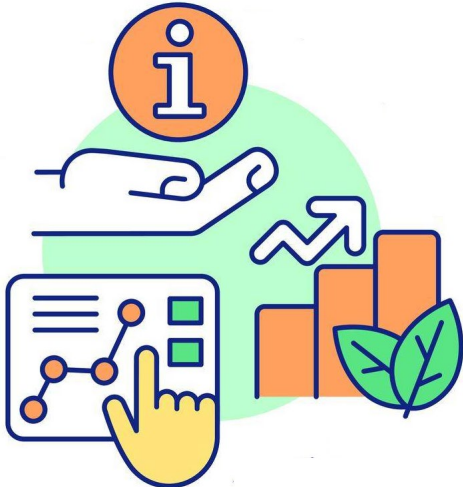
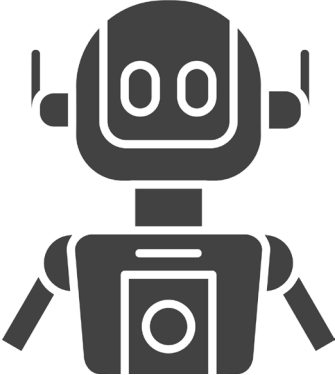
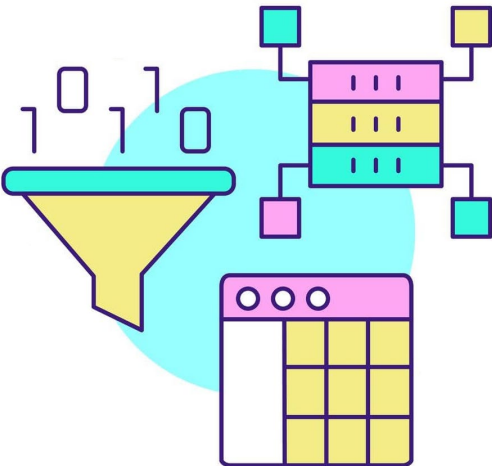


# Integrating Economic and Environmental Data for Sustainability Measurement (using Robotic Accounting)



# Context

- Why is widening the data collection schedule relevant?
- Policy and Private sector motivations
  - Policy – Farm to Fork etc
  - Private sector – marketing of products with better environmental and social credentials
- Make better use of the data that is imbedded in invoices
- Automate the collection of that data
- Use that data for cross checking the accuracy to the available data across economic and environmental attributes

# Data Collection Constraints



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Can we collect **good** data **quickly** at **low cost**?

Is satisfying all 3 objectives an impossibility?

# Some examples of why sustainability data is important

## 1. Environmental challenges, climate change, biodiversity

- need for **sustainable agricultural practices**
- **minimise negative impacts** on the environment

## 2. Retailer and consumer demands

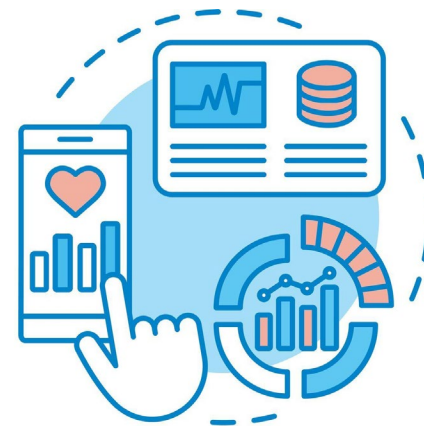
- for **sustainable** and **ethically** produced food

## 3. EU and nat. govs implementing **regulations and standards**

- to promote agricultural sustainability

## 4. **Long-term viability** of agriculture is crucial

- need to make the **best decisions**
- for **food security** and **economic stability**



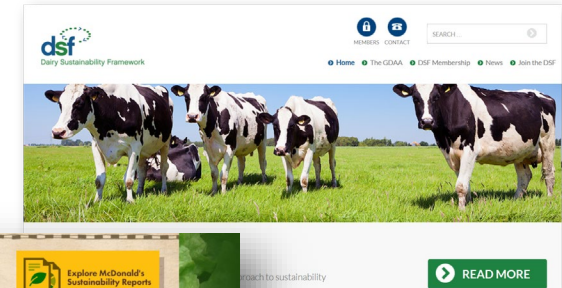
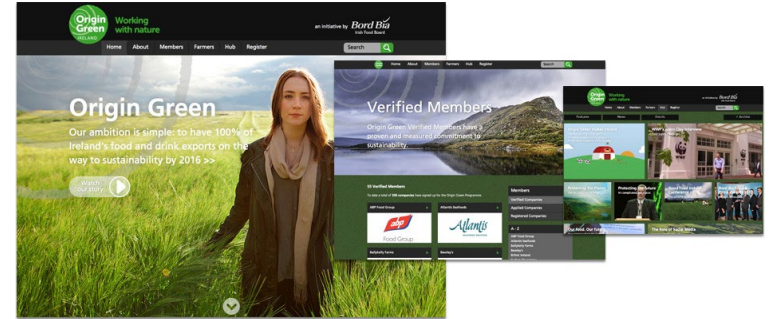
# Emerging Environmental Concerns (Farm2Fork)

- **Farm2Fork** is an EU policy document
- **GHG and Ammonia Emissions, Biodiversity, Water Quality**
  - All need to be addressed
- **Pesticides**
  - Reduce by 50% the overall use
- **Nutrient Losses**
  - Reduce **nutrient losses** by at least 50%
  - Maintain soil fertility
  - Reduce use of **fertilisers** by at least 20%
- **Antimicrobials**
  - Reduce sales of **antimicrobials** in farming by 50%
- **Organic Farming**
  - target of 25% of the EU's agricultural land in **organic farming**



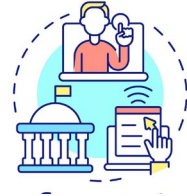
# Sustainability demands also in supply chain

- **Commercial pressure** for sustainability also
- “While price is a hot topic, sustainability remains crucial”
  - Consumers
  - Retailers
- **Pressure due to rising costs**
- **Pressure also from environmental NGOs**
  - Focus on adverse climate impact in particular
- Data is required to show what is really happening



# Rationale for additional data collection

1. Farmers engage with **commercial and governmental entities** requiring justification of their farming practices through **sustainability metrics**
2. Monitoring farm operations necessitates **efficient farm data management**.
3. Compliance with **sustainability criteria** yields benefits like
  - increased prices, government support, or reduced risk
4. The growing need for farm data presents an **administrative challenge** for farmers.



Data Management



Higher Prices



# Management of Farm Data

- Two important components in management of farm data:

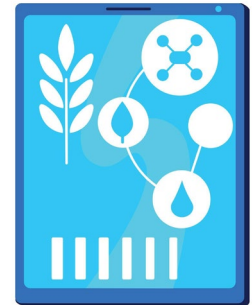
## 1. Farm Accounting

- **financial transactions data used to calculate financial statements**
- used for income taxes and financial management purposes
- focus on **monetary flows** (money amounts) and assets



## 2. Farm Management Information System (MIS)

- field records / animal records
- record input and output use per field
- guide farm management decisions
- focuses on **volumes and product flows** within the farm

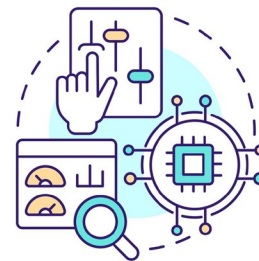


- Farm MIS can be made auditable by linkage to Farm Accounts



# Objective of efficient farm data management

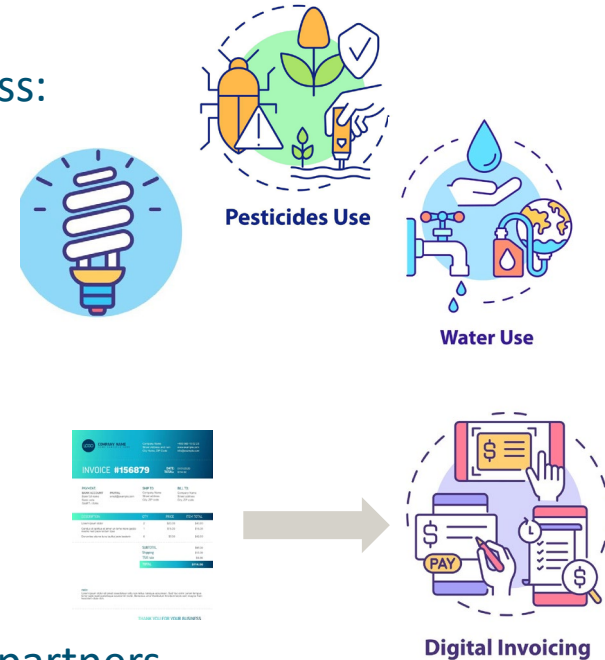
- Let's make use of efficient farm data management to support:
  1. sustainability monitoring (largely for policy makers)
  2. compliance auditing (largely for business purposes)
- Contribution to MEF4CAP project
- 1. enhanced monitoring and evaluation of farm and other data
  - support the evaluation and development of new and common EU legislation
- 2. combining data from existing sources (such as FADN) with alternative sources
- Fits with the objectives of FSDN



**MEF  
4CAP**

# Invoices are key

- Compliance auditing **data needs** requires indicators that address:
  - pesticide use,
  - mass balances (especially in organic farming),
  - material balances of N and P,
  - energy use (and production) etc.
- Invoices** provide a large amount of those data needs
  - Contain **financial and volume data need for**
    - Farm Accounts and
    - Farm MIS
- Input and output based invoices are created by farmers' trade partners
  - Invoices can be supplied in digital format** -standards like UBL, XML, UNCEFACT etc.



# Invoice Feed

FACTUUR nr: [redacted] Debiturnr: [redacted] Datum : 7 april 2020  
 Bonnr : [redacted]  
 BTWnr : [redacted]

Leverdatum	Art-nr	Omschrijving	Si-lo	Aantal	Gewicht	Prijs	Bedrag excl.	BTW %	Bedrag incl.	
06-04	9641	Optimabrok Top	1		12322	28,70	3536,41	318,28	9,0	3854,69
06-04	9646	Fresh Cow Boostbrok	2		2056	41,50	853,24	76,79	9,0	930,03
06-04	4045	Supplementmeel Royaal	3		2068	33,90	701,05	63,09	9,0	764,14
06-04	9647	Unimix 476	6		4034	24,20	976,23	87,86	9,0	1064,09
06-04	9645	TransLac brok Top	4		1028	44,90	461,57	41,54	9,0	503,11
		Bestelling (22 ton)				-0,20	-43,02	-3,87	9,0	-46,89
		Evening korting				-0,05	-10,26	-0,92	9,0	-11,18
		Jaar korting				-0,70	-122,32	-11,01	9,0	-133,32
						-0,30	-63,53	-5,72	9,0	-69,25
							Totaal bedrag factuur €	6855,42		

Invoice lines:  
5 product items  
+ 4 types of discounts

Kg

Amounts  
in €

Allocation to  
cows based  
on type feed

and N,P,K  
content are  
known

Software allocates  
discounts to product  
items. Entry incl. VAT  
generates excl. VAT  
and vice versa

Product names  
of supplier  
linked to FADN  
account code

GIRAF: vastleggen facturen en transacties (12-06-2021 -)

Bestand Special Help

AEE omschrijving boekstuk [redacted] Fakt: [redacted] Constant [redacted]

boekstuktype periode factuur inboeken [redacted] valuta totaal bedrag r[redacted]

EDI factuur 06-04-2020 07-04-2020 EURO 6.855,42 B[redacted]

courantverhouding [redacted]

Periode transactie	voorkomen	bedrag ex, BTW	BTW %	bedrag incl. BTW	soort		
06-04-2020 - 07-04-2020	Mengvoer	3.385,14	9,00	3.689,80	ankoop		
06-04-2020 - 07-04-2020	Mengvoer	825,37	9,00	899,65	ankoop		
06-04-2020 - 07-04-2020	Mengvoer	674,59	9,00	735,30	ankoop		
06-04-2020 - 07-04-2020	Mengvoer	956,48	9,00	1.042,56	ankoop		
06-04-2020	07-04-2020	Mengvoer		3.385,14	9,00	3.689,80	ankoop

Wijzigen Verwijderen

Soort Eenheid gewicht 100% toewijzen aan productie eenheid

Melkvee kilogram 22,00

omschrijving transactie  
Optimabrok Top

1067

alloceren? nee

# Invoice Milk (via XML)

09 september 2019

Bedrijfsnummer:  
 Factuurnummer: factuur uitgereikt door afnemer  
 IBAN:  
 BTW-nummer:  
 KvK-nummer:

Afrekening melkgeld augustus 2019

## Factuurgegevens

Omschrijving	Hoeveelheid	Prijs	Per	BTW	Bedrag	Toelichting
Garantieprijs		35,00	100 KG			
Eiwit garantieprijs	4.792,11	571,34	100 KG	L	27.379,24	
Vet garantieprijs	5.966,72	285,67	100 KG	L	17.045,13	
Lactose garantieprijs	6.585,33	57,13	100 KG	L	3.762,20	
Vaste kosten	1,00	100,00	1 ST	L	-100,00	
<b>Melkgeld totaal excl. BTW</b>					<b>48.086,57</b>	
Bijdrage ZuivelNL	145.434,00	-0,05	100 KG	G	-72,72	
BTW (Af te dragen)	9,000 % (L) over	48.086,57			4.327,79	
<b>Factuurbedrag (in euro's)</b>					<b>52.341,64</b>	

Vergelijking	Uw bedrijf	Uw bedrijf cum	t/m
Aflevering	08-2018	08-2019	08-2018
	121.014	983.709	943.951
	3,462	3,436	3,452
	4,054	4,372	4,054
	4,515	4,514	4,514
	25,7	24,7	25,7
	6,51	380.420,87	343.293,00
	36,66	38,67	36,37
	34,59	35,48	34,31
			34,60
			36,38

Milk delivery and price components (fat, protein, lactose, basic price) + levy

Amounts in €

Gelieve uw btw- en KvK-nummer te controleren en indien deze onjuist en/of onvolledig is aan ons door te geven. Dit kunt u doen door een e-mail te sturen naar [redacted], voorzien van uw bedrijfs(tank)nummer.

# Transaction viewer

GIRAF: vastleggen facturen en transacties (12-06-2021 -)

Bestand Speciaal Help

AEE omschrijving boekstuk Contant  
 Fak: 0092286232 nee

boekstuktype periode factuur inboeken btw: valuta totaal bedrag richting  
 EDI factuur 01-08-2019 01-09-2019 excl. + % EURO 52.341,64 Ontv

courantverhouding  
 (01-01-2010)

Periode transactie voorkomen bedrag ex. BTW BTW % bedrag incl. BTW  
 01-08-2019 - 01-09-2019 Melk 48.013,85 9,01 52.341,64

01-08-2019 01-09-2019 Melk 48.013,85 9,01 52.341,64 Verkoop

Wijzigen Verwijderen

Soort	Eenheid	Eenheid	gewicht	Eenheid	vetgehalte	eiwitgehalte	lactosegehalte	strafpunten
Koe	aantal	kilogram	145.434,00	procent	4,10	3,30	4,53	0
100% toewijzen aan productie eenheid								
		ureumgehalte		Eenheid	celgetal			
		25,0		milligram	194			

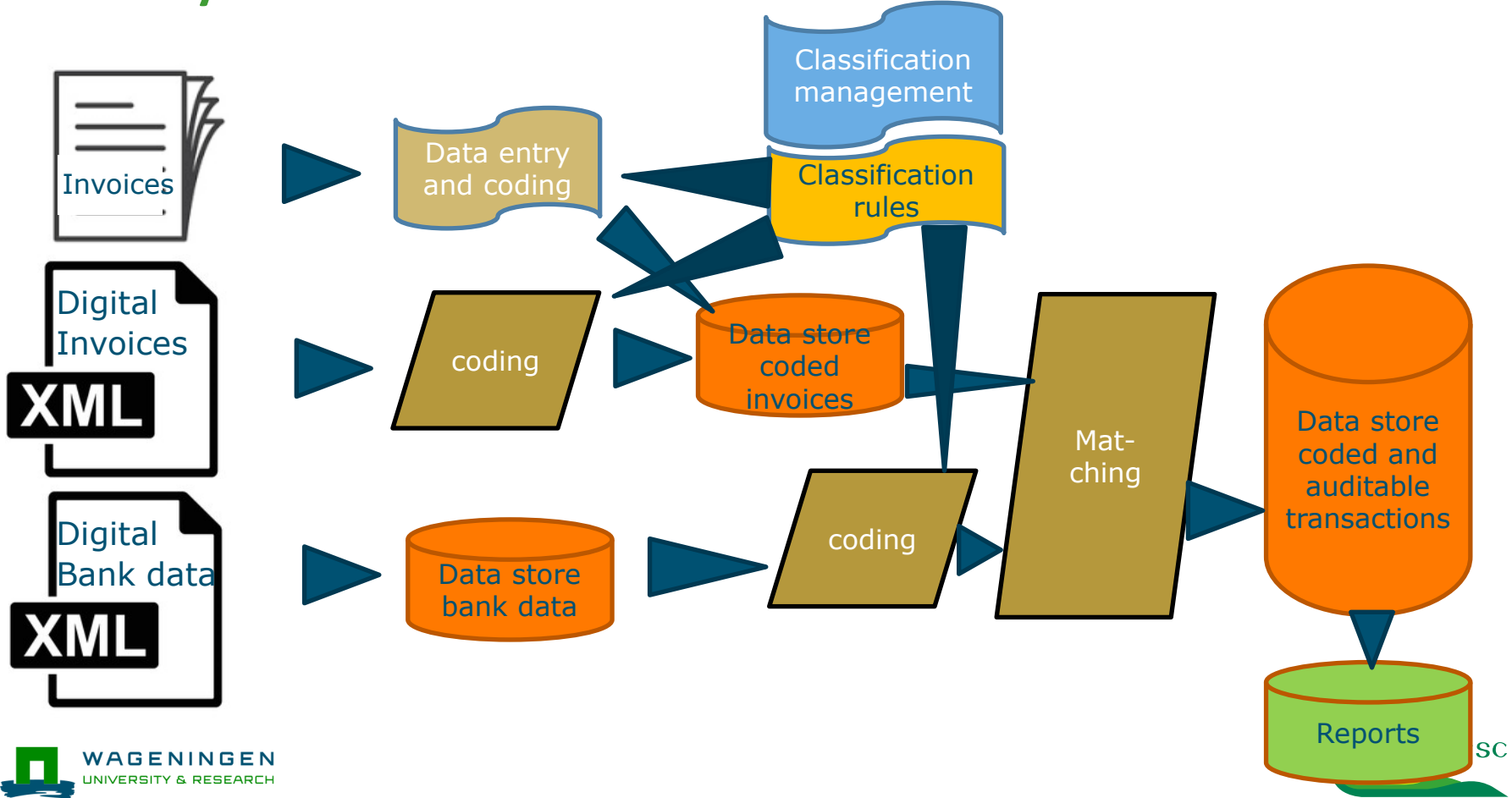
omschrijving transactie LEI synoniem alloceren?  
 Melk 1181 nee

Amounts in €

Data on type milk (cow), kg milk, fat, protein, etc are copied from XML message.

If data entry is manual, the software triggers these fields based on entry of item "milk" in field above.

# In summary: the data flow



# Role of financial data in auditing

- **Farm Financial Accounts are auditable if based on bank data**
- Auditing possible using financial bank data if all invoices are recorded
  - i.e. no inputs (or outputs) have been overlooked or ‘forgotten’.
- An **inputs invoice** could be deliberately omitted (if a cash based transaction)
  - To reduce the apparent level of input use (e.g. fertiliser) to meet sustainability target
- But that cost would then not be taken into account in the farmer’s financial records
  - not deductible as a cost in VAT and income tax calculations
- **Farm MIS** (and sensor data on use of inputs) can be made auditable in the same way by linkage via invoices to **Farm Financial Accounts**.



# How could such a system be developed?

- Invoices need to be digitalised (XML)
  - needed for farm level sustainability data
- **Centralisation of such data** in an industry data base is a short-term solution
  - but **not well integrated** in day-to-day farm management and
  - **audit-trail is difficult**
- Provide farmers with **digital copy of invoices**
  - reduces current administrative burdens with farmers, their advisors and accountants and
  - Makes it easier for FADN-sample data collection.
- Digital banking, Farm Accounting (VAT etc.) and FMIS (and sustainability apps)
  - can be integrated in an **easy-to-use digital dashboard** with coherent data relationships.



# How well could a systems like this work across the EU?

## Farmer side

- Could depend on the level of professionalization of the farmer
- Commercial farmers are now doing all of their business electronically
  - Using sophisticated data management tools
- Smaller and older farmers still working with cash transactions
  - Use cash transactions as cash flow management tool
- Initial applicability might work better in some parts of agriculture than others



## Food processor or input supplier side

- Not currently routinely supplying farmers with digital invoices
  - Paper invoicing still common
- Transition to digital invoicing (alongside paper invoicing) is required





# Conclusions

- **Opportunity: Invoices contain valuable data** for generating Sustainability KPIs
- **Action: The automation of invoice handling** through robotics
- **Benefits:**
  1. **Invoice digitalization** minimize administrative hassles, reducing workload for farmers.
  2. **Integration of digital invoices** is beneficial for **Farm Management Information Systems**, aiding in **reconciling discrepancies** between **financial and management reports**.
  3. **Connecting financial transactions with invoices** further diminishes administrative load and **enhances data auditability**, supporting farm certification processes.
  4. **Detailed invoice transactions**, when integrated with VAT accounting, enable the computation of **comprehensive financial and environmental reports**, including mass balances for monitoring material flows.

# Discussion

## Thanks to co-authors



Article

### Sustainability Monitoring with Robotic Accounting—Integration of Financial and Environmental Farm Data

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**Abstract:** The production of farm sustainability indicators is vital for all actors in the food chain. This paper shows how robotic accounting could assist in the monitoring and compliance of farm performance, to assess the various aspects of sustainability. We show how financial farm accounting, which is routine on most farms, can be extended to deliver a range of sustainability metrics. Using farm invoices from the Netherlands and Ireland, we show that many invoices contain volume data that can be used to calculate environmental indicators such as pesticide use, mass balances (especially needed in organic farming), material balances of N and P, energy use, antibiotics use, etc. Using a number of illustrative use cases, we show the feasibility of deriving both financial and sustainability data from invoices. Standard algorithms can be used to link the invoice data to bank payment data and code it with a chart of accounts using a simple data and process model. Linking invoices with bank data provides advantages with respect to completeness, reliability, and efficiency. We describe a software tool that provides flexible data management processes that can easily be adapted by the user to collect new data that reflect emerging environmental or social concerns. Data collectors can set up procedures in which new types of data can be acquired or new indicators calculated, avoiding the need for software reprogramming. The digitalisation of invoices, ideally in a standard (UBL) format, is a necessary step to facilitate the process described. This digital format would lead to reduced accounting costs and at the same time could also provide farmers with a dashboard of sustainability indicators. Once invoices are digitalised, accounting costs drop, the potential for errors or omissions is reduced, and the administrative burden for environmental accounting diminishes due to the low marginal cost of data management.

**Keywords:** farm accounting; robotic accounting; certification; sustainability; digitalisation



**Citation:** Poppe, K.; Vrolijk, H.; de Graaf, N.; van Dijk, R.; Dillon, E.; Donnellan, T. Sustainability Monitoring with Robotic Accounting—Integration of Financial and Environmental Farm Data. *Sustainability* **2022**, *14*, 4756. <https://doi.org/10.3390/su14114756>

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## MEF4CAP

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### About MEF4CAP

MEF4CAP is short for 'Monitoring and Evaluation Frameworks for the Common Agricultural Policy (CAP)', which in turn is a precise description of the project.

Developments in the political landscape (Paris Agreement, European Green Deal etc.) inevitably broaden the scope of indicators for monitoring and evaluating (M&E) the CAP. Data are increasingly generated by farmers and current information and communications technologies (ICT) development in the agribusiness create new opportunities to integrate them. Data integration is needed and so are new ways of making sense of them to monitor and evaluate the impact of the CAP.

M&E have so far been based on agricultural statistics and administrative data but with the new needs and possibilities, the

use of satellite and sensory data will be increasingly important. MEF4CAP will make an inventory of future data needs for M&E, describe the current developments in ICT and data capturing techniques and assess the technological readiness of these solutions.

The MEF4CAP project is designed to draw on the insights and perspectives of all relevant stakeholders to identify best practices, ensure the inclusion of all relevant developments and to discuss the potential of widening their application.

The project will deliver a roadmap for future monitoring, where the needs of different stakeholders are met, and the potential of different approaches is fully and optimally exploited.

# MEF 4CAP



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