agricultural Statistics (ICAS-V), Kampala, Uganda, 12-15 October 2010.

Breembroek, J.A., Koole, B., Poppe, K.J. and Wossink G.A.A. (1996): Environmental farm accounting: the case of the Dutch nutrients accounting system. Agricultural Systems 51, 29-40.

Brennan, Noreen, Mary Ryan, Thia Hennessy, Paula Cullen and Emma Dillon (2016a), Going beyond FADN: The use of additional data to gain insights into extension service use across European Union Member States, Studies in Agricultural Economics, 118(3), pages 145-153.

Brennan, N., Ryan, M., Hennessy, T. and Cullen, P. (2016b), The Impact of Farmer Age on Indicators of Agricultural Sustainability, FLINT deliverable 5.2H.

Buckley Cathal, Co Daatselaar, Thia Hennessy, Hans Vrolijk (2016) Using the Farm Accountancy Data Network to Develop Nutrient Use Efficiency Indicators for Milk Production. FLINT deliverable 5.2K.

Cahuzac E. and Garcia, B. (2017), Server Tools For Checking, Reporting And Mapping, FLINT deliverable D.3.3.

Dillon, E.J., Hennessy, T. and Hynes, S. (2010): Assessing the sustainability of Irish agriculture. International Journal of Agricultural Sustainability 8 (3), 131-147.

Dolman, M.A., Vrolijk, H.C.J. and De Boer, I.J.M. (2012): Exploring variation in economic, environmental and societal performance among Dutch fattening pig farms, Livestock Science 149, 143-154.

ECA (2016): Is the Commission's system for performance measurement in relation to farmers' incomes well designed and based on sound data? Special Report 2016-1. Luxembourg: European Court of Auditors.

Eguinoa P. and Intxaurrandieta, J.M. (2016) Water usage, source and sustainability: examples from the region of Navarra (Spain) and Greece, FLINT deliverable 5.2O.

Ehling, M. and Körner, T. (2007): Handbook on Data Quality Assessment Methods and Tools. Wiesbaden: European Commission.

Elkington, J. (1997). Cannibals with forks – Triple bottom line of 21st century business. Stoney Creek, CT: New Society Publishers.

EU (2010): Farm Accounting Data Network: An A to Z of methodology. Version 04/11/2010 23:14:03 [www document]. http://ec.europa.eu/agriculture/rica/pdf/site_en.pdf (accessed 18 November 2016).

European Commission, 2012 Feasibility study on data collection and analysis in the cultural and creative sectors in the EU, Brussels

Fresco, L and Poppe, K.J. (2016) Towards a Common Agriculture and Food Policy, Wageningen Economic Research, The Hague, The Netherlands.

Green, P.E., Tull, D.S. and Albaum, G. (1988): Research for marketing decisions. Englewood Cliffs NJ: Prentice-Hall.

Griggs, D., M. Stafford-Smith, O. Gaffney, J. Rockstrom, M. C. Ohman, P. Shyamsundar, W. Steffen, G. Glaser, N. Kanie, and I. Noble. 2013. Policy: Sustainable development goals for people and planet. Nature 495 (7441):305-307.

Herrera, B., Gerster-Bentaya, M. and Knierim, A. (2016a), Stakeholders' perceptions of sustainability measurement at farm level, Studies in Agricultural Economics, 118(3), pages 131-137.

Herrera, B., Gerster-Bentaya, M. and Knierim, A. (2016b), Social indicators of farm-level sustainability, FLINT deliverable 5.2E.

Herrera, B., Gerster-Bentaya, M., Tzouramani, I. and Knierim, A. (2016c), Advisory services and farm level sustainability, FLINT deliverable 5.2M.

Hoste, R. and Vrolijk, H. (2017), Farm data: help or hurdle? Agrifuture, 2017/1, 21 - 23.

Hill, B. (2012) Farm incomes, wealth and agricultural policy: filling the CAP's core information gap. 4th edition. CABI, Wallingford.

Hill, B., Bradley, D. and Vrolijk, H. (2016), Uses and Benefits of FADN Information in EU-28, Eurochoices, Issue 15 (3), 11-16.

Kelly E., Ryan, M , Finn J. and Hennessy T. (2015), Farm-Level Indicators for Evaluating Sustainability and Emerging New Policy Topics, FLINT deliverable 1.4.

Kis Csatári, E. and Keszthelyi Sz. (2016a), Effect of age of assets on farm profitability and labour productivity, FLINT deliverable 5.2F.

Kis Csatári, E. and Keszthelyi Sz. (2016b), Experience on Data Collection, FLINT deliverable D.4.5.

Kis Csatári, E. and Keszthelyi Sz. (2016c), Quality Control and Data Transfer, FLINT deliverable D.4.4.

Latruffe, L and Piet, L. (2014), Does land fragmentation affect farm performance? A case study from Brittany, France, Agricultural systems, 129, 68-80.

Latruffe, L., Y Desjeux, G. J. Hanitravelo, T. Hennessy, C. Bockstaller, P. Dupraz, J. Finn (2016). Tradeoffs between economic, environmental and social sustainability: The case of a selection of European farms. FLINT Deliverable 5.2L

Latruffe, L., Y. Desjeux and P Dupraz (2016): Database used for FLINT WP5 activities; description and quality assessment. FLINT Deliverable 5.1, December

Latruffe, L., Y. Desjeux, P Dupraz and K. Poppe (2016): Usefulness of the FLINT sustainability data complementing the FADN data. FLINT Deliverable 5.3, December.

Latruffe, L., Dakpo, H., Desjeux, Y., Hanitravelo, G. (2016), Cap subsidies and technical efficiency including environmental outputs: the case of European farms, FLINT deliverable 5.2B

Latruffe, L., Diazabakana, A., Bockstaller, A., Desjeux, Y., Finn, J., Kelly, E., Ryan, M. And Uthes, S. (2016), Measurement of sustainability in agriculture: a review of indicators, Studies in Agricultural Economics, 118(3), pages 123-130.

Lynch, J., Finn, J. and Ryan, M. (2016), Investigation of indicators for greening measures: permanent grassland and semi-natural area. FLINT deliverable 5.2J.

O'donoghue, Cathal, Devisme, S., Ryan, M., Conneely, R., Gillespie. P. and Vrolijk, H. (2016), Farm economic sustainability in the European Union: A pilot study, Studies in Agricultural Economics, 118(3), pages 163-171.

Kirkpatrick, Colin & Parker D. (2007). Regulatory Impact Assessment: Towards Better Regulation? Cheltenham, UK: Edward Elgar Publishing

Knierim, A., K. Boenning, M. Caggiano, A. Cristóvão, V. Dirimanova, T. Koehnen, P. Labarthe, K. Prager (2015), The AKIS Concept and its Relevance in Selected EU Member States, Outlook on Agriculture, Vol 44, Issue 1, pp. 29 - 36.

Koester, U and Loy, J.P. (2016): Policy evaluation on the basis of the Farm Accountancy Data Network. IAMO Policy Brief No. 29. Halle (Saale), IAMO.

Meier, M. S., F. Stoessel, N. Jungbluth, R. Juraske, C. Schader and M. Stolze (2015). 'Environmental impacts of organic and conventional agricultural products–Are the differences captured by life cycle assessment?'. Journal of environmental management 149, pp. 193-208.

Oenema. O., Amon, B., van Beek, C., Hutchings, N., Perez-Soba, M., Procter, C., Pietrzak, S., Velthof, G.L., Vinther, F. and Wilson, L. (2011), Farm data needed for agri-environmental reporting. Luxemburg: European Commission.

Platteau, J., Van Gijseghem, D. and Van Bogaert, T. (eds) (2014): Landbouwrapport 2014 [Agriculture Report 2014]. Brussel: Departement Landbouw en Visserij.

Poppe, K.J. (1997): Pacioli 4: Proposals for innovation of farm accountancy data networks (final reflection paper). Den Haag: LEI-DLO.

Poppe, K.J. (2002): Approaches to Obtaining Income Data – the Case of the Netherlands, Workshop on the Farm Household-Firm Unit: Its importance in agriculture and implications for statistics. Paper Presented at a Workshop on the Farm Household-Firm Unit: Its importance in agriculture and implications for statistics, Imperial College, London, UK, 12-13 April 2002.

Poppe, K, Vrolijk, H. , Dolman, M. and Silvis, H. (2016), FLINT – Farm-level Indicators for New Topics in policy evaluation: an introduction, Studies in Agricultural Economics, 118(3), pages 116-122.

Saint-Cyr L., Latruffe L. and Piet, L. (2016), Performance and subsidies in the European Union, FLINT deliverable 5.2D.

Ssekiboobo, A.M.N. and Zake, E.M. (2016): Strategies for improving administrative data for use in an integrated agricultural statistics system. Paper presented at the Seventh International Conference on Agricultural Statistics (ICAS VII), Roma, Italy, 26-28 October 2016.

Tocco, B., Davidova, S. and Bailey, A. (2014): Labour adjustments in agriculture: evidence from Romania. Studies in Agricultural Economics 116 (2), 67-73.

Tudor, M.M. (2015): Small scale agriculture as a resilient system in rural Romania. Studies in Agricultural Economics 117 (1), 27-34.

Uthes, S. (2016), deriving indicators for soil organic matter management from FLINT data. FLINT deliverable 5.2N.

Van Asseldonk, M, Tzouramani, I., Ge, L. and Vrolijk, H. (2016) Adoption of risk management strategies in European agriculture, Studies in Agricultural Economics 118 (3), pages 154-162.

Van der Meulen, H., Van Asseldonk, M. and Ge, L. (2016), The state of innovation in European agriculture: Innovators are few and far between, Studies in Agricultural Economics, 118(3), pages 172-174.

Vigneau, L., Humphreys, M. & Moon, J. J Bus Ethics (2015) How Do Firms Comply with International Sustainability Standards? Processes and Consequences of Adopting the Global Reporting Initiative, J. J Bus Ethics (2015) 131: 469.

Vrolijk, H.C.J. (2002): Working Procedures for the selection of farms in the FADN, in G. Beers and K. Poppe (eds), Pacioli 9: Innovations in the FADN. Report 8.02.02. Den Haag: LEI.

Vrolijk, H.C.J. (2016), Policy and research needs on economic, social and environmental farm performance, in Kowalski, A. and Wigier, M. (eds.), Competitiveness of the economy in the context of social policy measures, IERIGZ, Warsaw, 2016, 137 - 149.

Vrolijk, H.C.J. and K.J. Poppe (2016), Structural change in Dutch agriculture: the impact on farm-level statistics, Plenary Session at International conference on agricultural statistics, ICAS VII, Rome 2016.

Vrolijk, H.C.J. Poppe, K.J. and Keszthelyi, Sz. (2016): Collecting sustainability data in different organisational settings of FADN in Europe. Studies in Agricultural Economics 118 (3), pages 138-144.

To explore the potential of nature to improve the quality of life

Wageningen Economic Research
P.O. Box 29703
2502 LS Den Haag
The Netherlands
E communications.ssg@wur.nl
www.wur.eu/economic-research

Report 2017-061
ISBN 978-94-6343-203-0

The mission of Wageningen University and Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 5,000 employees and 10,000 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.