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Final report

Improving the organic control and certification system by integrating certification and product transaction data as well as geographical data and appropriate Internet of Things (IoT) applications

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Implementing organisation

Organic Services GmbH,
Gerald A. Herrmann
Hauptstr. 47, 82327 Tutzing
+ 49 8158 92293-06
g.herrmann@organic-services.com

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Cooperation partners involved in the project

Thünen Institute of Farm Economics,
Heike Kuhnert
Bundesallee 63, 38116 Braunschweig
Germany
+ 49-531-596-5123

Kiwa/BCS Öko- Garantie GmbH
Ronald Wesner
Marientorgraben 3-5, 90402 Nuremberg
Germany
+ 49 911 42439-72

Abaco SpA
Fabio Slaviero
Case Ghisiol, 46100 Mantua
Italy
+ 39 340 3941852

Agrarmarkt Informations-Gesellschaft mbH (AMI), Diana Schaack
Dreizehnmorgenweg 10, 53175 Bonn
Germany
+ 49 228 33805-270
diana.schaack@ami-informiert.de

Association of Organic Food Manufacturers (AöL)
Alexander Beck
Untere Badersgasse 8, 97769 Bad Brückenau
Germany
+ 49 9741 938733-0

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Bundesministerium für Ernährung und Landwirtschaft
BÖL Bundesprogramm Ökologischer Landbau
aufgrund eines Beschlusses des Deutschen Bundestages

Kurzfassung in Deutsch

Organic Services GmbH,
Gerald A. Herrmann
Hauptstr. 47
82327 Tutzing
+ 49 8158 92293-06
g.herrmann@organic-services.com

Thünen Institut für Betriebswirtschaft,
Dr. Susanne Padel
Bundesallee 63
38116 Braunschweig
+ 49-531-596-5123
susanne.padel@thuenen.de;
heike.kuhnert@thuenen.de

Verbesserung des Ökokontroll- und Zertifizierungssystems durch die Integration von Zertifizierungs- und Produkttransaktionsdaten sowie von geografischen Daten und geeigneten Verfahren des Internet der Dinge (IoT)

Das Gesamtziel des Vorhabens ist ein umsetzbares Konzept für die Verbesserung von Kontrolle und Betrugsbekämpfung für Bio-Produkte am Beispiel der Getreidekette zu entwickeln. Dazu wurden signifikante Lücken im derzeitigen Kontroll- und Zertifizierungssystems identifiziert, evaluiert und konkrete Maßnahmen vorgeschlagen, um diese schließen.

Eine der wesentlichen Schwachstellen des Ökokontrollsystems ist die fehlende verpflichtende digitale Erfassung aller relevanten Daten (Lage und Größe, Kultur, Ertrag, Verkaufsmengen), die eine Verknüpfung der Produkttransaktionen vom Feld entlang der gesamten Produktkette ermöglichen würde. Dabei wird zwischen Rückverfolgbarkeit von Zertifizierungs- und Produkttransaktionsdaten unterschieden. Die digitale Verfügbarkeit von Daten und die Möglichkeit der Verknüpfung spielt hierfür die entscheidende Rolle.

Mit dem hier vorgestellten Projekt zur Verbesserung des Öko-Kontroll- und Zertifizierungssystems, insbesondere durch die Integration von Zertifizierungs- und Produkttransaktionsdaten mit einem geografischen Informationssystem stellen die Projektpartner Empfehlungen für die verschiedenen Akteure in Politik, Verwaltung, den Kontrollstellen u.a. für die Weiterentwicklung des Kontrollsystems vor:

Ein- und Durchführung von betrieblichen Massenbilanzen und entlang von Produktketten

Eine wachsende Zahl von Verbrauchern ist bereit, für Bio-Produkte einen höheren Preis zu bezahlen. Die Preisdifferenz bringt die Gefahr von Betrug mit sich. Daraus ergibt sich die Verpflichtung für alle Beteiligten, die Integrität von Bio-Produkten zu gewährleisten. Massenbilanzen von Warenflüssen entlang der Lieferkette sind dafür ein einfaches und verlässliches Instrument zur Betrugsverhinderung und -bekämpfung. Dazu sind digitale Flächen, Kultur- und Mengendaten sowie Transaktionsdaten der gehandelten Produkte erforderlich.

Vorantreiben der digitalen Erfassung von Daten für die Ökokontrolle und Dateninfrastruktur

Die Förderung einer digitalen Infrastruktur für Kontrolle und Zertifizierung hat viele Vorteile, wie z.B. der Beitrag zur Betrugsbekämpfung durch mehr Transparenz in den Wertschöpfungsketten, Verschlankung der Bürokratie und durch einen verbesserten Datenaustausch im Ökokontroll- und Zertifizierungssystem. Dazu können bereits vorhandene digitale Daten genutzt werden.

Verbesserung der Ertragsdatenerhebung ökologischer Betriebe

Ertragsdaten zum ökologischen Landbau werden nicht systematisch erhoben und sind daher lückenhaft. Kontrollstellen erheben zwar Erträge für ihre Betriebe. Diese Information steht aber nur intern und meist nicht digital zur Verfügung. Folglich stehen Daten in der Regel nicht zeitnah zur Verfügung, um sie für vorrausschauende Ertrags- und Marktschätzungen zu verwenden. Das Projekt empfiehlt konkrete Schritte, die

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wesentlich zur Verbesserung der Datenverfügbarkeit von Ökoerträgen beitragen und eine realistische Schätzung der zu erwartenden Erntemengen ermöglichen würden.

Beitrag der Fernerkundung

Generell kann die Fernerkundung zur Verbesserung der Datengrundlage auch im ökologischen Landbau beitragen, indem sie wiederholt und unabhängig flächendeckende Informationen zum Zustand, zur Nutzung und deren Veränderung der Agrarlandschaft über große Gebiete liefert und vorhandene zeitliche Lücken in bestehenden Daten schließt.

Einführung eines digitalen Systems für Kontrolldaten und Massenbilanzierung

Die verpflichtende Einführung eines digitalen Systems zur Erfassung und Darstellung von Kontrolldaten (GIS) sowie eines Massenbilanzierungssystems, um das Kontroll- und Zertifizierungssystem digital weiterzuentwickeln, Betrug mit Bio-Produkten zu verhindern als auch die Markttransparenz zu fördern.

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Short version in English

Organic Services GmbH,
Gerald A. Herrmann
Hauptstr. 47
82327 Tutzing
+ 49 8158 92293-06
g.herrmann@organic-services.com

Thünen Institute of Farm Economics,
Dr. Susanne Padel
Bundesallee 63
38116 Braunschweig
+ 49-531-596-5123
susanne.padel@thuenen.de;
heike.kuhnert@thuenen.de

Improving the organic control and certification system by integrating certification and product transaction data as well as geographical data and appropriate applications of the Internet of Things (IoT)

The overall objective of the project is to develop an actionable approach to improving control and anti-fraud measures for organic products using the example of the grain chain. To this end, significant gaps in the current control and certification system were identified, evaluated and concrete measures were proposed to close them.

One of the main weaknesses of the organic control system is the lack of mandatory digital capture of all relevant data (field location and size, culture, yield, sales volumes) that would allow product transactions to be linked from the field along the entire product chain. A distinction is made between traceability of certification and product transaction data. The digital availability of data and the possibility of interconnection play a crucial role in this.

With the project presented here to improve the organic control and certification system, in particular by integrating certification and product transaction data with a geographical information system, the project partners present recommendations for the various actors in politics, administration, control bodies, etc. for the further development of the control system:

Introduction and execution of operational mass balances and along product chains

A growing number of consumers are willing to pay a higher price for organic products. The price difference entails the risk of fraud. This entails an obligation for all parties involved to ensure the integrity of organic products. Mass balances of product flows along the supply chain are a simple and reliable tool for preventing and combating fraud. For this purpose, digital acreage, culture and quantity data as well as transaction data of the traded products are required. No technical equipment and laboratory analyses or batch traceability is required.

Improving digital collection of data for organic control and data infrastructure

The promotion of a digital control and certification infrastructure has many advantages, such as contributing to the fight against fraud through greater transparency in value chains, streamlining the bureaucracy and improving data exchange in the organic control and certification system. For this purpose, existing digital data can be used.

Improvement of yield data collection of organic farms

Yield data on organic farming are not systematically collected and are therefore incomplete. It is true that control bodies collect yield data for their holdings. However, this information is only available internally and usually not digitally. As a result, data are usually not available in a timely manner to use it for predicting yields

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and market estimates. The project recommends concrete steps that would significantly improve the data availability of organic yields and allow a realistic estimate of the expected harvest volumes.

Contribution of remote sensing

In general, remote sensing can also contribute to improving the data base in organic farming by providing repeated and independently comprehensive information on the state, use and change of the agricultural landscape across large areas and by closing existing time gaps in existing data.

Introduction of a digital system for control data and mass balancing

The mandatory introduction of a digital system for the collection and presentation of control data (GIS) and a mass balancing system in order to digitally develop the control and certification system, to prevent fraud with organic products and to promote market transparency.

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List of abbreviations

ACA	Accredited Certifiers Association
AHV	Out of House Food
AMI	Agrarmarkt Informations-Gesellschaft mbH
AÖL	Association of organic food producers
API	Application programming interface
Art.	Article
BEE	special harvest survey
BLE	Federal Institute for Agriculture and Food
BMEL	Federal Ministry of Food and Agriculture
BVK	Federal Association of organic control bodies
BfR	Federal Institute for Risk Assessment
COI	Certificate of Inspection
CPA	Statistical quality classification in relation to economic sectors
CPC	Central Product Classification
GDPR	General Data Protection Regulation
DV	Implementing Regulation
ECA	European Court of Auditors
EOCC	European Organic Certifiers Council
EU	European Union
FADN	Farm Accountancy Data Network
FAO	Food and Agriculture Organisation
FCL	FoodChain Lab
GAP	EU Common Agricultural Policy (CAP)
GIS	Geographical information system
GPS	Global positioning system
HS	Harmonised system for the description and coding of goods
IACS	Integrated Administration and Control System
IACS/IACS	Integrated management and control system
INSPIRE	Infrastructure for SPatial InfoRmation in Europe; Title for Directive 2007/2/EC establishing an infrastructure for spatial data in the European Community
IoT	Internet of Things/Internet of Things
AI	Artificial Intelligence
KIWAS BCS	Kiwa BCS organic control body
CN	Combined nomenclature
KTBL	Board of Trustees of Technology and Construction in Agriculture
LPIS	Land Parcel Identification System
MS	Member States (of the EU)
NACE	Statistical classification of economic activities in the European Community
NOP	National Organic Program
OFFC	Official food and feed control
OFIS	Organic Farming Information System
OID	Organic Integrity Database by USDA
OLG	Organic Farming Act
PRODCOM	Product of the Community

SOE	Strengthening Organic Enforcement
TRACES	European Commission online sanitary and phytosanitary certification platform
UN	United Nations
USDA	United States Department of Agriculture
VO	Regulation
WEB UI	Internet user interface
WTO	World Trade Organisation
WZ	Classification of the economic sector

Chart and table directory

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1 Introduction

1.1 Subject of the project

With the project presented here to improve the organic control and certification system, in particular through the integration of certification and product transaction data, geographical information systems and suitable methods of the Internet of Things (IoT), the project partners present recommendations for the further development of the control system.

Organic products and organic farming promise many benefits for the environment and society (Sanders und Hess, 2019). Organic farming is the Federal Government's mission statement for sustainable agriculture.[1] However, yields in organic farming are generally lower than conventional yields. Additional costs arise from the need for control and certification along the entire supply chain. On the other hand, there are lower, overall social costs by avoiding damage to the environment and health.

Anyone who grows, manufactures, sells, certifies or supervises organic products is aware of the value of "organic as a brand". However, the credibility of this brand is endangered by fraudsters (DG Health and Food Safety, 2019; Whoriskey, 2017; Eurojust, 2019; organic-market.info, 2011; Sherwood, 2020).

A growing number of consumers is willing to pay a higher price for organic products. This readiness is at stake if legislators and the organic industry do not sufficiently guarantee the integrity of organic products.

Since 1991, the production processes as well as the control and certification in organic farming have been regulated by an EU organic regulation (EU 2092/1991). In Germany, the Organic Farming Act implements EU legislation and regulates in particular the approval of inspection bodies. The EU Organic Regulation was revised several times and completely revised in 2007 with the EU Organic Regulation 834/2007. For example, risk-based procedures were introduced to detect infringements and intentional fraud. The latest revision of the EU Organic Regulation 2018/848 (since January 1st, 2022) envisages further improvements.

Several major fraud cases, as well as the reports of the European Court of Auditors (ECA, 2012, 2019a), have underlined that the further development of the EU Regulation 2018/848 is likely to not effectively close the identified vulnerabilities for fraud. Although concrete measures have been proposed by various stakeholders, these were not or insufficiently taken up in the Regulation.

For example, opportunities arising from digitalisation and the availability of data from external sources (e.g., geographic information systems) have not been taken into account, even though these are already being used successfully in the monitoring and control of other CAP measures (EU Commission, 2018).

So far, it is not mandatory to collect and make available relevant data (location and field size, culture, yield) for rapid data exchange as information for authorised users while the digital availability of data plays a crucial role.

The report is divided into the introduction in Chapter 1, in particular the objectives and the task definition, and lists the work packages that have been processed in the project. Chapter 2 represents the scientific and technical state of play that has been worked on. In particular, the control and certification system with the possible use of data, but also the theory of mass balancing are discussed here. The understanding and presentation of Check Organic and geographical information systems are important for the creation of the prototype envisaged in the project. After a brief presentation of material and methods in Chapter 3, the results of DIGICHECK in Chapter 4 are presented in detail and discussed and implementations proposed. Chapter 5

[1] https://www.bmel.de/DE/themen/landwirtschaft/oekologischer-landbau/oekologischer-landbau-deutschland.html

summarises the results and gives an overview of the recommendations the authors derive from the DIGICHECK project.

1.2 Objectives and tasks

The overall objective of the project is to develop an actionable approach to improving control and anti-fraud measures for organic products using the example of the grain chain.

This included identifying significant gaps in the current control and certification system and proposing concrete measures to close them.

The project referred to the announcement of the Federal Institute for Agriculture and Food, Notice No 04/18/31 on the implementation of research and development projects (R & D projects) for the "Development of the Organic Control and Certification System and Strengthening Social Objectives in Organic Farming" as part of the Federal Programme for Organic Agriculture and Other Forms of Sustainable Agriculture (BÖLN) of 15.5.2018. The following points were formulated:

- Analysis of existing statutory and private sector control systems as well as analysis and evaluation of alternative concepts;
- Support the further development of control and certification systems, e.g. by developing proposals for the design of audit procedures in the legal and private sector, involving all relevant stakeholders;
- Different concepts for the transfer of trust characteristics, such as labelling, indicator-based certification schemes, guarantees of origin (also in combination);
- To optimise existing strategies and develop new approaches, provided that the principles of organic farming are respected, and consumer confidence is further strengthened;
- These studies are also intended to evaluate important experiences from other economic sectors.

The project refers directly to the objectives of the funding directive for the promotion of research and development projects and the topics of the funding notice (04/18/31). In addition, the research project addresses the following specific objectives and topics of the Directive:

1. The digital collection of real-time land, yield and certification data (from certifiers) and product transaction data (from companies of trading, processing, etc.) as well as the linking of this data as information for authorised users;
2. the calculation of mass balances along product chains calculated from land, income and transactions;
3. the use and linking of geographical information systems (GIS) and data collected by sensors to the certification data in order to provide control bodies with additional tools for their control activities, including independently of an on-the-spot visit;
4. the optimisation of control activities and quality assurance measures along the cereal product chain through the exchange of information between the operators involved;
5. clarifying which instruments and measures are permitted under the EU Organic Regulation and the German Organic Farming Act and could be implemented as required;
6. the evaluation of which tools can be usefully used by control authorities and which information should be made available in the event of fraud or monitoring;
7. the evaluation of the extent to which data can be evaluated for statistical purposes.

1.3 Planning and implementation of the project

The project was carried out by Organic Services GmbH with the support of the Thünen Institute for Farm Economics and other project partners. The project was divided into four work packages:

Work Package 1: Analysis and Improvements of Control and Certification

1. Synergies with the existing FoodChain-Lab (FCL) system
2. Vulnerability analysis of the legal framework and traceability of product chains
3. Analysis of the nomenclature/taxonomy
4. Analysis of data protection
5. Realignment of the control and certification procedure (incl. available yield data)
6. Design of a prototype of the application of mass balance and geographical information system (GIS)

Work Package 2: Implementation using the example of the grain chain

1. Collection of certification data
2. Data of product transactions
3. Verification by a Geographical Information System (GIS)
4. Recommendations
5. Statistical data/collection of market information data

Work Package 3: Estimation of costs and benefits

Work Package 4: Preparation of recommendations

Work Package 5: Project coordination

In Work Package 5, Project Coordination, two meetings of the Project Advisory Board were held. The project advisory board consisted of one representative of the following organisations: Responsible unit for organic farming in BMEL and BLE; State ministries or state control authorities of Saxony and Bavaria; Federal Association of Organic Control Bodies (BvK); Naturland as a German organic farmers association and the Association of Organic Food Manufacturers (AöL). The Advisory Board met in Nov 2021 and July 2022.

The knowledge transfer took place during the project period through presentations of results at the BIOFACH trade fairs 2022 and 2023.

2 Follow-up to scientific and technical status

2.1 Control and certification system in organic farming

Food quality assurance is central to the future development of the EU's common agricultural policy (CAP). The European Commission refers to a broad definition of food quality: "Quality" of agricultural products includes "product characteristics" (physical, chemical, microbiological and organoleptic properties – size, appearance, taste, appearance, ingredients, etc.) and "management characteristics" (production method, type of animal husbandry, application of processing techniques, place of management and production, etc.)(EU, 2009).

In the literature, similar definitions that distinguish between product qualities (such as harmful residues, problematic ingredients, nutrient content and technological qualities) and process qualities (such as animal welfare) are referred to as holistic definitions of food quality.

In agriculture and the food industry, there are a variety of mandatory and voluntary protection and certification systems. Such systems include the definition of production requirements and bodies carrying out controls/audits and issuing certificates. The requirements can be divided into legal regulations on food safety, good agricultural practice and voluntary standards for additional properties.

Essential food safety, animal health and animal welfare requirements are controlled by the Official Food and Feed Control (OFFC) regulated by Council Regulation (EC) 882/2004, (EU Parlament und Rat, 2004) repealed by Regulation (EU) No 625/2017 on official controls and other official activities to ensure the application of food and feed law, animal health and welfare rules, plant health and plant protection products (EU Parlament und Rat, 2017).

Good agricultural practice requirements are mainly linked to payments under the common agricultural policy and will be reviewed in this context.

Compliance with voluntary standards is given credibility through certification by a third independent body. This is communicated to consumers through the use of certification marks. The implementation of certification systems can lead to increased costs and, due to the variety of certification marks, to consumer confusion.

The EU has established a legal basis for organic farming, geographical indications and traditional specialities; further markings are being considered. Thus, organic certification is one of a number of overlapping and competing systems of voluntary standards. Requirements for products labelled as organic relate to the production process, not to product quality. They apply in addition to general food and feed rules, which all environmental operators must also comply with (Padel, 2010).

> **Excursus:** In its proposal for a full revision of the 2014 EU Organic Regulation, the European Commission proposed to introduce a threshold for non-authorised products and substances from which a product would have to be revoked/de-certified. This proposal was one of the main points of dispute in the subsequent negotiations. Representatives of organic farming in particular had expressed great concern about this position. They argued that while organic production should be free of pollutants and substances that are not allowed in organic production (such as GMOs, pesticides and fertilisers), organic producers operate in a world where contamination can often happen by chance. By focusing on thresholds as a central tool for organic certification and not on controlling the use of resources, the standards would move away from the previously prevailing process-oriented approach (Padel, 2018).

All farming and food operations which produce, process, trade, store or import unprocessed agricultural products, food, feed, seed or propagating material and market them with the reference to organic production must undergo the control procedure in accordance with EU organic farming legislation by an approved organic control body. The inspector shall record the results of the inspection in an inspection report. The farm manager shall receive a copy of this report and, after processing by the control body, the evaluation with explanations or, where appropriate, with conditions. If the control is positive, the company will receive a temporary organic certificate (certificate in accordance with Article 35 of Regulation (EU) 2018/848). In Germany there are 19 control bodies which are supervised by the authorities in the respective federal states (Ökolandbau.de Das Informationsportal, 2023).

Science has (e.g., Hermanowski et al., 2013) dealt in more detail with the recognition of quality specifications by organic consumers (e.g., Hemmerling et al., 2015) and with laboratory analytical methods.

The functionality of the control and certification system by control bodies and authorities in organic farming has so far received less attention in research.

The five-year FoodIntegrity Project (FP7 613688, 2014 to 2018), funded by the EU (DG Santé), has (FoodIntegrity, 2019) focused intensively on the complex issues and approaches to the prophylaxis, prevention and detection of food fraud. The project focused on laboratory analytical solutions, but also non-analytical approaches such as mass balancing to improve the transparency of commodity flows (FoodIntegrity Newsletter, 2018; FoodIntegrity, 2017).

The CERTCOST project (EU FP7, 2009-2011) (CERTCOST, 2012) carried out an economic analysis of the certification system in Europe and developed research-based recommendations to improve organic food certification systems in terms of efficiency, transparency and cost efficiency (Dabbert, 2012b; Dabbert, 2012a; Dabbert et al., 2014; Gambelli et al., 2014; Padel, 2010). Two recommendations are particularly relevant here: Harmonise terms and specifications for the collection of structural data (part of Recommendation 1) and promote the further development of quantitative control systems supporting a risk-based control system (part of Recommendation 2).

As part of the evaluation of the EU Organic Regulation, in order to improve control activities, in addition to more risk-oriented implementation of controls, the use of new technologies in control activities was recommended (Stolze et al., 2013).

The European Court of Auditors also dealt with the issue of organic control (ECA, 2012) system in 2012, which was cited as a reason for the revision of the EU Organic Regulation. The 2019 follow-up report notes that the Commission has implemented many of the recommendations of the first 2012 report, but that some weaknesses remain in the control system. In the context of this report, the results and recommendations on improving the (cross-border) traceability of the origin of organic products along the production chain are particularly relevant (ECA, 2019b). The Commission's reply[2] at the end of the Court's report shows that the development of an electronic certification methodology for the internal market is foreseen to be integrated into the future information management system for official controls. Therefore, where appropriate, the Commission has introduced, under the TRACES system, the electronic certificate of inspection, which significantly improves the traceability of products imported from third countries, as all goods imported into the EU must be registered in TRACES.

In recent years, the control bodies in Europe, as well as in the USA, through their umbrella organisations (EOCC: European Organic Certifiers Council; ACA: Accredited Certifiers Association) worked on internal coordination and alignment of procedures and advises the EU Commission and USDA during the revision of the regulations. However, harmonisation of procedures (training, design of audit procedures, in particular the use of existing nomenclatures) has proved difficult. So far, little attention has been paid to digital data collection and storage. When it comes to the question of which data should be collected (paper, digital) and how these have to be made available for further processing and exchange, the EU regulator does not make any requirements. The introduction of TRACES to map imports by Certificates of Inspection (COI) has not changed the principle of non-digitalised data collection. In this system, too, the data is usually still entered by hand. The European Commission has stated on request that it refrains from offering interfaces for an automatic data upload or download to TRACES (Organic Services GmbH, 2018).

The U.S. Regulation only requires the entry of general certification data into the central public database 'Organic Integrity Database' (OID). With the revision of the US regulation 'Strengthening Organic Enforcement

[2] https://www.eca.europa.eu/Lists/ECADocuments/SR19_04/SR_organic-food_EN.pdf

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(SOE) this has changed fundamentally with the obligation for control/certification bodies to register all certified areas. On January 19, 2023, the USDA National Organic Program published the final Strengthening Organic Enforcement (SOE) rules, the largest change in organic regulations since the National Organic Program (NOP) (2002) was in existence, which will become valid on March 19, 2024. The scheme closes gaps in current regulations and creates uniform certification practices to detect and prevent fraud, improve the transparency and traceability of organic products throughout the supply chain, and protect the integrity of organic farming to support the continued growth of the organic market. It affects all producers, processors and distributors of organic products, all organic certification bodies and inspectors and participants in the organic supply chain that are currently not certified organic (OTA, 2023; Federal Register, 2023).

2.2 Data collection and provision in accordance with EU Organic Regulation

With regard to the project, two main requirements of the EU Organic Regulation should be considered:

1. the type of data collection (paper, digital);
2. Data of the operators to be inspected, which must be made available (to the public).

The Regulation does not provide information on how a control body collects data as long as it is available in accordance with the purposes. It can do this on paper, e.g. with the area lists from the CAP funding application, by means of cadastral extracts or maps for area verification or digitised.

The use of databases enabling digitised collection of data has increased significantly in the last 10 to 15 years at the control bodies, in particular to provide the inspectors with sufficient information before and during the controls, but also to ensure internal certification and transparency of the data. However, the decision on which data is available digitally lies with the control body. The legislator does not claim this and thus gives the possibility to network data, largely from the hand. Thus, the exchange of information is still based solely on the certificates (paper, pdf). During the current revision of the Regulation, control bodies and associations opposed, for example, to record area data (digital) or to indicate them on certificates, as this would lead to bureaucratisation and cost increase (without improving the quality of certification), which should be avoided.

Public data are aggregated data whose origin is known only to the operators and the control body. The approach to the transfer of aggregated data has so far survived all reforms without prejudice. The General Data Protection Regulation (GDPR) or the previously applicable data protection laws in the Member States have certainly played a role in this: only the most necessary data should be stored.

Implementing Regulation 392/2013 of the (EU Kommission, 2013; gültig ab 01.01.2014) EU Organic Regulation obliges Member States to make the lists of[3] updated certificates[4] available to the public by appropriate means, including publication on the Internet(EU Kommission, 2013). The publication is very different: In Germany, the Federal Association of Organic Control Bodies (BvK) maintains the official list of controlled organic farming companies. The register can be searched for German controlled organic farming companies and their current organic certificates; in other EU countries, this is done through an official database or directly on the websites of certifiers, in the respective national languages and in some cases only with limited search options. In its recommendations, the Organic Data Network has also pointed out the need for mandatory expansion of data collection and publication(Organic Data Network, 2014a). Through the mandatory issuance of certificates to certified companies by the control bodies on the TRACES platform, TRACES will replace all other directories as

[3] pursuant to Article 28(5) of Regulation (EC) No 834/2007.

[4] in accordance with Article 29(1) of that Regulation, in accordance with the model set out in Annex XII to this Regulation.

an EU-wide directory.[5] With this measure, which takes place in addition to the issuance of COI in TRACES, the legislator intends to prevent fraud with counterfeit certificates of control bodies.

In the case of problems, suspicion of fraud or the like, tracking of products via the product chains is already a problem in Germany and the EU, but (EU Commission, 2020b) even more so if their origin is in the third country, as the ECA underlines in its reports (ECA, 2012, 2019b)(EU Commission, 2020a). The tracking of products/residues in the Organic Farming Information System (OFIS) proves to be problematic in practice (EU Commission, 2020a).

2.3 Preparation of mass balances

Mass balancing describes a calculation in which the "input volumes" and the "output volumes" are compared, whereby transformation factors can also be considered (output = input x transformation[6]factor). The mass balancing mechanism can be applied at different points and/or for different purposes: At a processing site when comparing input quantities with output quantities, at national level when comparing registered areas with national production, etc. The purpose of mass balance testing or the type of information obtained from the mass balance calculation depends on the definition of input and output quantities. Often, both input and output levels are differentiated between quantities of products with certain marketing and/or sustainability requirements. This is the case when mass balancing is applied to sustainability certification and segregated supply chains to ensure that the quantity sold as a certified product is consistent with the quantity purchased as certified.

Mass balancing follows the logic of thinking raw materials in the form of quantities – produced, processed, transported and stored – and focuses on monitoring these quantities within a certain time frame, e.g. a day, a year or a harvest cycle. On farms with animal husbandry, self-consumption must also be considered in order to reduce the possible sales volumes.

In the case of a mass balance, unlike batch traceability, the individual processing products, e.g. flour, bran, or processing losses, are not individually recorded, but the quantity purchased and sold (which includes processing losses) is compared in order to safeguard the integrity of the supply chain.[7]

For the calculation of a mass balance and for this project, it is necessary that agricultural land data are available digitally. If area data cannot be provided by the control bodies, they must be collected elsewhere, e.g. through the manual input of cadastral data, the InVeKoS database (Wikipedia, 2020) or via GPS/satellite data. Without area data, the generated quantity of product (return/area unit) cannot be calculated and therefore no mass balance can be created.

Mass balances of commodity flows represent a good and less complex tool for investigating fraud. The prerequisite is to collect reliable volume data at all stages of the product chain. This includes the size and estimates, possibly validated, e.g. through control bodies, yield potential of land, in the best case the weighted harvest quantity and the recording of transactions by companies.

[5] Since the EU does not offer an interface for uploading data by the control bodies or a (public) interface for downloading, the database cannot be used by third-party systems, e.g. Check Organic.

[6] Transformation means the processing of raw materials at the first stage, e.g. from sunflowers to oil, because not the cores in the mass balance are relevant, but the oil.

[7] In the EU organic regulation, the mass balance is to be understood in a company-related way and not across supply chains.

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The digital collection and processing of data could improve data access for all players in the product chain. Control bodies and control authorities would benefit from improved data transparency for the companies they control.

Prerequisites for a functioning system are:

- the input of data, either by hand, file upload or via data interfaces,
- the use of a uniform nomenclature or system that brings together different names; and
- access to data of different companies in compliance with data protection, by authorities in the context of their monitoring activities of control bodies and in the case of irregularities (fraud).

The topic of mass balance has also attracted attention in the field of data collection on organic farming (Recke und Hamm, 2005; Rippin et al., 2005). However, the practical implementation of calculations in the context of case studies of the Organic Data Network Project (Organic Data Network, 2014b) to improve market data in selected countries failed due to the lack of availability of volume data (Feldmann und Hamm, 2014). This should in principle have called into question the effectiveness of the EU control system and should have been taken up in the course of a revision (cf. chapter 4.1.2.1).

Unlike a batch traceability system, the calculation of the mass balance is easier because no internal company identification codes need to be transmitted together with the product from company to company. Batch traceability systems are usually used internally with the help of the ERP system in companies (ERP systems, e.g. SAP). They register the quantities purchased and sold (one up – one down)[8], taking into account recipes (e.g. for the processing of products from multiple ingredients). Batch traceability serves in particular transparency in the case of product recalls and thus food safety.

2.4 The mass balancing software Check Organic

In the organic sector, mass balancing is used to separate the certified product from the non-certified product and to ensure that there has been no artificial/fraudulent increase in certified quantities in the supply chain (identity assurance). In this case, a link between the quantities traded and the certified area is established in order to prevent food fraud. An example of such an application is Check Organic.[9] This means that in order to safeguard against fraud, the two dimensions of quality assurance (product characteristics, management characteristics) need to be extended by a third dimension – the supply chain – in order to significantly improve the integrity of the products traded. For this purpose, data must be available digitally.

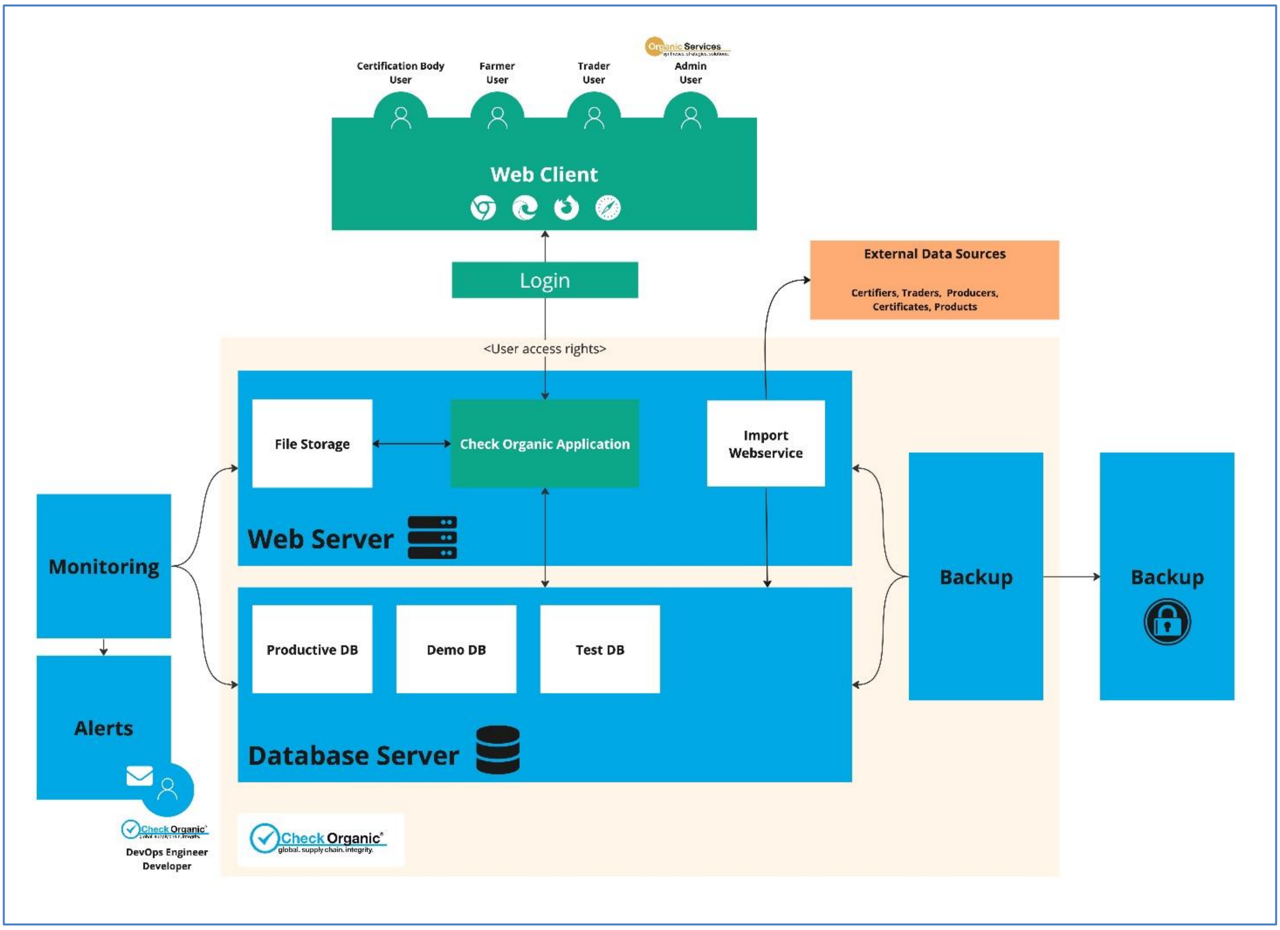
2.4.1 Functionality and architecture of Check Organic

For Check Organic, the principles set out in the previous chapter for the identity-preserved mass balance apply. Specifically focused on organic food, Check Organic provides a central platform for data from control bodies and linking this data to transactional data from agricultural and other companies along supply chains. Check Organic is a cross-stage application and allows the monitoring of individual as well as numerous food chains, national applications, industry solutions, geographical indications of origin, etc. and is therefore flexible to use according to the required criteria (Figure1).

[8] Companies in the EU are obliged to guarantee traceability only to their pre-supplier. The revision of the EU Organic Regulation does not provide for a further definition

[9] www.check-organic.com

Figure1: Architecture of Check Organic



Access by various users (access group) is governed by log-in, roles and rights that the administrator of Check Organic sets.

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Figure 2: Screenshot from Check Organic, Access Groups

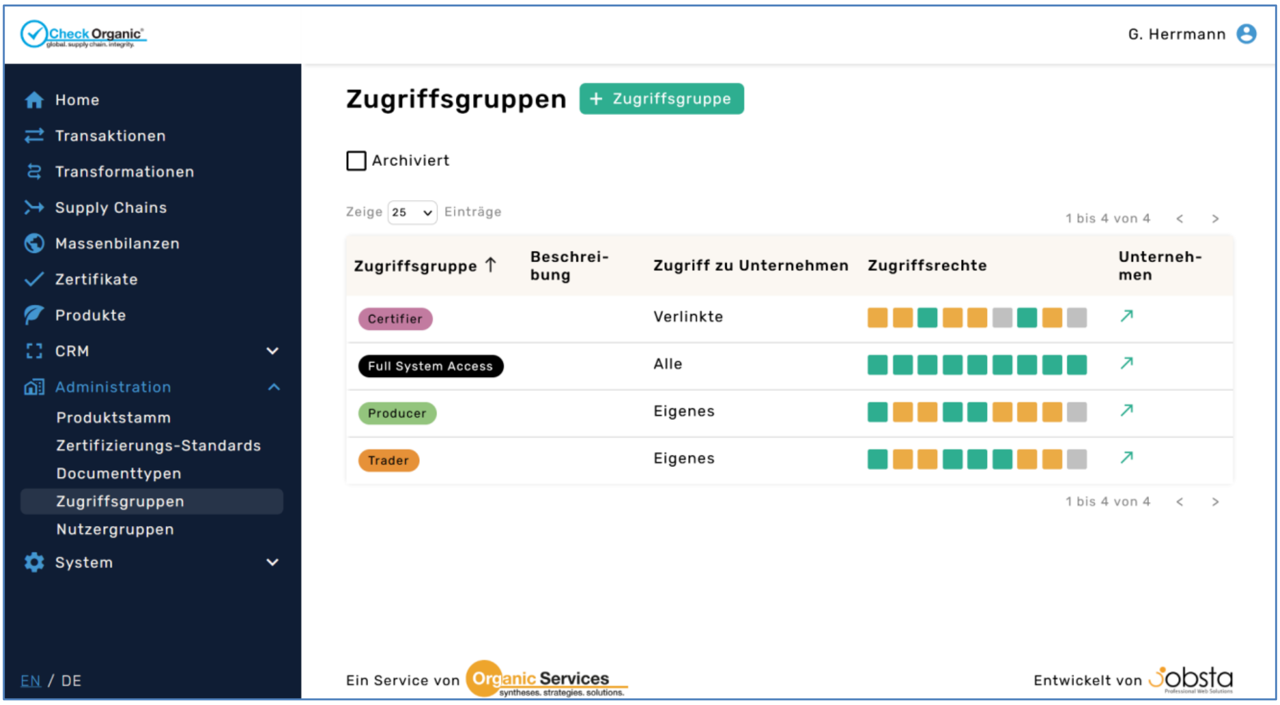
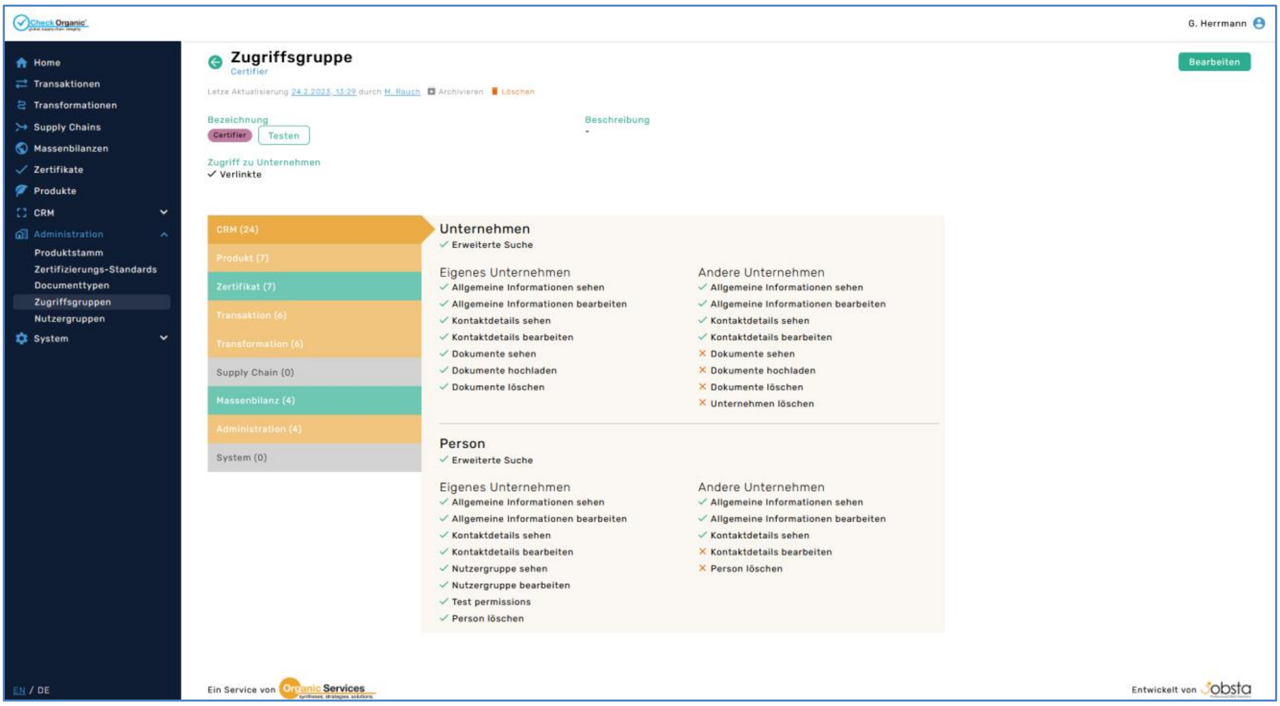


Figure 3: Setting the access rights of access groups



Based on the default settings, the administrator of a company with more complex tasks and employee responsibilities for its own company or other company can define user groups.

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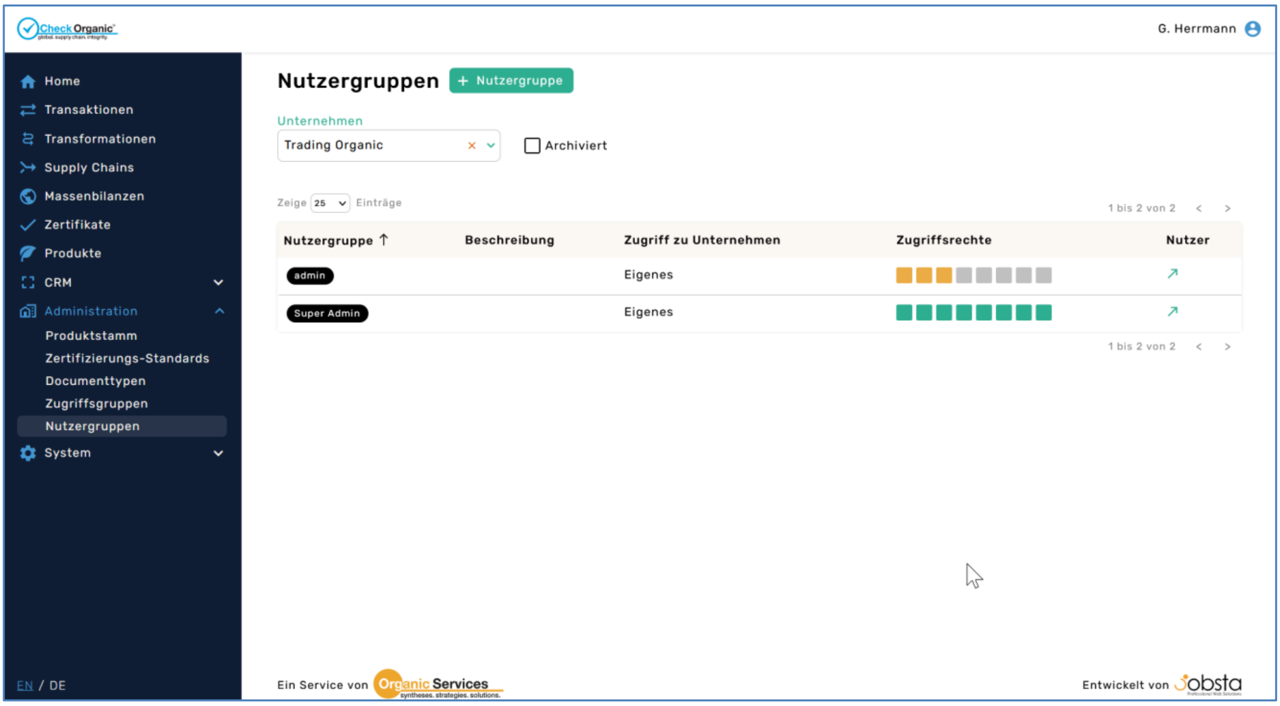
Figure 4: Definition of user groups



The traffic light system developed for Check Organic is intuitive and offers a quick and easy understanding of compliant or non-compliant certifications and the availability or non-availability of certified raw materials. Problems such as missing certification data, withdrawal of certification or quantity deviations can be displayed for individual companies for tracking by the logged-in users with their respective permissions. A presentation of product chain companies through lists and graphical presentation facilitates planning, adaptation, optimisation and overview of the certification and integrity status (product is certified, quantity is available). Thus, Check Organic makes it possible to prevent and inhibit fraud at the level of individual companies and to document the flow of goods along the supply chains. For the international application, the languages German and English can be extended accordingly.

2.4.2 Check Organic Implementations and Projects

Check Organic has already been successfully developed, tested and partly implemented for the following applications:

- Federbio Integrity platform with approximately 75.000 records, including farmers, traders, processors, 10 certification bodies and Accredia (the Italian Accreditation Body) – importing certification data from DATABIO and business transaction data (mass balance) and survey among users; 2016 to 2018;
- Bioland GmbH (commercial company) – data for internal compliance audit;
- USDA Organic Integrity Database (OID), approximately 40.000 records of companies are downloaded via the public interface and displayed in Check Organic, daily;
- Organic Standard, ICS, OTCO, ABCert – certification bodies, existing contracts; dormant;
- FAO Kazakhstan: Check Organic Proof of Concept – ready to be launched in Russian;
- CBI/Quinoa Sector Bolivia: Proof of concept for a “Royal Quinoa” mark (geographical origin assurance with producers, trade, export, associations, certifiers);

- GIZ/International tyre manufacturer: Proof of Concept for a traceability system for a wild collected, deforestation-free rubber chain.

2.5 Geoinformation and remote sensing data

Already in the late 80s and early 90s, "precision farming" was introduced with satellite data and control of agricultural machinery. However, it has only experienced its breakthrough with digitalisation and the rapid transfer of data.

Today, multiple applications of geographical data and sensors are in use to provide government agencies and other interested parties with monitoring tools and data, as well as industry planning and management data. The EU promotes through various programmes, the development and application of geographical data and the Internet of Things, 'Internet of Things' (IoT), e.g. the Horizon 2020 project "Internet of Food and Farming".[10]

The company ABACO offers (GIS-)services for agriculture through a software platform (farm management software) specialising in the upstream links of the food supply chain: from seed to food business. The platform is called ABACO Farmer and has among others:

1. the ability to merge multiple sources of field-level data such as soil, weather and climatology, agricultural practices, plant phenology, earth observation sources (satellite, air) and IoT sensors;
2. the ability to easily add special algorithms that combine the basic data into actionable decisions or forecasts (advanced analyses and alerts).

In general, satellite-based remote sensing contributes to the improvement of the data base in current and future monitoring projects and reporting obligations by providing repeated and independently comprehensive information on the state, use and modification of the agricultural landscape across large areas and by closing existing time gaps in existing data. The indicators on land use derived from satellite data support e.g., monitoring targets in the field of climate protection, the promotion of biodiversity, soil fertility and erosion protection.

The Thünen remote sensing working group[11] develops concepts and methods for the comprehensive and long-term assessment of the status quo and the change in land use in agricultural landscapes. For this purpose, the currently freely available satellite data (Sentinel satellites) and other available satellite missions (third party missions, e.g. Landsat, PlanetScope) are used as part of the[12] ESA/EU Copernicus programme. Both optical and radar data are considered.

2.5.1 Inspire – Open Data

The digitalisation strategy of Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing a spatial data infrastructure for the purpose of a Community environmental policy in the European Community (INSPIRE) provides for the (regulated) exchange of data. The European Commission has shared a document on data sharing in IACS, which was presented at an ESS workshop in October 2019.[13] The INSPIRE Directive requires Member States to provide anonymised data. For example, Austria publishes all

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[10] Internet of Food and Farming, Horizon 2020 Grant Agreement no. 731884; https://www.iof2020.eu/

[11] https://www.thuenen.de/de/thuenen-institut/verbundstrukturen/thuenen-fernerkundung

[12] https://www.copernicus.eu/de

[13] https://ec.europa.eu/eurostat/cros/system/files/iacs-data-sharing_gesa-wesseler_dg-agri.pdf

InVeKoS data in one dataset. The Agence Bio[14] offers precise insight into the land use of the individual organic areas. In addition to the location and outlines of the individual areas – without knowing which farm they belong to – you can also see the main type of use. See also chapter 4.2.4 on this subject.

2.5.2 InVeKoS

The integrated management and control system of the EU (IACS)[15] (InVeKoS in DE) consists of a series of electronic and interconnected databases, in particular:

- a system for the identification of all agricultural parcels in the EU Member States, the so-called system for the identification of agricultural parcels (LPIS);
- a system allowing farmers to mark on a map the agricultural land for which they apply for support (the geodata-based support application);
- an integrated control system that ensures systematic control of support applications by means of electronic reconciliations and physical checks in establishments (on-the-spot checks).

Implementing Regulation (EU) No (EU Kommission, 2014) 809/2014 as regards the integrated management and control system for rural development measures and cross-compliance sets out further details.

In Germany, the Act implementing the Integrated Management and Control System (CAP-Integrated Management and Control System Act – GAPInVeKoSG) is implementing[16] (Bundestag, 2022) the EU regulation. Other provisions regulate, for example, the processing of data (Law on the processing of data under the Integrated Administration and Control System in accordance with the EU legislation on agricultural payments (InVeKoS Data Act – InVeKoSDG).[17]

3 Material and Methods

Literature analysis

The *analysis and improvement of control and certification* (AP1) was mainly carried out by means of a literature review of legal and scientific sources relevant to organic control. In total, about 100 sources were considered.

Further development of the software Check Organic and its connection with a GIS

The software Check Organic was developed and implemented by Organic Services from the programs Ecert (certification management, today Intact Platform) and FlowWeb (supply chain management) of Intact GmbH, Austria. Various reasons, including the discontinuation of further development and support for FlowWeb, have led Organic Services to reprogram and optimise the software through jobsta OG, Austria. This applies, for example, to the programming language (Python) as well as the usability (user friendliness), but has the further

[14] https://www.agencebio.org/cartobio/

[15] The 2013 CAP reform made the use of the Land-Parcel Identification System (LPIS) in the Member States mandatory. It is based on aerial and satellite images where geometric distortions are corrected ("orthorectified"). For the aerial photographs, the 16 federal states are flown every three years by planes (about 30 percent of the state annually) on behalf of the respective state survey offices in order to create digital orthophotos (DOPs). In Germany, each region has an LPIS. The LPIS orthophotos have a very high spatial resolution (usually 25-50 cm per pixel).

[16] https://www.buzer.de/gesetz/14908/index.htm

[17] https://www.buzer.de/s1.htm?g=InVeKoS-Daten-Gesetz+%E2%80%93+InVeKoSDG&f=1

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advantage that Organic Services is now the owner of the source code of the software. The reprogramming was carried out in parallel to the DIGICHECK project funded by Organic Services.

The requirements of the *concept prototypes* (AP1) were taken into account in the reprogramming of Check Organic. For the implementation using the example of the grain chain (AP2), Organic Services first worked with the previous version and later with the reprogrammed.

In addition to the planned application of ABACO Farmer software from ABACO SpA from Italy, other experts in GIS services were identified for prototype development (AP1) and exemplary application (AP2) that could contribute to the project. The experience of experts from the Thünen Institute, Germany and Delimax, Austria, was able to access the expertise of digital space (size) determination, crop identification and yield assessment.

Collection and analysis of data for exemplary use in the cereal chain

To describe the yields in organic farming (part of AP1), data from the BEE (Special Harvest Determination), AMI yield estimation of organic farming, organic farms in the test farm network and pilot farms were evaluated.

Certification data and transaction data as well as yield data from companies of the project partner KIWAS BCS were used for the application at the example of cereals (AP2). This also allowed the estimation of costs and benefits to be carried out, which was supplemented by literature.

Expert discussions and discussions in the Advisory Board on the reflection of the results

Expert discussions were conducted mainly for the analysis and improvements of the control system (part of AP1). Since the questions and topics discussed were very different, no fixed conversation guide was applied. Expert discussions and the Project Advisory Board (see **Work** Package 5: Project coordination) were an essential method for the development of the project and the preparation of recommendations (AP4).

4 Presentation of the main results

4.1 Analysis of organic control and certification and proposals for improvement (vulnerability analysis)

4.1.1 Synergies with the existing FoodChain-Lab system

Possible synergies with the FoodChain-Lab approach (Federal Institute for Risk Assessment (BfR) (BfR, 2020) and Check Organic) were examined in detail. FoodChain-Lab serves a forward-looking risk assessment and the derivation of necessary measures in the event of food contamination. This is about relationships, probabilities and risks.

Together, both approaches are linking companies along the product chain and visualising them. Food Chain Lab looks at the aspect of food safety, while the focus of Check Organic is food integrity, essentially, working with the same basic data as suppliers, buyers, products, deliveries, supplier relationships. However, the visualisation shows different information and different information depths according to the area of application of the respective system.

The final assessment concludes that both systems have been developed for different application areas and with fundamentally different technology. Synergies would only be conceivable in the field of visualisation but would require significant development effort on both sides and would not lead to a common product development strategy, as the objective serves different purposes. Furthermore, further development of the

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Food Chain Lab could only be financed through third-party funded projects and was not foreseen in this project.

4.1.2 Legal framework for control

4.1.2.1 Provisions on the control system in the EU Organic Farming Regulation (EU 2018/848)

Since 1 January 2022, a new regulation is in force in the EU, which regulates organic farming. The legal framework has since been established by **the Basic Regulation (EU)** 2018/848 (by Council, Commission and Parliament).

Significant differences with the previous Basic Regulation 834/2007 and Implementing Regulation 889/2008 as regards control exist in the following areas:

- The Regulation provides for a much greater integration of the control system with official controls for foodstuffs. This link already existed in the previous Regulation, but is now more clearly developed (see, for example, recitals 21 and 88, Chapter VI, Articles 37 to 40) and rules on the suspicion or infringements affecting the integrity of a product (Articles 41 and 42) and the exchange of information (Article 43).
- In the EU, groups of entrepreneurs can now be controlled, not just individual companies. This is primarily intended to reduce the cost of control for small producers and aligns the provisions in the EU with what hitherto only applied in third countries (recital 85, Article 36).
- The standardisation of the approach to contamination is more detailed (see, for example, recitals 68 to 72 and Articles 28 to 29). This includes the need for companies to take and implement precautionary measures against contamination with unauthorised substances (Article 5).
- In the case of impurities/residues in organic products, companies are granted a higher level of responsibility in the assessment of the respective case and appropriate measures (Art. 27).
- In Annex I, other products have been included in the scope of the Regulation and thus in the control procedure, such as beeswax, mate, skins and furs, and other agricultural products.

The topics of yield and mass balancing relevant to the DIGICHECK project is addressed in the Regulation in that all chapters containing detailed production regulations indicate the obligation of companies to record quantities in terms of input and output calculations.

The issue of mass balance is explicitly addressed in Article 1 **of Commission Delegated Regulation 2021/771 of 21 January 2021**. This is intended to establish specific criteria and conditions for the implementation of official control, in particular with regard to integrity and traceability applicable to operators, groups of operators and third countries within the framework of the EU. However, the mass balance instrument refers only to a single company or group of operators, but not to the supply chains and thus complies with the general legal requirements in the food industry, which are limited to direct suppliers and customers.

The existing national and international control systems for organic farming are therefore lacking in effective mechanisms and tools to detect and prevent fraud in the organic sector. For the EU, this was[18] underlined by the Court of Auditors in its Special Report No 4/2019. At various points, the text indicates that in Regulation (EU) 2018/848 there are the control bodies carrying out this type of 'official control', in particular by linking the activities of control bodies to Regulation (EU) 2017/625 (Control Regulation).

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[18] ECA (2019b) The control system for organic products has improved, but some challenges remain: Special Report, available in https://www.eca.europa.eu/Lists/ECADocuments/SR19_04/SR_organic-food_EN.pdf

It has been confirmed that opportunities arising from the digitalisation and availability of control data and data from external sources (e.g. geographical information systems) for traceability in supply chains have not yet been considered in the revision of the EU Organic Farming Regulation. With the revision of the EU Organic Regulation in 2018ff., the EU Commission, the Member States and the organic sector have failed to include the necessary digitalisation of land, crop and yield data in the new Regulation. In doing so, they have given out the most effective tool for preventing fraud.[19]

In order to better understand **the legal framework for organic** farming, we also point out the three different legal instruments used at European level:

- Council, Commission and Parliament Regulation (EU) 2018/848 (hereinafter referred to as the Basic Regulation) contains the essential basic provisions and, to a large extent, final detailed provisions which may not be further regulated by further regulations. Regulation (EU) 2018/848 specifies which parts may be supplemented or specified by delegated regulations or by implementing regulations. The right to adopt them must be laid down in the Basic Regulation.
- Delegated regulations shall be adopted by the Commission on behalf of the Parliament or Council of Ministers on amendments or additions to an existing regulation. Delegated acts will be adopted into consolidated versions of the Basic Regulation (EU) 2018/848 sometime after publication. The last consolidated version of Regulation 2018/848 was published on 1.1.2022. Delegated Regulations supplementing the Basic Regulation are also noted therein but are not necessarily reproduced in full. However, the relevant regulation is legally valid, not the consolidated text.
- Implementing Regulations are intended to ensure uniform implementation of regulations in the Member States. They are usually proposed by the Commission and adopted by the Commission after consultation with the Expert Group for Technical Advice on Organic Production, where submissions can also be made. These implementing regulations shall be adopted in accordance with the examination procedure referred to in Article 55(2) with regard to applicable EU law. Implementing regulations may be amended again by further implementing regulations. They are not inserted into consolidated versions of Basic Regulation (EU) 2018/848.

4.1.2.2 Implementation in Germany by the Organic Farming Act (ÖLG)

The adaptation of the ÖLG to the new EU Organic Regulation was completed in 2021. The ÖLG regulates, among other things, the distribution of tasks between control authorities and control bodies in organic inspections. The control is defined as private control on the government’s behalf, i.e. with state approval and supervision.

The re-adaptation of the ÖLG became necessary because the new regulation of out-of-house catering (AHV) and the exclusion from organic law had to involve the AHV controls in the organic controls. In addition, the Upper House has added the authorisation of the Federal States to delegate control tasks to control bodies. The authorisation was necessary on the basis of the legal opinion that a delegation of tasks to control bodies for organic control via ÖLG is not possible, but that a transfer act by the Federal States must be carried out. Infringements can be punished by control bodies if they are authorised to act as public authority by the respective federal state. Otherwise, the control authorities are responsible for this. With the decision of the Federal Council in July 2023, the amendment of the ÖLG is[20] completed.

[19] On the other hand, the United States Department of Agriculture (USDA) has opted for the mandatory collection of area data in the near contemporaneous revision of the U.S. National Organic Program (NOP) regulation after examining alternatives.

[20] https://www.bundesrat.de/SharedDocs/drucksachen/2023/0201-0300/233-23(B).pdf?__blob=publicationFile &v=1

OLG Implementing Ordinance (ÖLG-DV)

The ÖLG Implementing Regulation (ÖLG-DV) regulates the requirements for the control bodies for the implementation of the organic controls, the procedure for the approval of control bodies, the tasks of the Federal Agency for Agriculture and Food (BLE) in the control procedure, the requirements for the qualification of the control staff and the measures to be taken in case of non-compliance. The ÖLG-DV[21] was also adopted by the Federal Council in July 2023.

4.1.3 Analysis of the nomenclature/taxonomy

Systems of nomenclature or classification play a central role in the standardisation and collection of data. If the data can be collected using recognised classifications, this significantly reduces the need for post-categorisation and potential errors. It has been examined which existing classification systems may be relevant to the project, and this has been illustrated using the example of wheat cereals.

Classification systems for trade in agricultural and processed products and systems for recording agricultural production, i.e. systems for cultivation and animal husbandry in agriculture are important. Both systems exist at different administrative levels, such as global (e.g. UN, WTO, FAO), European Union and national/country level.

A variety of classification systems are relevant for the cultivation and trade of cereals: agricultural statistical surveys and reporting, trade and customs systems and systems for the management of individual farm data for the purpose of promotion. These systems have been developed with different objectives and, despite various efforts at different levels, have so far been only partially harmonised.

In Germany, only two systems are used in which several international and EU systems are combined, and which would therefore be important for the control system of organic farming. These are the German Economic Sector (WZ) classification (which merges the NACE and CPA system) and the Product List for Production Statistics (GP), the CPA, the product classifications from the PRODCOM list and the Combined Nomenclature (CN). In addition, EU agricultural statistics for crop production and IACS are of interest for cereal applications.

For all types of crops that are funded in Germany, usage codes are stored in InVeKoS, but which so far differ individually. However, a decision to harmonise land use codes envisages further conceptual development (Statistisches Bundesamt, 2019).

A compilation of the wheat codes used in various classification systems at the global level, as well as at EU and Germany levels, gives a very mixed picture (Table1).

Table1: Combination of the classification of wheat in different systems

System	Section	Code for wheat	Remarks
WZ 2008 (NACE and CPA)	A Agriculture, forestry, fisheries	A 01.11.1	Subclass 1 includes wheat and other cereals
GP 2019/CPA	10 for food and feed	1061 21 000	Wheat reporting number
UN SITC Code	0 Food and live animals	041.2	Other wheat (not durum), unground, not for sowing

[21] https://www.bundesrat.de/SharedDocs/drucksachen/2023/0201-0300/233-23.pdf?__blob=publicationFile&v=1 and Ω(B).pdf?__blob=publicationFile &v=1

		046.1	Flour of wheat or meslin
HS 22 Code		1001.91	Other wheat (not durum), not seeds
		1101.00	Flour of wheat or meslin
CN 2022	1 Products of plant origin	1001.99.00	Wheat and meng grain (excluding seeds for sowing and durum wheat)
CPC (English only)	0 Agriculture, forestry and fishery products	0112	Code for wheat, no further subdivisions
Land use survey/Agricultural sheep census 2020	Cereals	C 0101	Winter wheat including spelt and Einkorn grain
InVeKoS Usage Code for BW, BY, BB, HE, NI, SN		112 durum wheat 115 common wheat	Thuringia uses 111150 and no data is available for other countries.

Source: Own compilation

However, the systems show similar structures of the sections. Therefore, it is possible to create match lists between the different systems if data is to be integrated from different sources. This can be supported by appropriate software. Such lists already exist by individual organisations (e.g. the FAO Caliper Project).[22] In addition, the harmonising project points out that wheat often suffers from incorrect inputs in the usage codes of common wheat, as the first code 112 for durum wheat listed on the list is incorrectly selected. As of 2023, only the terms winter and summer durum will be used for durum wheat (Statistisches Bundesamt, 2019).

Furthermore, with the increasing importance of organic farming in Germany and Europe, it would be of interest to consider whether specific identifiers for organic products could be created at national or European level in the HS/CN framework.[23] Statistics Denmark estimated in 2004 that around 2000 additional codes would be needed to adequately capture all organic products. In most cases, there are unused codes that would allow the inclusion of a common digit (which does not necessarily have to be the same for each chapter). For example, an organic equivalent could be created for all currently relevant CN8 categories, creating hundreds of additional codes. A common approach between EU Member States (MS) is conceivable in the future, as the EU's organic market is growing and with the target of 25 % organic farming has become politically important in Europe. It was not possible to clarify the possibilities at national level in the context of this project.

4.1.4 Analysis of data protection

The subject of data protection has different facets. They range from protection against misuse in data processing to the protection of privacy and fear of surveillance. With increasing digitalisation in all areas of life and networking in social, political and economic life, laws and regulations for the protection of personal data became indispensable.

Since the DIGICHECK project deals with the development of measures to "improve the organic control and certification system through the integration of digital certification and product transaction data and geographical data", data protection must also be taken into account and ensured here.

[22] http://datalab.review.fao.org/datalab/caliper/web/

[23] The USDA gradually introduces bio-HS codes, especially for unique allocation when importing organic products.

The differentiation between personal and non-personal data is fundamental to data protection and still needs clear clarification in some areas (e.g. agricultural data). Personal data refers to any information from which it is possible to draw conclusions about a natural person.[24] The European Union and the Federal Constitutional Court consider the protection of personal data to be a fundamental right; accordingly, each person concerned can decide for themselves who personal information will be shared with. The primary task of data protection is to protect individuals from the misuse of personal data by processing it without consent or passing it on to third parties.

However, in the DIGICHECK project, data protection was obstructing the collection and saving of area data. Where area data is publicly available (see chapter on 2.5.1 INSPIRE), the allocation of the land to a specific operator is lacking. Without this assignment, the area data is worthless for the calculation of the mass balance, as this can only be calculated if it is transparent which areas belong to which farmer.

Legal review should be carried out to allow access to such data while still safeguarding data protection. This presupposes that the uncertainty in the differentiation of whether area data (and related data) are personal or non-personal data is legally clarified in order to allow access to area data for the creation of a mass balance. Even aggregated data on land use in individual federal states or counties have not been made publicly available until now for data protection reasons.[25]

In InVeKoS, accurate area data with crops and the associated operating data are recorded in the best quality, presented in the GIS and officially verified. With reference to data protection with regard to the processing of personal data, the control bodies have so far been denied direct access to this data, although the data from IACS are the same as those collected for the control procedure under the EU Organic Regulation. Producers shall therefore make this data available directly to the control bodies, regulated by a data protection agreement with their control body. However, direct access by control bodies to the IACS data of the establishments they control is not possible, even though there is a data protection agreement.

The discussion on the use of IACS data for organic control is not new. Control bodies, associations and competent state control authorities have repeatedly raised the following questions and discussed them with each other and with the Federal Ministry of Agriculture (BMEL). Can access to the Central InVeKoS Database (ZID)[26]

1. put the control of operators by data collected and controlled by government institutions on a uniform and reliable basis and thus improve them; and
2. avoid repeated data collection and storage by using digitally available data and thus contribute to the streamlining of administrative procedures (cost reduction) for all parties involved?

This approach, which is justified in terms of content, precludes the purpose of data collection, which relates exclusively to the collection of data for payments under the CAP. Therefore, according to current legal opinion, this sensitive data may not be used for other purposes. However, CAP measures also support the conversion to and maintenance of organic farming. The question of whether the German Organic Farming Act could determine that InVeKoS data may be used by control bodies is probably ruled out on the basis of the legal system, since a subordinate (the Organic Farming Act) cannot extend or amend a higher-level law (the IACS

[24] https://ec.europa.eu/info/law/law-topic/data-protection/reform/what-personal-data_de

[25] The only exception here is LfL Bayern, which shows that the publication of aggregated data is quite possible. https://www.lfl.bayern.de/iba/agrarstruktur/279000/index.php

[26] https://www.zi-daten.de/

Implementing Regulation). Alternatively, a supplement, e.g. in the GAPInVeKoSG[27] in §16(3), 1 d) could be useful, citing the need for selected data to carry out the checks according to ÖLG. Although the control bodies operate as private companies in Germany according to ÖLG, they carry out the control of legal regulations and are approved by the competent state authority (BLE), mandated and supervised for certain tasks. Competent authorities of the federal states participate in the monitoring. In addition, the accreditation of the control bodies in accordance with DIN EN ISO/IEC 17065 regulates and supervises the handling of confidential data.

Access to IACS data could contribute to the creation of a digital infrastructure for the organic control system. The promotion of a digital infrastructure not only makes a valuable contribution to combating fraud through greater transparency in the value chains, but also in terms of streamlining bureaucracy in the organic control and certification system. It also helps to save time and resources by reducing manual multiple inputs, minimising error vulnerability and significantly increasing acceptance for the use of digital applications.

4.1.5 Reorientation of the control and certification procedures

4.1.5.1 Assessing of the possibilities for mandatory introduction of a mass balance system

As part of the project, a legal opinion was obtained from lawyer Hanspeter Schmidt, Freiburg; a law firm specialising in organic legislation and its application in organic farming.

The opinion assumes that a mandatory introduction of a mass balance system requiring both an organic control body and the operators it controls to provide much more and more up-to-date data and assigns the supervising authorities additional tasks that can only be based on a respective law.

The following questions were clarified in the framework of the opinion:

1. Does Regulation (EU) 2018/848 in relation to (EU) 2017/625 allow a Member State (e.g. Germany) to adopt further mandatory control rules for the introduction of a mass balancing system?
2. Could the obligation be enacted at European level by means of a delegated or implementing regulation, or should the basic regulation be amended?
3. Can the obligation be enacted by public law in a federal state or is a state law necessary?

As regards question 1, the following three organic regulations (EEC) No 2092/91, (EC) No 834/2007 and (EU) 2018/848 are considered: The opinion concludes that the provisions of Regulation (EU) 2018/848 are **not** to be understood as a full harmonisation and that Regulation (EU) 2018/848 currently in force lays down 'minimum control rules', which leaves room for each Member State to impose a mass balance system for organic control on its territory as an obligation.

As regards question 2, it is stated: The mandatory introduction of a mass balance system at European level does not require any amendment to the Basic Regulation (EU) 2018/848 but can be done by means of a Delegated Regulation of the European Commission. An implementing regulation is not sufficient.

As regards question 3, it is stated that: The obligation to use a mass balance system in organic control could be introduced in Germany by a federal law. Details would not have to be regulated in the Organic Farming Act, but the Organic Farming Act could authorise the details to be regulated in a statutory regulation. The obligation to use a mass balance system could also be introduced by a public law treaty at the level of the Federal States, based on the decision of the respective state legislature. A federal regulation is possible, but

[27] https://www.buzer.de/gesetz/14908/index.htm

not mandatory. However, if a federal law regulates this definitively, such an obligation can no longer be introduced by a state law.

4.1.5.2 Collection of control-relevant data by control bodies

According to the requirements of the EU Organic Regulation, control contracts and data protection agreements, control-relevant data of farmers are made available in various formats, such as paper, pdf, Excel, which must be administered and processed by the control bodies for inspection. As long as the data is not available digitally, they can only be processed with additional effort, e.g. stored in a database, and are therefore not available for evaluations, links or subsequent years.

By changing the collection of data by the control bodies, with the requirement to export data via Shape File individually by each controlled operation from the IACS application (a geographical information system (GIS) and to import it into a GIS application of e.g., the respective control body), the data base and the digital availability of data for organic control can be fully and legally compliant. However, the data is only available in the GIS application of e.g., the respective control body. In order to be applicable for the mass balancing software Check Organic, the data would have to be transmitted via an interface. The same applies to the transmission of data via the establishment of an interface to the internal database of the control body (e.g. ERP certification management systems), where available. Alternatively, by integrating the GIS directly into Check Organic, an interface can be omitted and the procedure for further use of the data for controlling mass balances can be simplified. This would mean that control bodies use Check Organic as their GIS application.

Such a change in the collection of data would:

- reduce the administrative burden on farmers;
- reduce the administrative burden on control bodies;
- reduce the effort during the inspection, as inspectors, with the representation of the areas in the GIS, have access to areas, crops and other data,
- improve the implementation of controls while reducing their (temporal) effort;
- harmonise the IACS and the data underlying the controls;
- improve data retention and enable better data analytics of control-relevant data,
- by combining with other satellite-[28]based services e.g., monitoring/recognising management measures or for determining yields, improve the monitoring of quantities produced and traded (mass balancing during controls);
- allow timely statistical evaluations of the land use of certain areas/regions that give market participants a better assessment of the availability of certain products;
- accelerate and significantly improve the reporting of control bodies to the competent authorities.

However, it should be noted that due to the lack of direct data protection agreements between the farm and Check Organic, the data necessary for mass balancing in Check Organic may not be easily transmitted by the

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[28] https://www.eca.europa.eu/Lists/ECADocuments/SR20_04/SR_New_technologies_in_agri-monitoring_DE.pdf; https://www.landwirtschaftskammer.de/foerderung/hinweise/flaechenmonitoring.htm

Within the framework of the Common Agricultural Policy, the European Commission has created the legal framework for a new satellite-based area monitoring. Area monitoring refers to permanent monitoring of all agricultural land requested under EU agricultural support on the basis of satellite data (e.g. Sentinel data from the Copernicus programme). Satellite image time series (approximately every five days for Sentinel) are used to automatically check the areas for compliance with certain eligibility requirements, obligations and other requirements using artificial intelligence.

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control bodies to Check Organic for free use, even if they are digitally available at the control bodies. The advantage that the data about the export of shape files from InVeKoS is available digitally is only effective at the control bodies, but not directly at Check Organic. However, if the control bodies use Check Organic internally for their purposes, the data remains in their sovereignty. This can also be achieved through a data protection agreement between the control body and Check Organic, as long as it is ensured that the data about log-in and related roles and rights are only editable and visible to those who have the right to do so.

The clear legal clarification that space and related data are not personal data would facilitate the exchange of data and its further processing (linking), see the discussion in 4.1.4. In the other case, the legal requirements must be implemented by means of agreements and in the software accordingly.

4.1.5.3 Availability of yield data from organic farming

A central element of digital data acquisition in the project is the creation of mass balances, which relies on yield/quantity data at all stages of the product chain. In order to verify the plausibility by means of quantity matching, the estimated yield potential of individual areas, if applicable, validated by the control body, or, in the most favourable case, the weighted harvest quantity is required. Self-consumption on farms e.g., for fodder purposes, and the processing of raw materials at the first stage e.g., grains to oil, must be considered. In the first place, the yield data is not about high accuracy, but about a good estimate of the order of magnitude, so plausible estimates are sufficient, since the vast majority of known fraud cases in recent years and decades concerned commodities (commodity fraud). Fraud in processing companies usually has a different character e.g., the processing of a non-certified raw material or concern food safety.

On the one hand, data on the yield potential can be collected from the control if, for example, yield is directly measured and substantiated by sales proceeds. The plausibility of non-weighted yields usually results from the inspection body's research prior to the start of the inspection, or the experience of the persons involved in the inspection. Another source is statistical data. Since the statistical yield estimate in Germany so far does not show yields of organic farming nationwide and separately, no representative yield data on organic farming is currently available.

The project evaluated two different ways of closing this gap.

Derivation of reference data from existing data sources

An alternative was the derivation of reference data from existing data sources for organic yields. AMI yield data for cereals and from organic farms from the Test Farm Network were compared with each other and with reference data (e.g. KTBL). This comparison showed a rough indication of average yields and fluctuation widths. Available data from the special harvest collection (BEE) were only considered exploratively.

Result: Reference data for organic yields can be obtained for use in the digital mass balance and in other models from existing sources (AMI/Test Farm Network). However, these data are fraught with uncertainties regarding regional differences and the reliability of individual data.

A combination of sources, considering the respective area size, would improve the reliability of the averages. In addition, considering other sources e.g., State variety trials, organic farms from the special harvest survey in all federal states, and by coordinating the recording of yield measurements of the organic Test Farm Network, and practice research networks in individual federal states could also contribute to improving the data situation.

The marketing partners (mills, marketing organisations) could also contribute data and are already partly considered in the AMI survey. This is particularly relevant for the market-oriented application of yield data.

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Systematic recording of organic farms in the Special Harvest Survey (BEE)

The systematic recording of organic farms in the BEE was considered as an alternative. Metadata from the special harvest survey provides for documenting the organic management of the land as a feature, which is currently only done for a small proportion of the areas covered. Consistent identification of organic farms in all federal states could lead to an improvement of the data situation. In this context, yield measurements on organic areas of state research institutes, universities and State variety trials could also be considered, which would further improve the data situation. Georeferenced organic areas would also help to provide a reference system for remote sensing that could develop algorithm-based yield estimates on this basis, at least for the crops affected by fraud.

4.1.5.4 Possible contributions of remote sensing for the organic control system

For the determination of yields using remote sensing data (optical spectrum and radar of publicly available satellite data), reference data in the form of measured yields are a fundamental prerequisite. A study by the State Statistical Office in Hessen in cooperation with the University of Darmstadt has shown that a combination of remote sensing data, specialist statistical data and administrative data could be used to obtain comprehensive and small-scale agricultural yield data of moderate accuracy (Holberg et al., 2020). It is conceivable to apply this methodology also to organic farming; however, so far the necessary data sources and experience are lacking. For further use of the methods of remote sensing for yield determination, impact-specific yield data with clear spatial data assignment are best suited. Yield measurements in the same or higher resolution as the planned estimate (sub-area, impact, municipality) are a fundamental prerequisite. This is the only way to model yields and evaluate models with the help of remote sensing.

The distinction between organically and conventionally managed areas by remote sensing is also conceivable e.g., due to differences in characteristics of cultural management and development. The "Cert-EO" Feasibility Study funded by the European Space Agency, in which Organic Services was involved as a subcontractor, has, among other things, devoted itself to algorithm-based differentiation of conventional from organic management in order to carry out plausibility checks of this IACS data for entire regions or countries using IACS data (InVeKoS in DE).[29]

The remote sensing working group at the Thünen Institute[30] uses satellite data and aerial images to support monitoring tasks for land use. Comprehensive maps of land use and their change are created.[31] Since autumn 2022, the group has been working on a project with the overarching objective to develop a comprehensive data base for assessing the scope, measures and effects of an expansion of organic agriculture in Germany with Copernicus and other satellite data and methods of artificial intelligence (AI).[32] Here, the approaches "expanding organic farming" and "digitisation" are combined as a means to achieve sustainable agriculture.

The availability of digital data on land use in organic farms compared to conventional farms is considered an important precondition for the evaluation of policy measures and the assessment of the achievement of targets in the expansion of organic farming. The project explores the question of how the farming structures in the agricultural landscape have changed in recent years and what proportion of this has been played by the

[29] https://business.esa.int/projects/cert-eo

[30] https://www.thuenen.de/de/thuenen-institut/verbundstrukturen/thuenen-fernerkundung

[31] https://atlas.thuenen.de/atlanten/fernerkundungsatlas

[32] https://www.thuenen.de/de/fachinstitute/betriebswirtschaft/projekte/erdbeobachtung-und-kuenstliche-intelligenz-fuer-das-monitoring-im-oekologischen-landbau

expansion of organic farming. Differences in areas/structures and productivity between conventional and organic farming (and within organic farming) are also considered. There are no results yet.

4.1.5.5 Integration of IACS data into a GIS

To Delimax GmbH, which offers Food Integrity & Lean Management Solutions, an expert report was commissioned to check the technical feasibility of using geo-area representation data from the InVeKoS system.

The primary task included the question of whether, and if so, at what level geo-area data from the EU-IACS (InVeKoS in DE) databases of the country or Member States can be integrated into a mass balance system such as Check Organic. This involves a) the geographical location and b) the derivation of possible harvest quantities per area of certified products or producers (according to the EU organic regulation).

The result can be summarised as follows:

Geo-area data from the databases or systems are provided in shape format. The Shape file format is a quasi-standard for vectorial spatial data or the representation in geoinformation systems. It was originally developed by ESRI Inc. and is now widely used by other companies.

A shape file is not a single file, but consists of at least three files:

- .shp is used to store geometry data;
- .dbf material data (also called attribute data) in dBASE format;
- .shx serves as an index of geometry for linking the factual data.

In principle, the shape files from three different data sources from Austria and Bavaria (real data provided by KIWA BCS) corresponded to the ESRI format and could be integrated into an agricultural documentation software ([33]CIBUS.farm GIS). However, there were differences in detail due to different shape file formats, but geocoordinates as a minimum requirement for the content of shape files were met in any case but need to be reprocessed in order to be displayed correctly on the selected interface, e.g. Google, Leaflet. This allows arable land and possible harvest volumes to be calculated per crop. The quantities thus calculated can be compared with the declared or controlled sales or captive quantities of the farming operations and thus checked for plausibility.

4.1.6 Conception of a prototype for combining mass balance with a GIS using the example of Check Organic

As explained in detail in chapters 2.4, the area, crop and yield data of certified farms are required for the calculation of mass balances. These data are available and can be obtained in all EU Member States via the IACS. For data protection reasons, this cannot be done directly and for all controlled operators via the control bodies, but the shape files of each farmer must be downloaded from IACS and made available directly to the control body. This is not problematic under data protection law, since it is the same data as for the control under the EU Organic Regulation, as long as a data protection agreement between the company and the control body has been concluded. The control body must change its (previous) procedure for collecting data from paper, pdf, Excel or the like to digitally, include it in its procedural description and communicate it to the farmers. Upon receipt, the data will be uploaded by the control body to a GIS used by it.

[33] https://agrochron.at/cibus/

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The prototype was developed with ABACO SpA, see also chapter 3. The approach was to use the GIS of ABACO Farmer and the mass balancing of Check Organic, thus allowing two independent software applications to exist.

The following section describes the alternatives to integrate GIS data into the Check Organic mass balancing system.

For this purpose, various possibilities of data integration were examined. The analysis was awarded to jobsta, who exchanged ideas with Organic Services, Abaco's DIGICHECK team and IT specialists. The system provided by ABACO as part of the project is a complex, multi-modular platform for agricultural farm planning as well as for the first stage of the supply chain. One module is the Geographic Information System (GIS), which is suitable for uploading and displaying data.

The following data integration options have been identified, see Table2:

1. Rest API (data interface)[34] integration for structured exchange of information, regardless of the technologies used in different applications;
2. Integration via an Internet-based user interface (WEB User Interface, UI and Rest API;
3. such as (2) but with integrated user authentication;
4. complete system integration of the ABACO application in Check Organic;
5. a complete self-development by/in Check Organic.

The seamless integration of agricultural land, crop and yield data from the ABACO GIS in Check Organic, which is preferred for users of Check Organic, is best possible via the solution (1), the REST API integration. This maintains the integrity of the Check Organic application; the user experience remains consistent and system dependencies resulting from the different objectives and architecture of ABACO Farm Management Software are kept to a minimum. This means that the majority of the functionalities of the ABACO application, which are made visible to the user, should be developed independently by Check Organic. The user interface including the display of the GIS data (area position, size, culture) on a geographical surface (e.g., Google, Leaflet) as well as the display of previous years from which crop rotations can be controlled and yields per harvest year must be implemented within Check Organic. While these user interfaces need to be redesigned and developed in Check Organic, the existing data model already meets much of the necessary scope and needs to be adjusted only slightly. On the database side, the integration of PostGIS[35] functionality has already ensured that spatial data can be processed.

It is common to all of the above solutions that any user would have to purchase both a license for Check Organic and ABACO Farmer. Experience has shown that this is not a promising approach because companies are unwilling to run multiple software solutions side by side, even if integrated.

Regardless of technical considerations regarding integration, the issue of data origin and usability or their transfer possibilities by ABACO to Check Organic is central. So far, the ABACO application works on the basis of demo data for selected regions. Any form of integration proves appropriate if Check Organic's relevant target markets can be served by ABACO's data. However, this is not to be expected, as ABACO has an identical

[34] A REST API (also known as the RESTful API) is an API (application programming interface) or web API. The rest stands for "Representational State Transfer". An API consists of several tools, definitions and protocols for developing and integrating application software.

[35] The PostGIS database extension offers the ideal basis for a powerful geodata infrastructure on the free database PostgreSQL.

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access problem to data-protected data, such as Check Organic. Abaco is focused on Italian customers, which makes cooperation difficult for e.g., German control bodies.

Against this background, as well as the expected effort for the integration of the interfaces and the associated necessary reconciliation between ABACO data and check organic data, a complete in-house development by Check Organic as an alternative variant is to be preferred.

Table2: Summary of the results of the review of alternatives in the integration of GIS data into Check Organic

1 Rest API	2 WEB UI 2 logins required	3 WEB UI 1 Login	4 Full system integration	5 Self-development
Uses existing interface in ABACO	Immediately applicable as iframe in Check Organic	Only one login for both applications by external identity providers	Direct access from Check Organic to ABACO data	Complete independence and freedom in the design
Independence of systems	Separate access rights	Integrated access rights	Integrated user interface	
Minimal effort for ABACO	Minimal effort for ABACO	High effort for ABACO by changing the system architecture	High effort for ABACO by adjusting the user interface	
High effort for Check Organic (approx. 1080 programming hours)	Medium effort for Check Organic (approx. 700 programming hours)	High effort for Check Organic (approx. 1060 programming hours)	Highest effort for Check Organic (approx. 1780 programming hours)	Medium effort for Check Organic (approx. 760 programming hours)

Source: Own compilation

4.2 Implementation using the example of the grain chain

The implementation of cereals was tested for example with “virtual” product chains designed by Organic Services with data from certified farms (from several federal states) of the project partner KIWA BCS and fictitious processing plants. Based on the experience of Organic Services with the presentation of product chains in Check Organic, practical chains could be created.

4.2.1 Collection of certification data

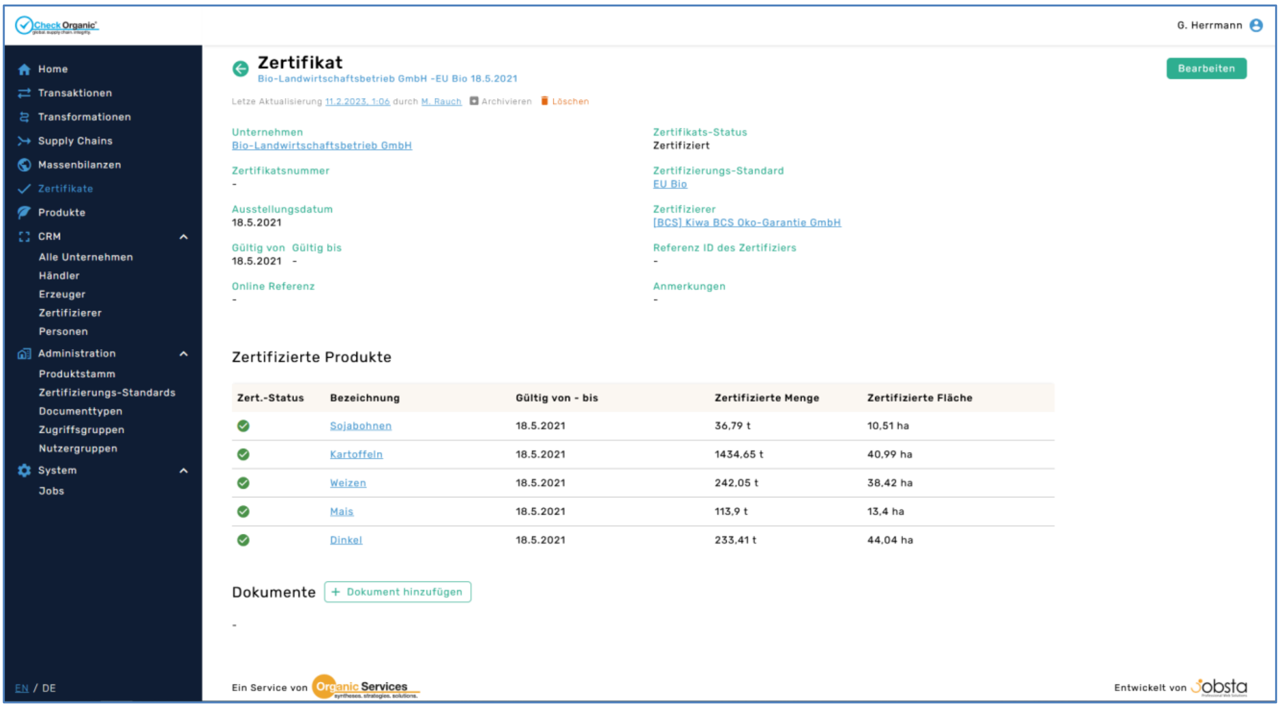
After discussions with control bodies and state control authorities (including with members of the Advisory Board of DIGICHECK), the research on the collection of certification data focused very quickly on the question of whether and to what extent IACS data, which are available in digitised form, can be used as a basis for the control, but also for the preparation of mass balances. The use of IACS data for organic control has already been discussed in chapters 2.2 with the conclusion that under the current legal situation neither the control bodies nor private service providers (e.g., for Check Organic) can access German IACS/InVeKoS data or the data of other Member States. It is not foreseeable that anything will change in the near future. However, with the appropriate political will and focus on digitalisation strategies nationally and at EU level, as well as on the urgently needed data consistency and integrity, this could and should be possible in the future.

In the DIGICHECK project, another way of accessing the required data had to be found for the above reasons, which hinder the direct use of data: Individual companies have access to their own InVeKoS data and can export them as a .ZIP file. The shape files contained in it can be imported into a GIS program. Once imported, this data can be shared with other authorised parties, e.g. control bodies or other private users. This path was chosen for the implementation at the example of grain.

With the companies identified for the collection of certification data, KIWA BCS concluded extended data protection agreements that allowed the transfer of their data to Check Organic. It was data from 2021 from the KIWA BCS database and from 2022 on the export of shape files from InVeKoS. For data protection reasons, the data of all establishments were pseudonymised for the presentation in Check Organic, because only part of the companies had consented to the publication of their data. Since there is no interface to the ABACO GIS yet, the data was entered by hand in Check Organic.

The following screenshot (Figure 5) from Check Organic shows the control/certification data of "Bio-Landwirtschaftsbetrieb GmbH", Saxony.

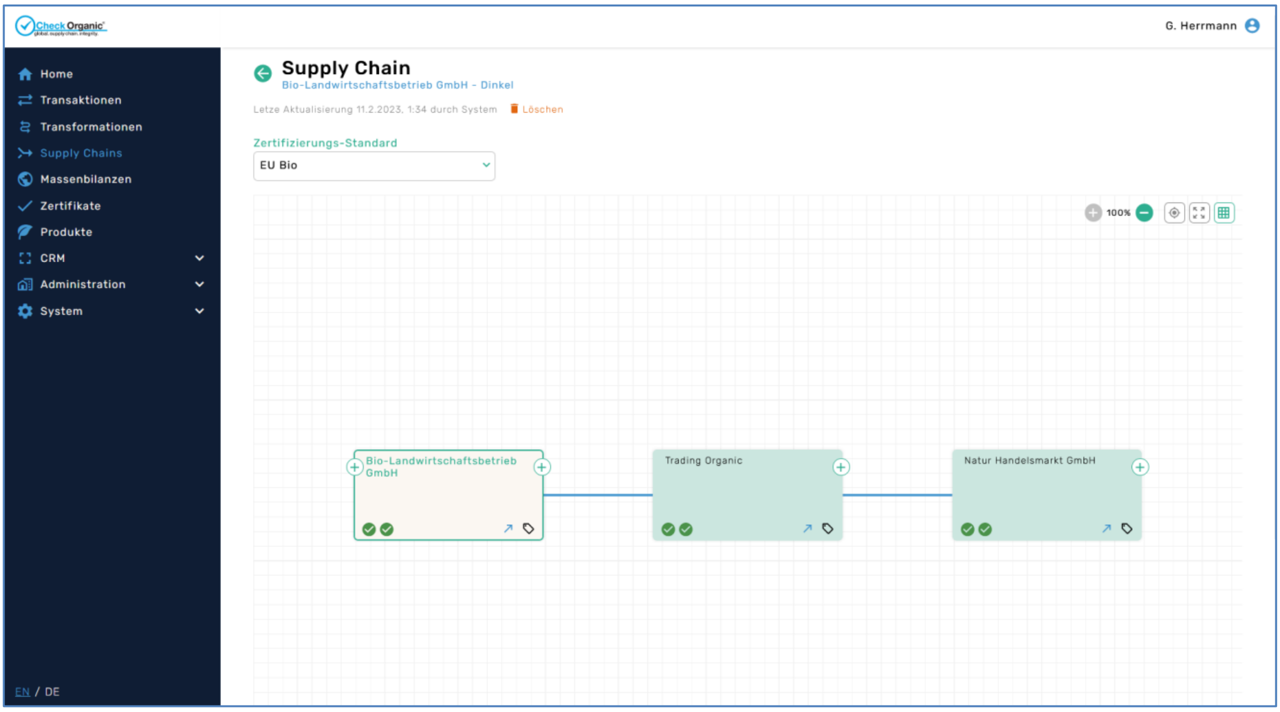
Figure 5: Control/certification data Sample operation



G. Herrmann is logged in as Super Admin of Organic Services (top right). The blue left column therefore shows the complete menu, which builds up for users depending on the roles and rights. The operation was found via the initial certificate search. The details of the standard, certification status, certifier, date validity and the certified products with quantity and area are displayed. The green traffic light points indicate that the operation is certified for the products. In addition, the certificate could be uploaded under documents, for example.

If the operation is searched for supply chains, the supply chains of the company are displayed (Figure 6), in this case for spelt. This display shows two traffic light points, the first for certification status, the second for integrity (product is certified and the quantity is available). In the supply chain, you can see that the company sold to "Trading Organic", and it continued to be sold to "Natur Handelsmarkt GmbH". All traffic lights are green, all participants are certified, the transactions (traded quantities) available and the entire supply chain in order.

Figure 6: Example of presenting a simple supply chain



The mass balance (Figure 7) shows the amount of spelt produced, the data from the control point data on area, crop and yield. The mass balance is calculated for each harvest season (2022). The presentation can be changed to the respective harvest years. The screenshot shows that 12.030 kg has been sold off, the initial quantity is removed, visually and can be displayed as a list. The remaining amount will be displayed. Here's everything in the "green" area.

Figure 7: Example of the presentation of a mass balance

Under the menu item Transactions one can search the individual transactions, shown here is the same operation, product spelt, traded in 2022, quantity 12.030 kg. Above right “Correct booking” offers the possibility to adjust or cancel bookings. Deletions are also possible. Check Organic automatically calculates changes and updates the data and shows any changes in traffic lights for all affected companies. Changes in quantity must, where appropriate, be released by the competent control body; a corresponding system is defined for this purpose.

The consideration of the trader ‘Trading Organic’, which purchased from ‘organic farm’ (see Figure 6), shows the other establishments from which ‘Trading Organic’ also purchased goods (see Figure 8). In this example, too, all traffic lights are green, both for the certification status of the respective companies and for the integrity status of the traded spelt (certified and quantity available).

Figure 8: Example of the supply chain from a trader’s point of view (suppliers, buyers)

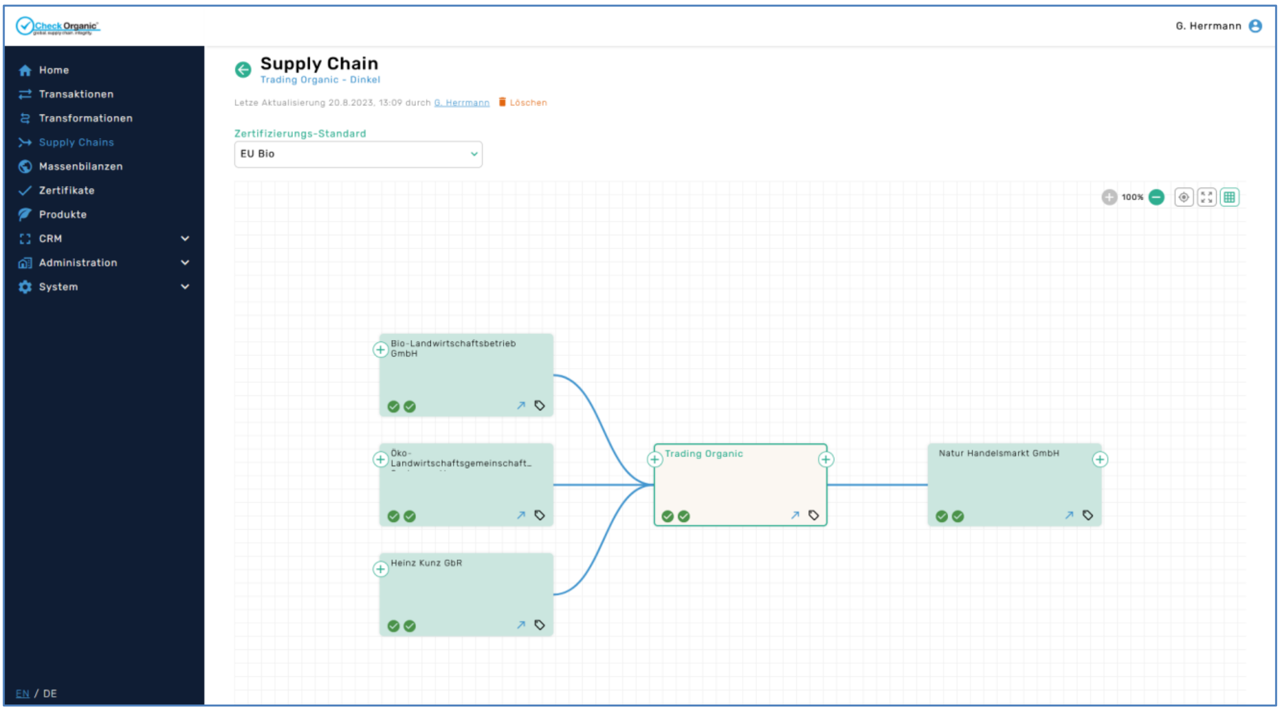
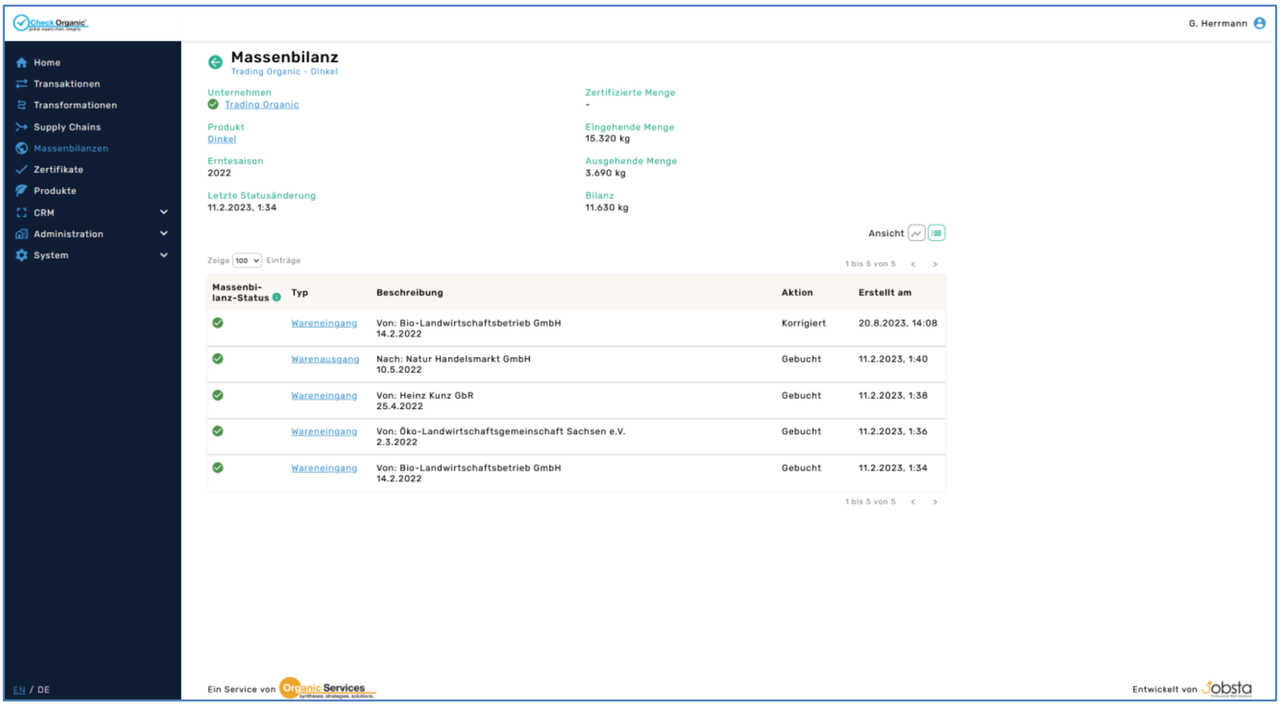


Figure 9 shows the mass balance from the perspective of “Trading Organic”.

Figure 9: Mass balance of “Trading Organic”, product spelt

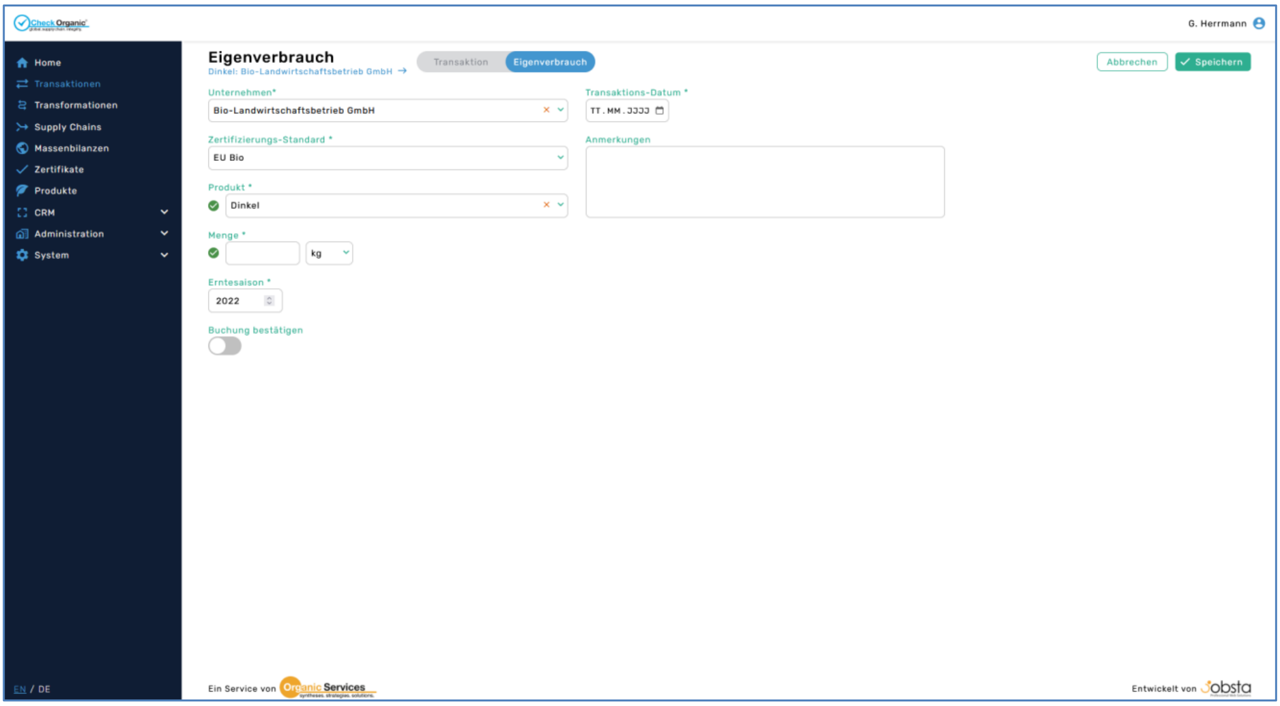
Figure 10 shows the same mass balance of the trader “Trading Organic”, in this view as a list showing all the details of the bookings.

Figure 10: List presentation of the mass balance, detailed overview of the bookings (company as above)



Since self-consumption (e.g. through animal husbandry) affects the mass balance, “Bio-Landwirtschaftsbetrieb GmbH” has to book a self-consumption in this case, see Figure 11.

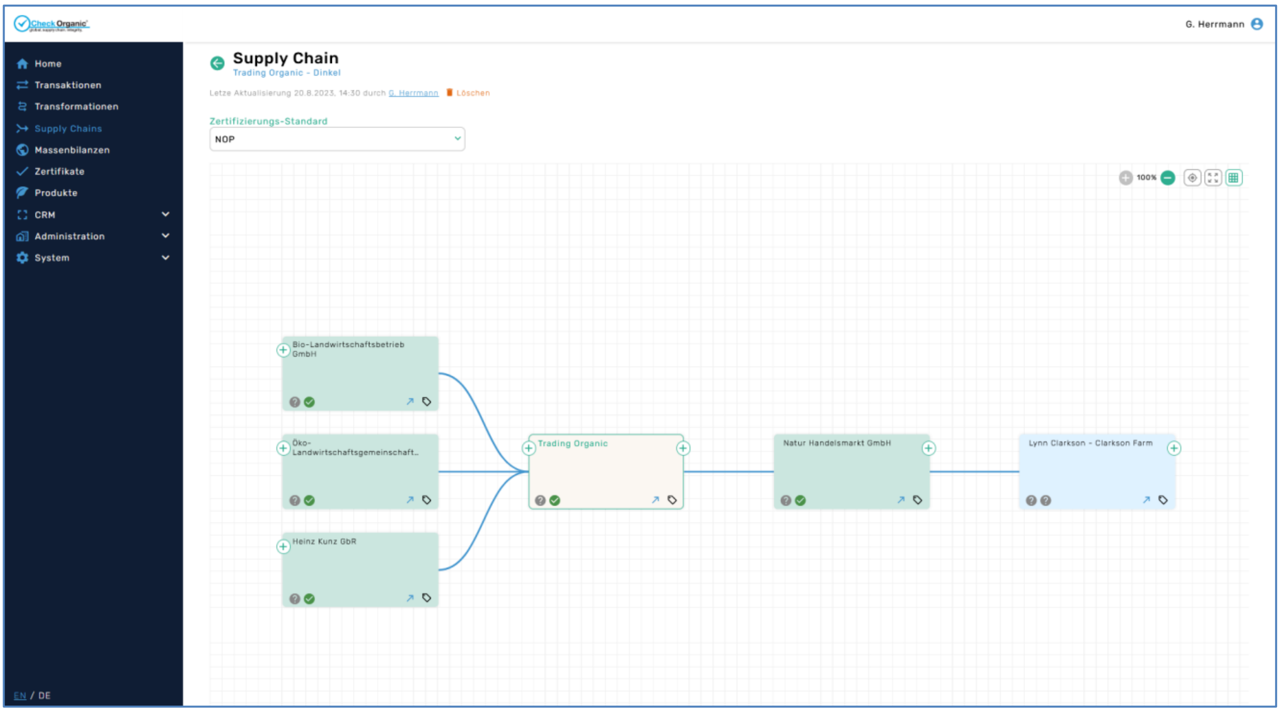
Figure 11: Example of booking self-consumption



4.2.2 Data from product transactions, transformations and international supply chains

All Check Organic functions can also be used internationally. Figure 12 shows an example of an export to the United States. U.S. operations data come in "real time" from the Organic Integrity Database (OID), as this data is imported into Check Organic daily via a publicly available interface provided by the USDA NOP.

Figure 12: Example of an international supply chain (Spelt)



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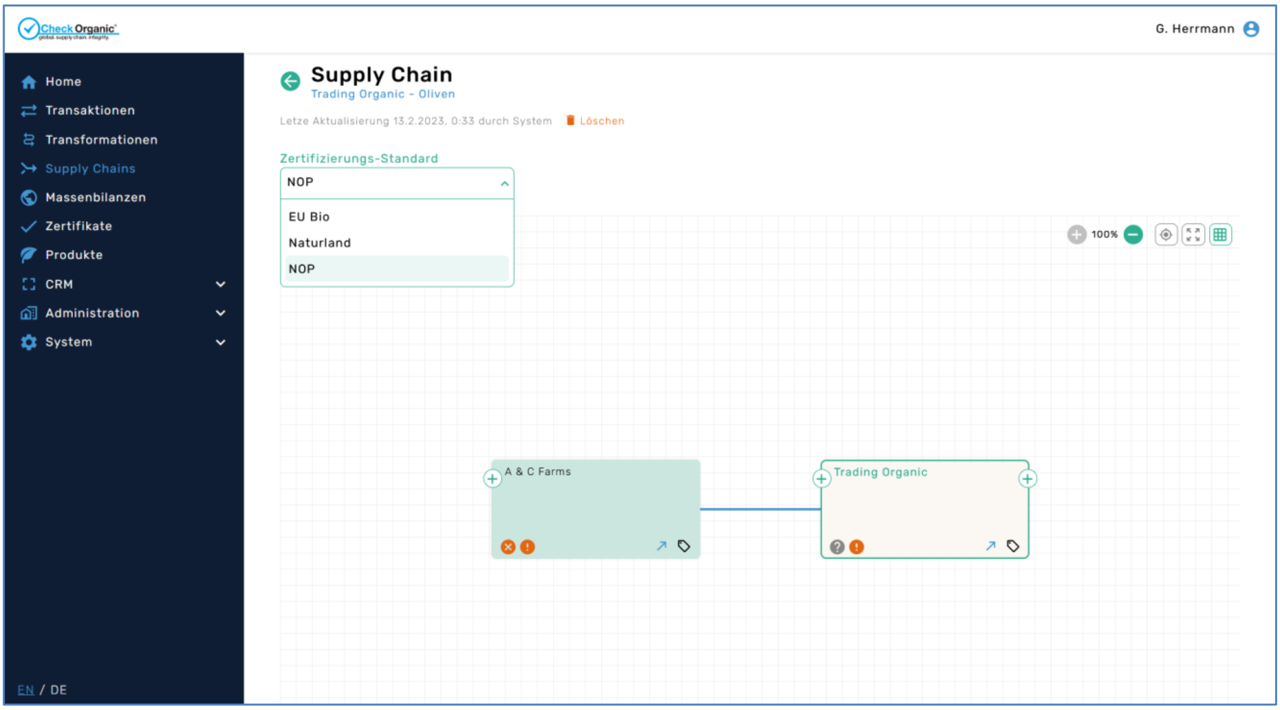
"Clarkson Farm" is shown in blue: no trade has taken place yet, the integrity status is gray (right traffic light). The left traffic lights in the German companies, which were previously green, are "suddenly" grey. This is because the chosen standard is now NOP and no longer EU-Organic. Clarkson Farm would have to show a green status (left traffic light) due to NOP, but: Clarkson Farm has no green certification status because the farm is not certified for spelt, although it has a valid farm certification. This example shows the complexity that needs to be mapped in Check Organic: operation, product, cross-over standards (equivalence between EU-NOP etc.)

Excursion to another product with international trade (Figure 13): The following example shows the trade in olives between "A & C Farms" and "Trading Organic". Displayed through the traffic lights red, orange, and grey, there are various problems here. In Check Organic one can investigate these issues, e.g. "A & C Farms" has returned its NOP certification, "Trading Organic" does not have NOP certification and both integrity statuses are red due to the lack of NOP certification by "A & C Farm" and "Trading Organic". Now it would be assumed that the certification light for "Trading Organic" and EU standard is green, but it does not, because "Trading Organic" is not EU-certified for olives.

Figure 13: Complexity of interrelations and resulting traffic lights



For completion, a transformation is presented (Figure 14): olives to olive oil. Again, we see "A & C Farms", but not the certification status, but the mass balance and transformation. A red light can be seen. If one follows the list view of the red traffic light, one can see that the transformation from 22.8.2022 is green, but the subsequent transformations are not, hence the red traffic light. One of the transformations was booked and corrected later. This is actually fine, provided the certifier confirms the correction, otherwise it could be tried by booking back and forth until the traffic light colour is right, a possible case of fraud. With "Reset Status" only the certifier can save changes. If in this case the certifier acknowledges the error of a false transformation and its correction, the traffic light changes to green (not shown here).

Figure 14: Example of a mass balance of a transformation (processing olives to olive oil)

The examples presented from Check Organic show an excerpt of the functionalities and reflect the complexity of data and relationships. The logic behind Check Organic does not eliminate the complexity, but it is comprehensible and transparent, so that the participants can act on the screen without having to research the why, where and how on the spot or over the phone.

4.2.3 Presentation in GIS

The system provided by ABACO as part of the project is a complex, multi-modular platform for agricultural farm management as well as for the first stage of the supply chain. One module is the Geographic Information System (GIS), which is suitable for uploading and displaying data.

In addition to collecting control-relevant data, ABACO Farmer, like many other agricultural, software-based planning and documentation systems (farm management systems), can also digitise many of the recording obligations required by the EU Organic Regulation on farmers. These records are consulted by the control bodies during the inspection e.g., on seeds, fertilisation, etc. However, these are not relevant for the DIGICHECK project.

Organic Services and ABACO have therefore selected the functions relevant to the organic control and certification system from ABACO Farmer. Organic Services has provided ABACO data from the KIWA BCS certified test facilities as well as the link to the Austrian InVeKoS (IACS) data for uploading and testing in the ABACO Farmer test environment.

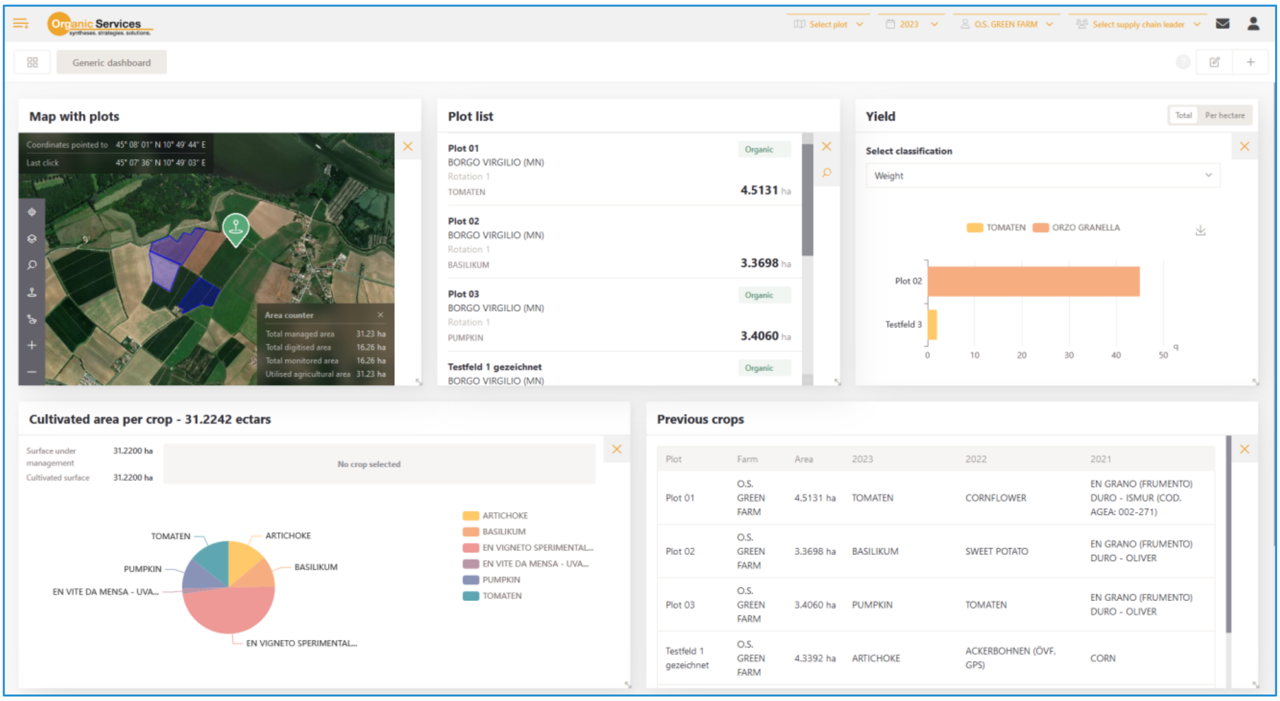
The selected functions include:

- The representation of agricultural land on a layer (e.g. Google Maps, Leaflet) with geographical location, size and culture (map with plots),
- The area list of the holding with name, size, culture (plot list),
- Where available, the yield is shown, either area-based and or as a sum over the crops (yield),

- The representation of areas and crops over several years for the presentation of the crops (previous crops),
- Aggregated area of crops (Cultivated area per crop).

Figure 15 shows the selected data/functions in modular tiles.[36]

Figure 15: Abaco Farmer GIS with data important for control and certification



In chapters 4.1.6 the options are presented to integrate the GIS application shown in Figure 15 into Check Organic, based on the data of the control bodies.

4.2.4 Statistical data and acquisition of market information data

The Check Organic system requires individual company data. For the companies and value chains considered, data can be linked and evaluated as well as plausibility checks on the volume flows of value chains be conducted.

In accordance with the requirements of the EU Organic Regulation and the German Organic Law (ÖLG), the control bodies collect data that need to be reported to the competent authorities. Nationally, the following information must be reported to the BLE per state and quarter (for the 15th of the first month of a completed quarter) and per year (as of 15 February of the following year): number of farmers, area organic (and in conversion), area non-organic, total area. In each case separately: all information for new customers as well as for farmers who have terminated during the period under consideration. The Federal Agency for Agriculture and Food (BLW) reports data to the EU Organic Farming Information System (OFIS). With a database such as Check Organic, the collection, aggregation, evaluation and reporting of data can be systematised, with the advantage of being up to date.

[36] For data protection reasons, no KIWA BCS company was presented for this purpose, as no pseudonymisation could be carried out.

For statistical purposes, the individual farm data such as land, harvest quantities, processing quantities or sales volumes can be evaluated and used e.g., for a specific region and certain crops and products. And here Check Organic or a related system offers different possibilities.

Data on land, yields and production volumes are important for market participants to estimate quantities and availability of certain products. However, up-to-date statistical data are particularly relevant in order to assess, for example, the quantities of wheat and their availability for the market. In this way, processors can better estimate whether they can supply themselves in sufficient quantities from domestic production, whether imports of certain products are necessary or whether sufficient quantities are available for certain regional brands. Statistical data on land and yields have so far only been available with a great delay and only when the information is no longer relevant to the market. The biggest advantage of GIS and mass balances for statistical purposes is the temporal advantage this survey has over conventional data.

By linking mass balances with GIS applications, individual farm data could also serve as reference data for remote sensing and application e.g., to distinguish between organic and conventional crops using artificial intelligence (AI). It is also conceivable to predict the cultural developments of organically and conventionally managed land on different soil types. Thus, organic area of certain land use types can be collected and published as the sum of a given region via satellite data. From this, crop areas and yield estimates can already be created during the growing season. This would be an immense advantage, because until now, the organic soil usage data will only be published with one year late when the products have been sold long ago.

Yield data are the largest gap in the collection of organic data to date and this is rather unsystematic (see chapter 4.1.5.3). Geo-reference data from organic farms is also required for a yield estimate using remote sensing (see chapter 4.1.5.4). There are already various applications for conventional agriculture to estimate yields. The cultural development of organic crops shows different growth patterns e.g., through other fertilisation and crop rotation. Brighter leaves, certain diseases and other factors allow for a distinction from conventional management and thus a demarcating assessment and yield determination.

Data from mass balances, among other instruments – e.g., the integration into the special harvest collection or data from the German Test Farm Network within the framework of Farm Accountancy Data Network (FADN) – are an efficient and, above all, very timely possibility for yield estimates. These, in turn, can be processed with up-to-date area data for timely harvest volume estimates.

Special applications can be developed or already used for horticultural crops in which several sets are placed on a single surface.[37] Since the satellites usually fly over an area every 2 weeks, the different cultures can be recorded over time. Also in the quantity balances, vegetable crops with several sets can and must be recorded differently than agricultural area crops. By linking it to the volume balances, production volumes can be determined as a collected position for a region similar to that of cereals. Check Organic does not currently show any horticultural crops and sets.

Location, sizes and outlines of the individual areas, on the other hand, are less interesting for market evaluations. These come into play when it comes to evaluations of nature and species conservation. Thus, differences in organic and conventional management can be investigated, for example, in the biodiversity of natural areas.

By presenting organically managed areas in the GIS, possible causes of e.g., contamination caused by drifting off conventional land can be assessed and evaluated retrospectively in the case of positive residue analyses

[37] For AgroChron, Delimax has developed an application-ready system with its software Cibus.farm: https://agrochron.at/cibus/, for Delimax see also chapter 4.1.5.5

through the analysis of crops and management of neighbouring areas. Regulation 2018/848 provides detailed specifications for the investigations to be carried out by a control body.

France offers an example of very transparent handling of the exact location of the organic areas: the Agence Bio[38] shows precisely the location of individual organic areas and their borders but without plant allocation. In the main use, the cultivation of arable crops (grandes cultures), forage, vegetables, fruit, wine or medicinal and spice plants can be distinguished. Even the size of the individual plots and the exact use of the crops in the past 3 years is indicated – for example, individual cereals. What would make sense for the purpose of market information is then a sum of the pea area, for example per department or all of France. This would be a tabular representation of the cartographic data, which would then be easier to process with databases.

In the United States, with the revision of the US Regulation 'Strengthening Organic Enforcement (SOE), published on January 19, 2023, certifiers are required to register all certified areas with effect from March 19, 2024.

In Germany, certifiers have so far only had to report the total area to the competent state authorities. In addition, the AMI collects data on land use at the control bodies on a voluntary basis (this means that only about 85 % of the area is actually collected, the remainder is estimated) and this with one year delay. This could be changed if the BLE or the Federal States authorities would provide the control bodies with a single software for data collection and analysis. The software would use uniform coding for land use and animals or would compare different codes, so that the area data from the InVeKoS (IACS) Shape File could already be published in January of each year or after the growing season, if all controls were carried out. That alone would mean a time saving of almost a year. With Check Organic, such a database is available as the above data and harmonisations are part of the software.

A less detailed alternative would be to publish the IACS data in aggregate form in all federal states, similar to Bavaria.[39]

4.3 Estimation of costs and benefits

4.3.1 Savings on control bodies

The integration of a GIS into Check Organic supports where the current control and certification system has weaknesses. Check Organic/GIS supports, with the strategy of digitisation and the linking of data of the control system with the quantities generated and the transaction data along the product chain, essential needs and workflows of the control bodies – on the one hand their administration and support before, during and after the control on the other hand in the consistency (integrity) of data storage. In addition, the Check Organic/GIS not only serves the intrinsic motivation to prevent food fraud, but also offers control bodies the tool for this, combined with a concrete economic advantage.

Table 3: Activities and potential savings for control bodies

Activity	Currently	Check Organic/GIS	Savings (estimated)
Collection of area and cultural data	Co-workers. Data on paper, Excel, pdf are provided by farmer	Farmer Downloads Shape File from InVeKoS → Upload in Check Organic/GIS	25 %

[38] https://www.agencebio.org/cartobio/

[39] https://www.lfl.bayern.de/iba/agrarstruktur/279000/index.php

Entering and updating data in the control body database	Co-workers	Data transfer from Check Organic/GIS to the control body database via interface (API)	25 %
Preparation of control documents	Co-workers	Access via smartphone, notebook, etc. Access to Check Organic/GIS	25 %
Implementation of the control	Inspector, reference documents on paper	Usage Check Organic/GIS	20 %
Updating data during control	Inspector (on paper, Excel)	In Check Organic/GIS	25 %
Collection of yield data	Inspector (on paper, Excel)	In Check Organic/GIS	25 %
Mass balance calculation	Inspector (on paper, Excel)	In Check Organic	25 %
Input and update of the control body database	Co-workers	Via interface	50 %

Thanks to the integrated Check Organic/GIS, one co-worker of four can be saved or the politically and economically desired growth of organic farms with fewer employees can be implemented more cost-effectively. With a license price of approximately EUR 40.000/year, the software[40] will be profitable after four years at the latest (EUR 60.000 total costs/co-worker), for large control bodies rather than for small ones.

4.3.2 Savings on traders and processors

The DIGICHECK project planned to carry out concrete estimates and surveys on costs and benefits, comparable to the control bodies, through the participation of a processor. This could not be realised by the exit of already selected processors from the project.

For this reason, the results of a survey of Italian distributors and processors carried out by Organic Services as part of the Food Integrity Project (FoodIntegrity, 2019) among the users of the national Italian FederBio Integrity Platform (a Check Organic Application) are summarised.

The survey was conducted online. The aim was to understand the use, costs and benefits of the system for the participating operators and the possibilities for further development of the system. 165 traders and processors of all sizes were contacted, 38 of whom participated in the survey, representing a return rate of around 23 %:

- In June 2017, more than 200 traders and 63.046 farmers were registered in the FederBio Integrity Platform (FIP).
- Out of approximately 600.000 tonnes of cereals (total Italian harvest volume approx. 1 million tonnes), transactions were recorded through the platform.
- The FederBio Integrity Platform (FIP) has great potential for time and cost savings for its participants as soon as it is taken up by a majority of stakeholders in the supply chain.
- The better certification data and trade data are available, the fewer information gaps display in the system, which are expressed by a grey traffic light (missing data).
- The same applies to the calculation of mass balances where missing data is expressed in red traffic lights.
- Thus, there is a correlation between the percentage of the volume registered in the FIP and the time savings of the participants. Participants who reported having registered 100 % of their volume in the

[40] This price is a first assumption, which can only be quantified more precisely after the implementation of the integration of Check Organic with a GIS in cooperation with users.

FIP achieved a higher time savings than participants who had registered a lower percentage of their volume.

- This means that, on the one hand, participants depend on the participation of their suppliers and certifiers, but that they, on the other hand, can also contribute to increasing their own efficiency by registering as much as possible all traded quantities.

5 Discussion of results and preparation of recommendations

5.1 Summary of results

The overall objective of the project is to develop an actionable approach to improving the organic control and certification system by integrating digital certification and product transaction data as well as digital geographical data and appropriate Internet of Things (IoT) tools to combat fraud with organic products using the example of the grain chain using a mass balance system.

The project was funded under the theme "Development of the organic control and certification system and strengthening social objectives in organic farming" within the framework of the Federal Programme for Organic Farming and Other Forms of Sustainable Agriculture (BÖLN) (announcement dated 15.5.2018).

Scientific and technical status

Although the functionality of the control and certification system by control bodies and authorities in organic farming has so far received little attention in research, findings from previous research projects support the project approach:

- Taking into account data for mass balances in the data collection on organic farming (Recke und Hamm, 2005; Rippin et al., 2005; Organic Data Network, 2014a)
- Introduction of mass balancing as a method and with Check Organic to increase transparency in product flows (Source Food Integrity Project).
- Further development of quantitative and risk-based control systems (Stolze et al., 2013; Dabbert, 2012a)
- Combination of Earth Observation data, GIS and Apps to support the work of the Control Bodies (ESA Feasibility Study (2021-2022) "Organic Plausibility Checker" and ESA Feasibility Study (2021-2022) "Cert-EO").

The existing national and international control systems for organic food and farming lack effective mechanisms and tools to detect and prevent fraud in the organic sector. This was largely confirmed by the European Court of Auditors (ECA, 2012, 2019).

With TRACES, the EU Commission has introduced a platform for import certificates of control. The 2018 revision of the EU organic Regulation introduced the necessary digitalisation of land, crop and yield data, which could improve fraud prevention, but not mandatory.

The development in the USA is different, where the revision "Strengthening Organic Enforcement, SOE" requires the digital collection of area data. In doing so, the USDA has deliberately laid the foundation for applying mass accounting at both corporate and supply chain levels.

A major sub-objective of the DIGICHECK project is the development of a prototype for the “combination of mass balance with a GIS” (Check Organic and ABACO’s GIS system). GIS data are widely used today e.g., EU Integrated Management and Control System IACS (InVeKoS in Germany).

For this purpose, the existing software applications were used as part of the project and recommendations for further development were developed.

The prerequisite is the presence of digital farm, land, crop and yield data from the control and certification system, as a manual input and update of tens of thousands of agricultural farm data per control body is unrealistic. The same applies to product transaction data of processors and traders along the supply chain in order to account for the quantities traded with the quantities available at origin (farm, area and crop).

Results of the work packages

Three content-related work packages were carried out for the implementation of DIGICHECK, which consisted of:

- the analysis of the existing control and certification system (AP1);
- an exemplary implementation of a mass balance system for cereals using a GIS-enhanced approach of Check Organic, with the development of a prototype, (AP2) and
- an assessment of the benefits and costs of this application (AP3).

In this section, the results of these work packages are now briefly presented, discussed and in the following section recommendations are derived.

Work package 1: Analysis and improvement of control and certification (six steps)

1. FoodChain Lab synergies with the existing system FCL

At the request of the project funding agency system synergies were evaluated. Both systems have been developed for different objectives and with different applications. Therefore, no synergies could be identified for a joint future development.

2. Vulnerability analysis of the legal framework with regard to traceability of product chains

The legal framework at EU level requires individual companies or groups of operators to record input and output volumes. This is mainly aimed at food safety and less on fraud prevention. This data can be used to produce a mass balance of individual companies, but the application of mass balances in supply chains is not further considered in the Regulations, e.g. in the EU Organic Regulation 2018/848. The revision of the EU Organic Regulation since 2017 has not yet considered the possibilities arising from the digitalisation and availability of control data and data from external sources (e.g., geographic information systems) for the traceability of product chains, neither in the text of the Regulation nor in its application in the control and certification procedures. Unlike in the US, where the prerequisites for the mandatory collection of data for the production of mass balances are laid down in the USDA NOP.

A legal opinion prepared as part of the project notes that a mandatory introduction of a mass balance system in supply chains, which is mandatory for control bodies and companies, requires a legal regulation. This could be done within the framework of the EU through a delegated regulation or by federal or state legislation.

3. Analysis of the nomenclature/taxonomy

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A large number of classification systems are relevant for the cultivation of and trade in cereals, which have not yet been harmonised despite a wide range of efforts at different levels. However, the systems show similar structures of individual sections. Thus, it would be possible to create match lists between the different systems if data is to be integrated from different sources. This can be supported by appropriate software.

It was mentioned, but not further investigated, whether, with the increasing importance of organic farming in Germany and Europe, specific identifiers for organic products could be created in the HS/CN framework at national or European level, such as partly implemented by the USDA NOP.

4. Analysis of data protection

The considerations on data protection mainly related to the use of InVeKoS (IACS) data, as these are already available digitally. Thus, with reference to data protection, the control bodies have so far been denied access to IACS data, although they collect the same data for the control process, regulated by a data protection agreement. The results also show that, among other things, agricultural data has a legal grey area between personal and non-personal data, which requires urgent clarification.

Open data strategies (e.g., INSPIRE) are implemented in Germany (by the Federal States) to a different degree. Area data is publicly available but cannot be assigned to a single farm and thus cannot be used for mass balancing. There are no open and standardised interfaces to official data systems.

Under the current interpretation of data protection, the IACS data cannot be used directly by the control bodies. The control bodies would have to request the individual download of the operating data from the controlled farmers (.Zip File). In addition, they would have to operate a GIS in order to upload the data and display the surfaces. This would theoretically be possible, but expensive, and would only insufficiently improve data pooling in the sense of fraud prevention.

Even if the data on export from InVeKoS (IACS) are available to the control bodies digitally, the data are not available for Check Organic for the presentation of mass balances due to the data protection regulations. For this, additional data protection agreements would have to be concluded by Organic Services with each individual company, which is not feasible. If control bodies use Check Organic themselves, they can use their data, but this data will not be available to third parties. This would largely exclude mass balancing across control bodies. The clarification of personal and non-personal data would enable the transfer e.g., of land, crop and yield data.

The future EU central database TRACES on which operator and import certificates will be issued will not improve data availability and exchange as neither upload nor public download interfaces are planned to use the existing data. In contrast, USDA NOP operates the Organic Integrity Database OID, which offers a public interface; at present, however, not the area/field data.

5. Reorientation of the control and certification procedure (including available yield data)

A central element of the digital identification of product transaction data in the project is a mass balance that takes quantity data into account at all stages of the product chain.

In order to check the plausibility of quantities, the estimated, possibly validated yield potential e.g., through control points, of individual areas or, in the best case, the weighted harvest quantity, as well as potential self-consumption e.g., feed, and transformations e.g., from grains to oil, is considered. This is not about high accuracy, but about a good limitation of the orders of magnitude. Fraud in the recent past is usually mass fraud (commodity fraud).

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As part of the project, it was evaluated whether yield reference data can be derived from existing sources. The comparison of yield data from the AMI, of organic farms from the Test Farm Network and exploratory of available data from the BEE was based on reference data (e.g., KTBL) which showed an indication of average yields and fluctuation widths that can be used in the mass balance but are subject to uncertainties regarding regional differences and the reliability of individual data. A more systematic recording of organic farms in the special crop survey, considering the respective area and the yield results of State variety trials on organic land, organic research farms and agricultural research networks in individual Federal States, could significantly contribute to the improvement of yield data.

Promoting a digital infrastructure for control and certification would have many advantages. It not only makes a valuable contribution to the fight against fraud through greater transparency in the value chains, but also in terms of streamlining bureaucracy, management and control implementation, and data exchange in the organic control and certification system. It also helps to save time and resources by reducing manual multiple inputs, minimising error vulnerability and significantly increasing acceptance for the use of digital applications. In addition, this can be achieved by:

- Harmonising IACS and control data;
- Improving data retention and enabling better data analytics of control-relevant data,
- Combining with satellite-based services e.g., monitoring/tracing of management measures, determining yields, and improving the monitoring of quantities produced and traded.

6. Conception of a prototype of the application mass balancing with integrated GIS

The examination of which method of integrating an existing geographical information system into Check Organic concluded that self-development i.e., the full integration of a GIS module into Check Organic, is the leanest (a software application, integrated data usage, multiple benefits, etc.) and the cheapest solution.

Work package 2: Implementation using the example of the grain chain (5 steps)

1. Collection of certification data

Control and certification data were collected by KIWA BCS from some selected companies. These companies have downloaded their .Zip (Shape) file from InVeKoS application and provided KIWA BCS as well as Check Organic and ABACO. In the software applications it was possible to process farms, areas and crops; with the help of the ABACO Farmer GIS they were also visually displayed. In addition, KIWA BCS provided yield data from the farms, which served as a basis for the calculation of mass balances and were used for the exemplary calculation of mass balances across supply chains.

2. Data of product transactions

The product transactions were created by Organic Services in Check Organic to represent these and the resulting exemplary supply chains.

3. Verification by a Geographic Information System (GIS)

The data of KIWA BCS farms was transferred to the application ABACO Farmer and presented on the integrated geographical information system. For each farm, the area, its location and size as well as the culture of the respective year were displayed. With these farmers and their information, the modules that are important for the control and certification system have been developed: visual display of surfaces on the layer, area list (with location, size and crops), yield overview by area and aggregated, crop rotation over several years. Further modules are possible in the ABACO Farmer but were not included for the development of the prototype.

4. Recommendations

Recommendations for data collection, presentation and development of the prototype were discussed and elaborated and are included in section 5.2.

5. Statistical data/collection of market information data

Control bodies collect individual farm data and report them in accordance with EU Organic Regulation and the German organic law (ÖLG). BLE transmits processed data to the Organic Farming Information System OFIS. With Check Organic, the collection, aggregation, evaluation and reporting of data can be systematised on a daily basis.

In cooperation with AMI, the collection of yield data and its use in an integrated system of mass balancing with a GIS were discussed in particular. In particular, the focus was on the timely collection of data for market information.

Work package 3: Estimation of costs and benefits

The estimation of the costs and benefits has shown itself to be challenging because the prototype does not represent a practical application and only a limited number of operational data were available. Therefore, the application of Check Organic with an integrated GIS for the control and certification system was theoretically analysed step by step according to the procedures of a control body and evaluated with an average working time savings in administration and control of about 20 to 25 %. For processing companies, the results of a survey by Organic Services in the FoodIntegrity project were used. A percentage assessment is difficult due to the diversity of farms, but it can be found that with a company's growing size and the completeness of the data entered, the benefits increase.

5.2 Recommendations

Entry and execution of operational mass balances and along product chains

A growing number of consumers are willing to pay a higher price for organic products. The price difference entails the risk of fraud. This entails an obligation for all parties involved to ensure the integrity of organic products. Mass balances of product transactions along the supply chain are a simple and reliable tool for preventing and combating fraud. For this purpose, digital areas, culture and quantity data as well as transaction data of the traded products are required. For this purpose, the project has developed a prototype:

- The model developed by DIGICHECK for the collection of control and certification data via the farmers' .Zip files (Shape Files) can be implemented by control bodies at any time if a geographical information system is available to display the areas and information.
- A prototype for the integration of a geographical information system with Check Organic has been developed. In the case of software implementation, after the end of the DIGICHECK project, a data-integrated tool for collecting data, carrying out checks and producing mass balances (at operational level) is available.
- In Check Organic, mass balances can also be mapped along product chains (national and international) and for various standards/regulations, taking into account data protection (log-in, roles and rights).
- The mandatory introduction of mass balances (also along supply chains) is only possible through a legal regulation at EU, federal or state level. DIGICHECK proposes solutions for this.

Driving digital collection of data for organic control and data infrastructure

The promotion of a digital control and certification infrastructure has many advantages, such as contributing to the fight against fraud through greater transparency in value chains, streamlining the bureaucracy and improving data exchange in the organic control and certification system. The DIGICHECK project recommends:

- Clarifying the legal grey area of personal and non-personal data in different contextual contexts, in particular the clarification of whether individual farmland, crop and yield (and-animal) data are considered personal or not;
- Adapting regulations/laws to enable interoperability and data exchange between different systems and actors (even within public administration) in a digital ecosystem;
- Consistent implementation of INSPIRE's Open Data Strategy to improve the usability of data;
- Offer open and standardised interfaces to and from government applications and reporting systems (IACS, HIT, TRACES, etc.);
- Explicitly include the concerns of organic control in the digitalisation strategies of the agricultural sector (with a medium to long-term impact);
- Make available the existing individual farm data from the IACS organic control system directly from IACS and for import into GIS applications;
- The integration of digital data from different databases/origins requires a comparison (match lists) between different nomenclature systems; this is possible with the help of software offered on the market;
- Specific identifiers for organic products should be introduced in the HS/CN framework with a view to the 25 % and 30 % organic growth targets respectively;
- Mandatory implementation of a GIS and mass balancing system to link and evaluate data in compliance with data protection at control body level and along supply chains.

Improvement of yield data collection of organic farms

Yield data on organic farming are not systematically collected and are therefore incomplete. It is true that control bodies collect yields for their holdings. However, this information is only available internally and usually not digitally. As a result, data are usually not available in a timely manner to use it for forward-looking yields and market estimates. The project recommends the following steps, which would significantly contribute to improving the data availability of organic yields and allow a realistic estimate of the expected harvest volumes:

- More systematic recording of organic farms in the Special Harvest Survey (BEE) in all Federal States, taking into account the respective region and area;
- Systematic recording of yield results from regional variety trials on organic areas, of organic research department of universities and research institutes, and of practice research networks in individual Federal States with geo-reference data.
- Consider data from geo-referenced mass balance systems as reference data for remote sensing.
- Mandatory introduction of a mass balancing system allowing access to the yield data collected by the control bodies.

Contribution of remote sensing

In general, remote sensing can also contribute to improving the data base in organic farming by providing repeated and independently comprehensive information on the state, use and change of the agricultural landscape across large areas and by closing existing time gaps in existing data. This applies to:

- Monitoring/recognising specific management measures;
- Determination of yields for the purpose of monitoring quantities produced and traded (mass balancing during control).

A necessary prerequisite for use in organic farming is geo-referenced organic data, for which other specific characteristics are known to develop and calibrate models. A combination with data from the public administration is recommended.

6 The usability of the results

The results developed in the DIGICHECK project are practical and can be implemented at any time by the various actors in politics, administration, control bodies, etc.

DIGICHECK has drawn up specific recommendations for legislators and competent authorities that can be implemented. This includes, in particular, the recommendation on the introduction of the mandatory collection and processing of digital control data as a prerequisite for the mandatory introduction of a national mass balance system, first of all for the main fraud-prone raw materials. This includes improving the systematic yield collection as reference data for the mass balance system and market transparency with regard to the most important organic raw materials. Last but not least, the data protection issues raised should be clarified.

Particular attention should also be paid to the recommendation to use public interfaces for the provision of digital data to and from TRACES.

The conversion of internal processes of control bodies for the collection of control-relevant data from farms to digital data can take place at any time. For this purpose, the.Zip files (Shape Files) from InVeKoS (IACS) can be used, to which each farm has access. After downloading, the company may make this data available electronically to the control body,[41]which will record this data into a geographical information system. Transmitted via interfaces or integrated into software applications, the control data can be further processed e.g., in a mass balance system.

Geographical information systems and services are provided by a wide range of companies. Users are not bound to the use of Check Organic or a GIS integrated in Check Organic.

Organic Services can exploit the results of DIGICHECK insofar as the development of the prototype for the integration of a GIS with Check Organic provides the necessary information to implement its programming. Organic Services will involve control bodies/certifiers in this development in order to implement a practical solution tailored to the organic control and certification process.

7 Achievement of objectives

The overall objective of the project, an actionable approach to improving the organic control and certification system through the integration of digital certification and product transaction data, as well as

[41] This procedure is already used by forest communities or machine rings.

digital geographical data to combat fraud with organic products using the example of the grain chain using a mass balance system, has been achieved.

Due to the several decades of experience of the applicant and Dr. Padel as a scientist at the Thünen Institute with the system of control and certification in organic farming, nationally and internationally, the project managers were aware of significant gaps in the EU control and certification system already at the beginning of the project. This awareness has led to the development of the mass balancing software Check Organic at Organic Services. Participation in other projects such as the EU FoodIntegrity Project and ESA feasibility studies have also contributed to this.

In particular, the implementation of work packages 1 to 3 has further carved out the gaps in the system. These are clearly identified in the project, as well as concrete solutions for the closing of these gaps and the further development of the control and certification system. These solutions and recommendations are aimed at policy makers, authorities, control and certification organisations and science.

The following further questions were worked out:

- The calculation of mass balances across different organic regulations, taking into account equivalence schemes, presents specific, also financial challenges to the programming of the software;
- The automation of different Shape File formats when uploaded to the GIS for correct display on selected layers;
- Interfaces with third-party systems e.g., certification management systems, and the willingness of these providers to develop and set up the interface on their side;
- Automation (possibly by using third-party software) of taxonomy harmonisations;
- The development of satellite-based yield assessment algorithms;
- The detection of fields neighbouring organic fields and the potential contamination risk for organic fields, including through time-retrospective analysis in the case of contamination.

8 Summary

The overall objective of the project is to develop an actionable approach to improving control and anti-fraud for organic products using the example of the grain chain. To this end, significant gaps in the current control and certification system were identified, evaluated and concrete measures were proposed to close them.

One of the main weaknesses of the organic control and certification system is the lack of mandatory digital collection of all relevant data (location and size, culture, yield, sales volumes) that would allow product transactions to be linked from the field along the entire product chain. A distinction must be made between traceability of certification and product transaction data. The digital availability of data and the possibility of interconnection play a crucial role in this.

With the project presented here to improve the organic control and certification system, in particular by integrating certification and product transaction data with a geographical information system, the project partners present recommendations for the various actors in politics, administration, control bodies, etc. for the further development of the control system:

Entry and execution of operational mass balances and along product chains

A growing number of consumers are willing to pay a higher price for organic products. The price difference entails the risk of fraud. This entails an obligation for all parties involved to ensure the integrity of organic products. Mass balances of product flows along the supply chain are a simple and reliable tool for preventing and combating fraud. For this purpose, digital areas, culture and quantity data as well as transaction data of the traded products are required.

Driving digital collection of data for organic control and data infrastructure

The promotion of a digital control and certification infrastructure has many advantages, such as contributing to the fight against fraud through greater transparency in value chains, streamlining the bureaucracy and improving data exchange in the organic control and certification system. For this purpose, existing digital data can be used.

Improvement of yield data collection of organic farms

Yield data on organic farming are not systematically collected and are therefore incomplete. It is true that control bodies collect yields from their certified farms. However, this information is only available internally and usually not digitally. As a result, data are usually not available in a timely manner to use it for yield projections and market estimates. The project recommends concrete steps that would significantly improve the data availability of organic yields and allow a realistic estimate of the expected harvest volumes.

Contribution of remote sensing

In general, remote sensing can also contribute to improving the data base in organic farming by providing repeated and independently comprehensive information on the state, use and change of the agricultural landscape across large areas and by closing existing time gaps in existing data.

Introduction of a digital system for control data and mass balancing

The mandatory introduction of a digital system for the collection and presentation of control data (GIS) and a mass accounting system in order to digitally develop the control and certification system, to prevent fraud with organic products and to promote market transparency.

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10 Project publications

The presentation of the project took place especially at the world's leading trade fair for organic products, the BIOFACH (February 2021 Online Congress, July 2022 Congress in Nuremberg, February 2023 Congress in Nuremberg).

Gerald A. Herrmann is a member of the Steering Committee of IFOAM Organic Europe's Interest Group on Organic Certification & Integrity (IGOC). At the internal and public meetings, the contents of the DIGICHECK project were regularly introduced into discussion with the target group, the control and certification organisations, but also with other companies.

The project is described on the websites of Organic Services and Check Organic.

Further presentations, discussions and written exchanges took place with the target groups, e.g. USDA, DG Agri, DG Santé, control bodies and certifiers, etc.

In parallel to the duration of the DIGICHECK project, Organic Services was involved in two ESA feasibility studies, in which the experience of the project was taken into account, but also additional insights could be gained for the successful implementation of DIGICHECK, provided that these were not subject to data protection.

Organic Services' participation in two innovation platforms Space2Agriculture and IoT4Food has led to an exchange with third parties; the Thünen Institute is also a member of Space2Agriculture.

In its own interest, Organic Services will pursue the further development of Check Organic with the aim of implementing and introducing the prototype of GIS integration developed in DIGICHECK. An application for funding from the DIP Agrar programme was submitted on 15.8.2023. Regardless of possible funding, the results obtained can be used for the further work of Organic Services. Therefore, Organic Services will continue to disseminate these results as part of its public relations work.