Development and validation of a method for assessing the sustainability of farms: IDEA4, its tools and uses

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Abstract

The ACTION project validated the use of the IDEA4 method (Farm Sustainability Indicators 4th version) with three major outcomes: i) its versatility for use in a variety of contexts (education, research, agricultural advice, support, public action) and in a majority of farming systems (crops, livestock, orchards, viticulture, and market gardening); ii) its functionality, underpinned by three freely accessible tools (Excel calculator, IDEATools and the WEB-IDEA platform); and iii) the establishment of a broad collaborative community of around 300 IDEA4 users (advisers, teachers, researchers and farmers) who have conducted more than 800 farm diagnoses using IDEA4. In the field of education, this method's dual sustainability approach (consisting of three dimensions and five properties of sustainability) enhances its pedagogical performance. In the area of research, IDEA4 contributes to the expansion of knowledge on the sustainability of transitions. The forthcoming WEB-IDEA 2.0 platform will pave the way for national open data sets on the sustainability of French agriculture.

Keywords: IDEA4, Sustainable agriculture, Farm sustainability indicators, Farm diagnosis, Sustainable farm, Properties of sustainability, Decision Support Tool for Strategic Management, WEB-IDEA platform, IDEATools

Introduction

The conventional agricultural model has demonstrated its limitations in terms of sustainability. Its yields have remained relatively stagnant since the 1990s (Schauberger *et al.*, 2018) and it generates insufficient incomes for many farmers (De Fournas and Le Peih, 2022). This raises the social question of its sustainability, given the arduousness of certain production conditions and the low attractiveness of this form of agriculture for younger generations (Forget *et al.*, 2019). Furthermore, it is responsible for a multitude of adverse impacts on the natural environment (water, air, soil, etc.), on human health (due to pesticide use in particular) and on biodiversity. Its unrestrained consumption of resources fundamental to its functioning (phosphorus, energy, mineral nitrogen, water) raises concerns about its medium-term sustainability (Guyomard *et al*., 2017). In addition, climate change and the challenges of adapting to it (RAC, 2014; Claveirole, 2016) are prompting many farmers to pursue agroecological transition initiatives which find support at the national or regional level (MAAF, 2013; MTES, 2020). In order to meet the individual and collective challenges of transitioning farming systems towards greater sustainability, it is essential for farmers, agricultural development stakeholders and various regulators to have access to assessment methods that can identify the levers of change on farms. It is similarly incumbent upon educators to adopt transparent teaching methods to help them and their students examine sustainability from a systems perspective. The provision of diagnostic methods has been identified at the national level in France as one of the generic levers of the agroecological transition in the form of a future platform of strategic decision-support tools in line with the conclusions of the national consultation on the pact and the 2023 law on the orientation and future of agriculture (Mauguin *et al.*, 2023).

This article presents some of the results of the ACTION project[1], with a view to illustrating the utility of the IDEA4 method (*Indicateurs de Durabilité des Exploitations Agricoles, version 4* [Farm Sustainability Indicators, 4th version], Zahm *et al.*, 2023) as a tool for diagnosing the sustainability of a farm. It shows how this method can be used for a variety of purposes in support of the agroecological transition (agricultural support and advice, public action, teaching, research). The first section provides a concise overview of the objectives of the ACTION project. The second section presents the conceptual framework of IDEA4 and the computerised tools developed to meet different needs. The third section presents the various applications of IDEA4, as evidenced by the findings of the ACTION project. The final section considers the prospective evolution of the WEB-IDEA 2.0 platform and analyses how the method is being used in other countries.

1. The ACTION project

1.1 Objectives and structure of the project

The ACTION project (2017-2022) has allowed the the following **four objectives** to be achieved: i) the finalisation of the scientific development of IDEA4; ii) the testing of IDEA4's capacity to facilitate changes in the agroecological transition; iii) the development of its computerised tools; and iv) the provision of

[1]ACTION: Support (***A**ccompagnement* in French) for **C**hange towards agroecological **T**ransit**ION** for the overall performance of farms (project supported by the CASDAR fund).

dedicated resources to support the various uses of IDEA4 (advice, teaching, public action, research). In terms of methodology, the project has been structured into four distinct actions (Figure 1).

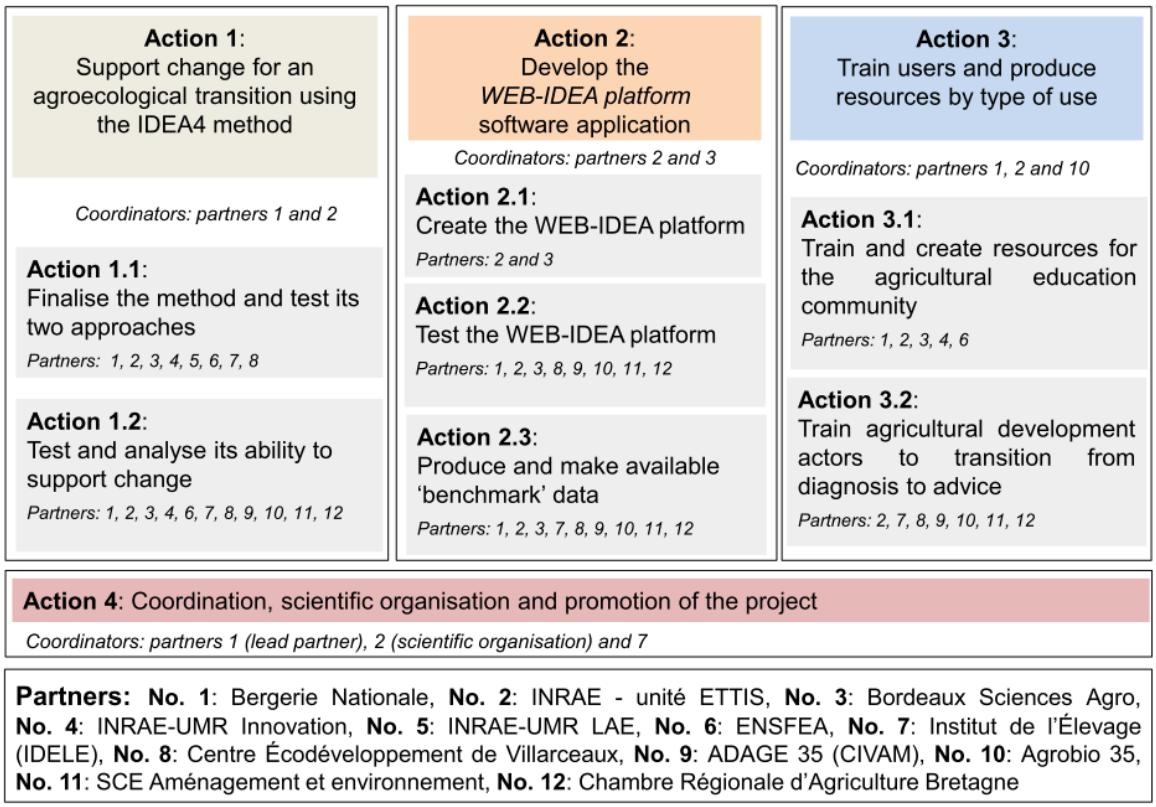

Figure 1: Structure of the ACTION project and contribution of the 12 partners.

This work has been carried out by 12 partners, whose activities span the various uses of IDEA4 (agricultural education, support and advice, local public action, research). At the same time, the IDEA Scientific Committee has been responsible for the scientific development of IDEA4. Validation and use tests of the IDEA4 method were conducted between 2017 and 2023 by a collaborative community of nearly 300 users, whose diversity of uses enabled the range of tests and feedback to be diversified over time (see assessment of uses in section 3.1).

1.2 Main resources produced to facilitate the utilisation of IDEA4

The results of the ACTION project include a set of deliverables that can be directly utilised by users, including:

- Two articles that present the theoretical framework of the IDEA4 method and which include an illustrative example of sustainability diagnosis (Zahm *et al*., 2019a and b);
- A free downloadable book (https://www.edued.fr/LS/IDEAV4) that details the IDEA4 conceptual framework, its 53 indicators with their calculation methods and recommendations for the method's use (Zahm *et al*., 2023);
- Five user guides available for download, including two dedicated to teaching (Cohen *et al*., 2023; Viel *et al*., 2023), one to agricultural advice (Angot *et al*, 2022), one to collecting farm economic data (Girard *et al*., 2023a) and one to the use of the WEB-IDEA platform (Saillard *et al*., 2023);
- Three computerised tools for calculating and publishing results (see section 2.2);
- A website dedicated to the method, giving access to the project deliverables (see https://methode-idea.org/).

2. The IDEA4 method: conceptual framework and IT tools

IDEA4 is a method for conducting a sustainability diagnosis of a farm. It uses two complementary evaluation approaches, utilising the same set of 53 indicators, derived from a theoretical framework, which is outlined in the following section. It is one of a range of strategic decision-support tools designed to 'support transition advice that focuses on the farmer's overall decision' (Gagneur and Thiery, 2018). The development of the method was based on a comprehensive evaluation of the uses of its three preceding versions (Rousselet, 2011) and on the consideration of the variety of purposes associated with the diversity of its users. The method:

- Provides knowledge and insight on the level of sustainability of farms;
- Enables and facilitates teaching and training in the assessment of sustainability in agriculture;
- Provides tools for individual or collective advice and support to farmers as they reflect on their production systems;
- Enables contribution to the implementation, monitoring and assessment of public initiatives to encourage changes in farming practices or systems.

2.1 The conceptual framework

The general conceptual framework of IDEA4, which brings together its theoretical foundation and operational framework, serves as the foundational structure for the selection of the 53 indicators and the two evaluation approaches. A schematic representation of the framework is shown in Figure 2.

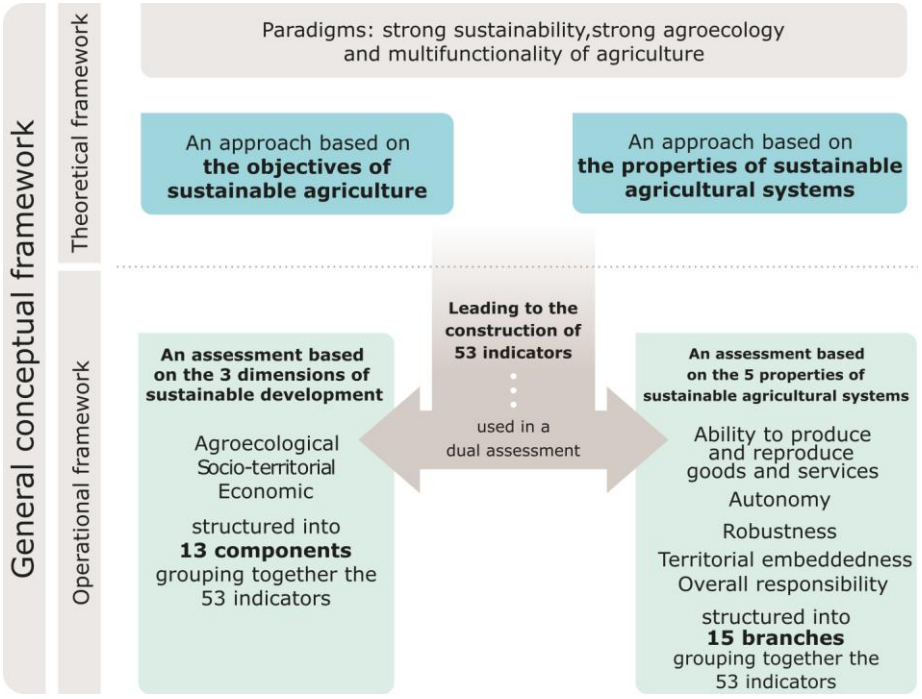

Figure 2: Conceptual framework of the IDEA4 method and its two evaluation approaches (Zahm *et al.*, 2023).

The constituent principles of the IDEA4 conceptual framework can be summarised around the following 4 points (Zahm *et al*., 2023):

1. A theoretical foundation that incorporates three trends: strong sustainability, strong agroecology, and the multifunctionality of agriculture.

2. A theoretical framework based on **two** complementary **interpretations** of sustainability:

- A first reading structured around 12 societal objectives to which a sustainable farm contributes to meet the challenges of sustainable agriculture. These objectives form part of the normative trend[2] of sustainable development and are broken down into three dimensions (agroecological, socio-territorial, economic);
- A second reading characterised by five emerging properties of sustainable agricultural systems: the ability to produce and reproduce goods and services; autonomy; robustness; territorial embeddedness; and overall responsibility.

3. A set of 53 indicators with calculation methods adapted to the context and diversity of agriculture in mainland France, and more widely in Europe.

4. An operational framework structured around **two complementary evaluation approaches** for reporting on sustainability:

- The first approach assesses farm sustainability according to **the three dimensions of sustainable agriculture,** by aggregating the 53 indicators into a structure divided into 13 thematic components. The assessment is based on the assignment of a score to each indicator and the aggregation of these scores using a capped-sum process. The final sustainability score is determined by the lowest score of the three dimensions (in reference to strong sustainability);
- The second approach is used to analyse this sustainability **according to the five properties of sustainable agricultural systems.** This involves the structuring of the 53 indicators into 15 main branches (known as 'level 1' branches) (see Figure 3). The aggregation process employs DEXi software (Bohanec and Rajkovic, 1999) to assign a performance class (unfavourable, favourable, etc.) to the indicators and subsequently to the various branches up to the property level.

[2] The normative vision of sustainable development is characterised by its capacity to achieve a set of societal objectives such as the Sustainable Development Goals (SDGs) defined by the UN.

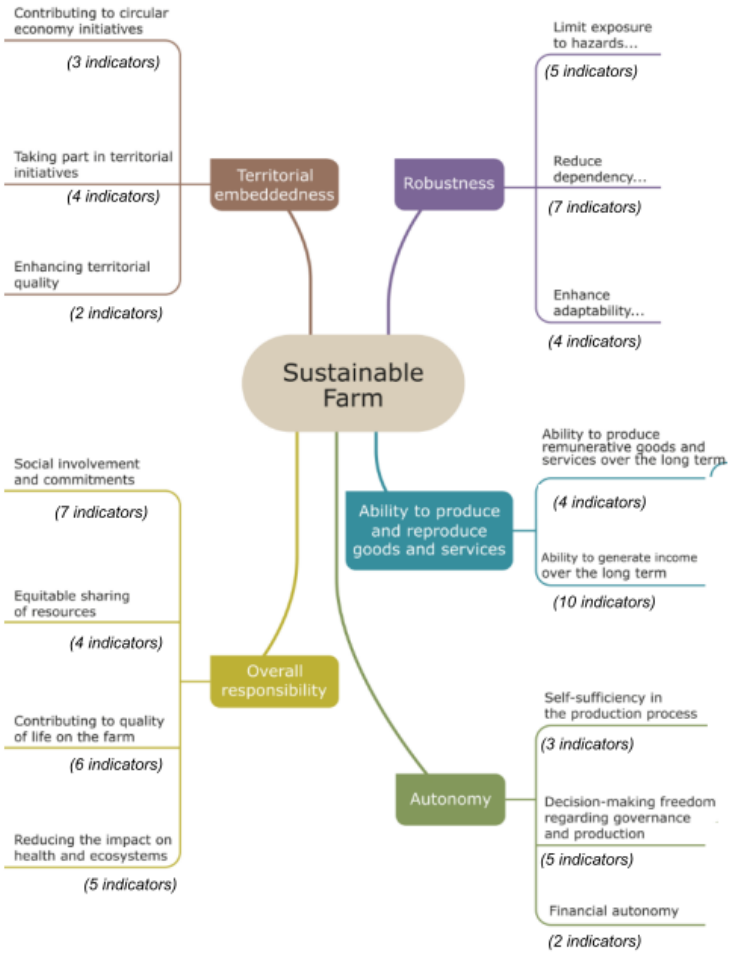

Figure 3: Heuristic map of the five properties of a sustainable farm, with its fifteen level-1 branches (Zahm *et al.*, 2023).

2.2 Three computerised tools for reporting results on different scales

Three free, transparent software tools are available for download from the official website of the method (https://methode-idea.org/). These tools are designed to operationalise the IDEA4 method in a variety of ways.

The **IDEA4 Excel calculator** (Girard *et al.*, 2022) allows the creation of a printable survey document, the recording and organising of farm data, the calculation of the 53 indicators, and the generation of the results of the dimensional approach (presented in simple tabular and graphical formats). It also generates a file (.json format), which can be used to transfer indicator results to the WEB-IDEA platform.

The **R IDEATools package** (Carayon, 2022) serves as the calculation and editing engine for the various automated analyses offered by the WEB-IDEA platform.

The **WEB-IDEA platform** (https://web-idea.inrae.fr/) serves to store the results of the Excel calculators and offers a range of distinctive functions for processing the data (results of the properties approach, group analysis, benchmark data).

The WEB-IDEA platform offers two principal types of functionality and associated results depending on the scale of analysis required. In the case of a single farm or a group of farms surveyed by the same organisation (e.g., a GIEE, Economic and Environmental Interest Group), WEB-IDEA can be used to publish individual results from both approaches (dimensions and properties) in the form of tables and graphs, as well as basic statistical analyses (mean, median, boxplot, etc.) of the group's results. At a broader scale, the WEB-IDEA platform generates benchmark data for both approaches, representing the

mean values for a set of farms selected based on specific filters (e.g., type of farming, utilised agricultural area, etc.). These data are published in a manner that respects the anonymity of individual data points. These benchmark data serve two principal functions. First, they allow for the positioning of the results of a given farm and thus facilitating the identification of potential avenues for improvement. Second, the data provide an overall picture of the sustainability of a group of farms. The results are automatically returned in three formats for ease of use: PDF for printing, DOCX for writing a report, and XSLX for reprocessing results as required.

As an example, Figure 4 depicts the benchmark data derived from the method with the use of the filters 'OTEX = Viticulture' and 'Département = Gironde' in order to obtain the sustainability data for the 55 winegrowers surveyed in Gironde department, whose calculators were imported into the platform between 2017 and 2023.

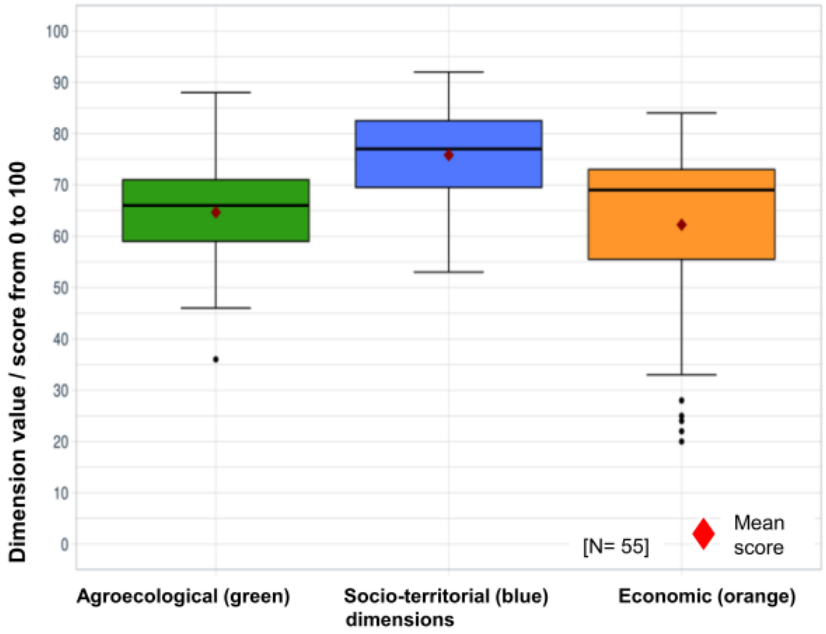

Figure 4.1: Assessment using the dimensions approach. *(Scores are calculated in sustainability units on a scale from 0 to 100.)*

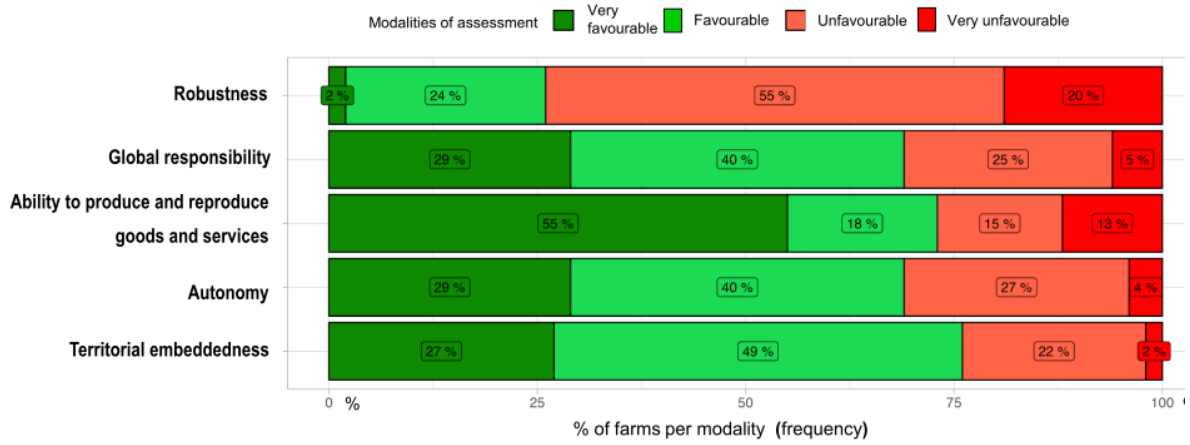

Figure 4.2: Assessment using the properties approach.

Figures 4.1 and **4.2:** Illustration of automated outputs, for the dimensions approach (4.1) and the properties approach (4.2), generated by the WEB-IDEA platform for 55 winegrowers (Gironde department, France).

Figure 4.1 shows that the socio-territorial dimension is, on average, the highest (76/100), followed by the economic dimension (69/100). In contrast, the agroecological sustainability dimension is the lowest (65/100). Figure 4.2 shows that 29% of these 55 winegrowing farms have been rated as having a very favourable level of autonomy, while only 2% are rated very favourably for robustness. To explain these scores, the user has to conduct a more detailed analysis of the results obtained from the various indicators.

3. Uses of the IDEA4 method

3.1 Review of six years of testing in various applications

The IDEA4 tests were based on its usage by a collaborative community of 288 users, constituted by 12 ACTION project partners and 276 other entities and individuals who expressed a desire to use IDEA4 in their activities. This community includes professional bodies from the domains of agricultural advice, territorial public action, research, and teaching. In total, the tests, carried out over a six-year period (2018 to 2023) yielded the results of 802 diagnoses carried out by the various users. The breakdown of these results is presented in Table 1. Two points warrant particular attention: the significance of using IDEA4 in the field of education, with 150 partner establishments (comprising 119 secondary education and 31 higher education institutions), and its prominent role in research (22 organisations, including 12 INRAE units). While agricultural development structures, private advisers and chambers of agriculture represent relatively minor proportions of users (7%, 6% and 4% respectively), they have nevertheless demonstrated a greater propensity to utilise the method, carrying out multiple diagnoses. Farmers who carry out their own diagnoses and upstream and downstream organisations (cooperatives, etc.) represent a third group of users who have employed the method to a lesser extent.

Table 1: List of partnerships and number of diagnoses carried out by type of user from 2018 to 2023.

Type of user (or organisation)	Number of users		Number of IDEA4 diagnoses carried out	
Secondary and higher education institutions	150	52%	277	35%
Research establishments	22	8%	120	15%
Agricultural development associations	21	7%	142	18%
Farmers for their own farms	21	7%	13	2%
Private users offering advice	17	6%	56	7%
Chambers of Agriculture	11	4%	78	10%
Local authorities and public administrative bodies	11	4%	96	12%
Upstream and downstream economic organisations	11	4%	19	2%
Civil society actors	4	1%	1	0%
Organisations offering economic and management advice	7	2%	0	0%
State and local authorities	6	2%	0	0%
ONVAR (FNCUMA, FADEAR, FNAB, etc.)*	3	1%	0	0%
Agricultural technical institutes	4	1%	0	0%
TOTAL	**288**	**100%**	**802**	**100%**

* ONVAR: National Agricultural and Rural Organisation; FNCUMA: National Federation of Agricultural Machinery Cooperatives; FADEAR: Federation of Associations for the Development of Agricultural and Rural Employment; FNAB: National Federation of Organic Agriculture.

The tests show that the time required to survey each farm varies between two and a half hours and four hours, depending on the diversity of the farm's production, the availability of and access to certain technical or accounting documents, and the experience of the interviewer.
A typology of uses was constructed in order to facilitate the understanding of the different uses of the method. This typology is based on the users' responses to a multiple-choice questionnaire, which they fill in when they sign the General Terms and Conditions of Use (GTCU) or upon initial login to the platform. Table 2 shows that 55% of the members of the collaborative user community utilise the platform for educational purposes. They are followed by those who utilise the platform to support the agroecological transition (including GIEEs and 30000 groups[3]) (22% of users), research projects (21%) and local development projects (such as PATs[4], watershed managements, etc.) (8%). The number of the diagnoses carried out during the implementation or monitoring of public action programmes, such as the PAEC[5] and Payments for Environmental Services, is notable, given the very low number of actors involved.

Table 2: List of partnerships and diagnoses by type of use from 2017 to 2022.*

Typology of uses	Number of users		Number of diagnoses	
Teaching	157	55%	320	40%
Supporting voluntary agroecological transition initiatives	63	22%	170	21%
Research	61	21%	366	46%
Supporting the implementation of local development projects	23	8%	73	9%
Reporting on the conformance with regulatory or other requirements	11	4%	49	6%
Supporting the implementation or monitoring of public action programmes	9	3%	169	21%
Supporting a Corporate Social Responsibility (CSR) process approach	8	3%	22	3%
Other types of uses	1	0%	0	0%
Total	**288**	**116%**	**802**	**146%**

**This multiple-choice declarative typology allows double counting (sum greater than 100% of users).*

These tests have become an essential part of the process of continuous improvement and validation due to the regular feedback provided by the users during the years of development of the method. Their results have informed the deliberations of the IDEA Scientific Committee and the ACTION project partners, leading to several modifications to the indicators and tools. Of the 543 feedback items collected on the indicators, the majority pertained to queries regarding the manner in which the indicators were calculated (56%) and to general difficulties in understanding them (27%). More than two-thirds (68%) of these comments led to modifications, the majority of which were implemented between 2018 and 2020. With regard to IDEA4's tools, and most notably the IDEA4 Excel calculator, the majority of the 676 feedback items collected concerned difficulties in understanding the tools' functioning (28%), issues in data collection (28%) and the calculation of descriptors (20%). Of the comments received, 61% were addressed and resolved before the conclusion of the project (2022). The remaining comments will be incorporated into subsequent versions of the calculator (Girard *et al*., 2023b).

3.2 In technical and higher education

[3] Groups of farmers who implement systems and practices that reduce reliance on plant protection products.
[4] Territorial food project.
[5] Agri-environmental and climate project.

In **agricultural technical education,** the IDEA4 method has been subjected to rigorous testing and development at different levels over a four-year period (2018-2022). On completion of these test phases, the participating teachers, who had been trained in the method, provided regular feedback to the IDEA Scientific Committee on their results and suggested future improvements. These tests resulted in the identification of four types of teaching configurations for the IDEA4 method (Figure 5), corresponding to different teaching situations, based on sequences and activities using IDEA4 with learners, ranging from a vocational baccalaureate to vocational degree programmes.

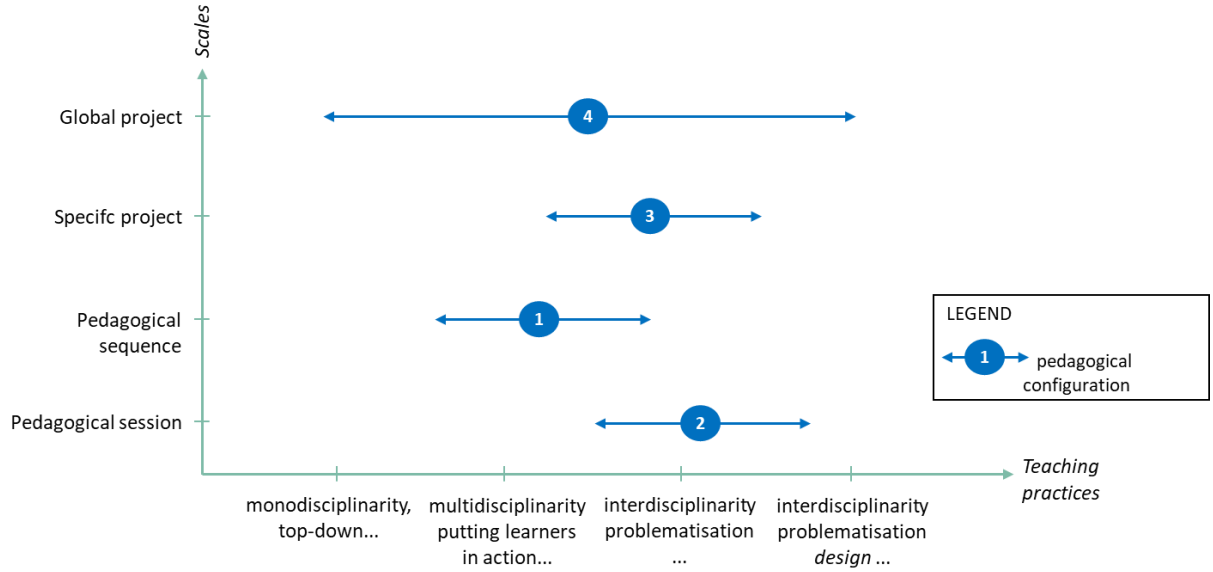

Figure 5: Diagram showing the four main teaching configurations for the IDEA4 method (Cohen *et al.,* 2023)

Depending on the educational institution and the level of training being imparted, the IDEA4 method has been integrated to varying degrees into the pedagogical ribbon[6] by teachers, in subject-specific or cross-curricular sequences. In certain instances, the method enables the examination of the concept of sustainability, illustrating how this concept can be subjected to scrutiny and assessment at the farm level. In other instances, IDEA4 serves as a framework for determining the sustainability of a farm, commissioned by a local professional. It offers a solution to the issue in question through a comprehensive diagnosis and the formulation of plan of change for the farmer. These configurations are determined according to two principal criteria: the scales of action and the teaching practices. These different teaching situations and testimonials are presented in a guide for the use of the method in a pedagogical context (Cohen *et al.*, 2023), which is available for download free of charge from the method's website.

Based on these results, a tool to assist in creating teaching sequences (depending on the time available to the teacher and the level of training of the learners) is currently being formalised. This tool is now being tested annually during IDEA4 method training sessions with teachers.

The IDEA4 method has been extensively used in the domain of **higher education** – with the exception of the Diploma of Advanced Technician, which is part of agricultural technical education. The majority of agricultural engineering schools have incorporated the method in at least one teaching module. These efforts were supported by several universities. Over the course of five years, between 2018 and April 2023, 49 training modules were used to teach approximately 1,150 students. This figure is an underestimate, as it only considers the training modules carried out with a member of the ACTION project.

[6] The term 'pedagogical ribbon' is used to describe the process of organising the content of teaching in a way that allows young people to progress in their learning so that they acquire the skills targeted by the training framework. This involves the consideration of the organisational and conceptual knowledge that the learners will need to gain (Cohen *et al.*, 2023).

Half of the students trained have a Bachelor's degree and the other half have a Master's degree (mainly Master 2). The majority of the former pursued theoretical modules, with a select number of practical exercises based on illustrative examples. The latter typically followed modules that entailed practical application of the method on one or more farms. Some of the modules used IDEA4 for the dual purpose of providing training in both theoretical and operational knowledge of farm sustainability assessment and critical analysis of multi-criteria assessment tools.

These numerous training courses have facilitated the consolidation of both the pedagogical efficacy of the method and the ergonomics of its tools. They illustrate the value to training courses of integrating the use of IDEA4 to examine sustainability into their teaching methods. The considerable number of students trained suggests that IDEA4 will be employed extensively in the coming years by future younger generations recruited by agricultural development organisations.

3.3 In support and agricultural advice

Work on supporting farmers and advisory activities has informed the development of a user guide for IDEA4 (Angot *et al*., 2022). The guide, available for download online, provides assistance to advisers engaged in a range of activities, including:

- Facilitating a re-evaluation of a farmer's overall strategy;
- Providing individual or group support (GIEE, thematic networks, etc.) to assist farmers in identifying unsustainable practices or activities;
- Providing assistance with the process of transfer of a farm to a potential purchaser;
- Contributing to local action programmes designed to change practices and report on the achievement of targets set by water agencies, local authorities, drinking water syndicates, etc.;
- Contributing to the design of new production systems (ex-ante or ex-post) or to broader issues such as the sustainability of food systems.

Furthermore, the guide provides recommendations for analysing the results of the diagnosis in accordance with the particular circumstances and production system in question: carrying out the analysis from the general to the specific, becoming familiar with the methods for calculating the indicators before making any recommendations, choosing the most educational approach (by dimensions or by properties) to provide advice, and contextualising the results according to local issues and the farmer's priorities.

3.4 In agri-environmental public action

The use of the IDEA4 method has been extensively inventoried between 2017 and 2023. One highlight that has emerged is its widespread use in agri-environmental public action (Table 2). This finding is in line with the historical trend towards the use of extra-financial diagnoses as a decision-making or societal reporting tool for companies, and more broadly, towards the integration of 'non-financial' indicators into public action systems to monitor and evaluate their results. This use is set to intensify, as the 2023-2027 Common Agricultural Policy (CAP) has made such diagnoses mandatory in the new Agri-Environmental and Climate Measures.

The IDEA4 method, with its scientific basis applicable to most agricultural production systems in mainland France, offers significant advantages for supporting agri-environmental public action. It is currently being used to assist individual farms as part of Agri-Environmental and Climate Projects, to steer groups of farms such as GIEEs or 30000 groups, and to facilitate the development of territorial initiatives such as PATs or catchment management projects. The case study in Box 1 is an example of how IDEA4 contributes to projects managed by local authorities to assist farmers in achieving enhanced sustainability in the context of local challenges.

Box 1: *Terre de sources*, a local public initiative using IDEA4 (Helle and Busnel, 2021; Helle, 2023).

Terres de sources is an ongoing project, initiated in 2015 by the local authority Eau du Bassin Rennais (EdBR), that facilitates access to drinking water for 72 communes and 580,000 inhabitants in the vicinity of the city of Rennes. This project, supported by the *Banque des territoires* as part of the *Territoires d'innovation* programme, has the objective of protecting and improving the drinking water resources of the Rennais basin by offering a public service contract to farmers located in the catchment areas of the water extraction points. These farmers can sell their agricultural produce at advantageous and stable prices (prices set by the farmers + a financial bonus provided by EdBR) (four-year contracts) to local authorities in the Rennes region if they undertake to avoid implementing practices deemed to be detrimental to water quality (for example, the use of certain pesticides and antibiotics) and, at the same time, commit to adopting a progressive approach aimed at improving the sustainability of their production methods.

This progress approach is built and subsequently evaluated on the basis of an overall assessment, obtained through an IDEA4 diagnosis, which is reconducted every four years. In addition, it is supplemented by a targeted analysis of 12 key indicators linked to water and soil protection with data partly derived from IDEA4.

In 2023, the *Terres de sources* project involved 88 farms. However, the objective is to expand to over 500 farms by 2030. To this end, the farmers are developing specialised marketing channels for traders, processors and end consumers, thereby creating new and profitable outlets. A number of regions in France and elsewhere in Europe have expressed interest in the *Terres de sources* project as a template for local agri-environmental public action for the development of local food systems that ensure water quality.

3.5 In research

The IDEA4 method is a widely used research tool in France and elsewhere (see section 4.2 for the international dimension). In 2023, the IDEA Scientific Committee conducted a survey and subsequently created a group of 22 researchers and teacher-researchers from 14 French research units with the objective of producing a cross-sectional and comparative analysis of the uses of IDEA4 in research. This group's finding is that the method is capable of fulfilling a number of different needs, which include being used: i) for comparing and/or complementing other evaluation methods; ii) as a conceptual and methodological framework for assessing sustainability in agriculture; iii) as a tool for collecting and structuring data; iv) as a catalogue of reference systems (indicators, threshold criteria, formulas and calculators); v) as a tool for constructing scenarios and forecasting changes in agricultural practices; and finally vi) as a support for discussions with farmers (co-design of systems, transition approaches, etc.). This research focused on the following 5 main themes and issues:

- Ecosystem services: Is it possible to assign an economic value to the production of environmental services at the farm level?
- Assessing the costs involved in preserving a farm's human and environmental capital: Can the combination of the IDEA4 method and the methodology derived from the C.A.R.E. framework[7] lead to integrated accounting that will enable farmers committed to sustainable agriculture to account for their financial efforts and to integrate their preservation costs with a view to getting a fair price for their produce?
- Water quality: Can the IDEA4 method be used to encourage changes in agricultural practices that lead to improved water quality?
- Interactions between farms: Do interactions between production systems help increase their sustainability?

[7] C.A.R.E: Comprehensive Accounting in Respect of Ecology.

- Marketing methods: What is the overall performance of farms using short and local distribution channels?
- System resilience: What are the factors that enhance the resilience of farms?

The analysis showed that the IDEA4 method is being employed since 2016 in several research projects[8], primarily as part of internships or theses. These projects are being conducted from a variety of epistemic postures (on a gradient from strict research to action research) and protocols (comparative studies of groups, studies of farm trajectories, co-design of systems, individual analyses, analyses of collectives and territories, etc.). The IDEA4 method is being used in various configurations: in its full implementation; with just one of the two approaches (properties or dimensions); partially (selection of a few indicators); and redesigned versions to meet specific objectives. These projects are shedding light on several aspects of the use of IDEA4 in a knowledge production approach. How can IDEA4 be used optimally in longitudinal studies to monitor the development of farms engaged in a 'design-implement-evaluate-readjust/redesign' progress loop? How can IDEA4 be employed to examine the transition to a regional scale or to study groups of farms (cooperatives, professional networks, etc.) with a view to assessing group sustainability? How can the WEB-IDEA platform be linked to other data sources, such as INOSYS[9] and ODR[10]?

All the researchers consulted expressed a keen interest in consolidating the WEB-IDEA collaborative platform in response to the need for comparable, accessible and free data. This benchmark data will provide researchers, and more broadly professionals and civil society, with key inputs and insights on sustainable agricultural systems and their performance. Furthermore, they will also help identify sustainability levers and margins for progress, orient advisory mechanisms, facilitate forecasting and contribute to the formulation and evaluation of public policies.

4. Prospects for international use

4.1 Prospects for the development of the national WEB-IDEA platform to support *open data* on sustainability with IDEA4

As a complement to the findings of the ACTION project, the conclusions of the POLIDEA project[11] corroborate the assertion that the WEB-IDEA platform is an indispensable tool for the diversity of uses of IDEA4, and that its development has to be supported. By positioning itself as the national open database offering benchmark values on sustainability, the platform forms the foundation of a collaborative approach involving professionals, educators, researchers and civil society. To this end, it is necessary to consolidate the current organisation of the WEB-IDEA platform in order to meet broader objectives. These include the provision of the most up-to-date benchmark values on the sustainability of the agricultural systems monitored with IDEA4, as well as the availability of sufficient data to study the determinants of sustainability, with the aim of supporting all the initiatives contributing to the agroecological transition. A two-pronged development strategy has therefore been devised: i) to consolidate the management of a large community of users so that they can discuss and identify new needs for automated processing depending on usage, and ii) to develop the platform into an 'enhanced' 2.0 version, collecting a wider catalogue of data to meet all analysis needs.

[8] For example: PSDR PerfeCTo (*PerformancE des Circuits courts et de proximité et TerritOires*); Domaine de Mirabeau (Installation of a collective of farmers on public land); ANR Be-Creative (Design of pesticide-free agro-ecosystems on a territorial scale); Coccinelle (*CO-Concevoir avec les CItoyens un Nouvel ELevage Laitier Ecologique de montagne*); and DairyMix (H2020 project Multi-criteria evaluation for sustainable circular mixed farming systems in dairy production).

[9] INOSYS: A system for generating technical and economic benchmarks at the farm level for ruminant livestock, arable crops and winegrowing. The benchmarks are produced by advisers of Chambers of Agriculture on farms that have been classified according to the INOSYS typology and monitored annually.

[10] ODR: The Rural Development Observatory is a resource centre on agricultural policies and systems (developed by INRAE), designed to assist those engaged in the monitoring and evaluation of public policies (rural development) and agricultural research.

[11] POLIDEA: *POlitiques publique et Indicateurs de Durabilité en Agriculture* or Policies and sustainable indicators (INRAE internal project supported by the *Direction de l'Appui aux Politiques Publiques* from 2021 to 2023).

4.2 Extending the analysis to IDEA's uses in other countries

The global analysis of the IDEA method's uses underscored the importance of its usage in other countries. This mainly pertains to version 3 of the method (Vilain *et al*., 2008), though a few users did indeed use version 4, which was still in the testing phase between 2015 and 2022. Our analysis was based on a literature review[12] that relied on three sources of information: i) publications, not always scientifically referenced, that were collected through a systematic bibliographic search, supplemented by documents compiled by the IDEA Scientific Committee over time (internal database); ii) current projects or publications incorporating IDEA of which the IDEA Scientific Committee was aware; and iii) information contained in the GTCU signed by international users wishing to use IDEA4. Thirty documents were analysed. The results demonstrate that the IDEA method is being used in many regions of the world outside mainland France: French overseas departments and territories (Reunion Island, New Caledonia), Europe (Italy, Spain, Greece, Sweden, Denmark, Romania, Switzerland), South America (Argentina, Brazil, Colombia), America (Mexico, United States of America, Canada) and Africa (Algeria, Benin, Burkina Faso, Cameroon, Morocco, Democratic Republic of Congo, Senegal, Tunisia). Most of the documents are scientific articles (two-thirds of which are in English), course reports and theses that refer to the use of IDEA3. Some of the documents include a brief mention of the method, while others compare it to other sustainability assessment methods, carry out group analyses as part of a sustainability analysis, or use it as a starting point for designing an original method. While the specific version of the method used is rarely mentioned, we can deduce from the indicators used that it is IDEA3. IDEA4 was tested and subsequently adapted in 2021 by the Universidad del Magdalena (Colombia) within the context of its property-based approach. In general, IDEA is employed in its entirety or in part (solely for the agroecological dimension, for example). In countries of the northern hemisphere, it is used more for comparing production systems (regardless of whether they are organic or not) or for developing new sustainability assessment methods. In contrast, in countries in the southern hemisphere, IDEA is usually adapted to suit the specific crops or research question under investigation. The indicators are modified based on expert opinion or as part of participatory research. While this analysis will require further development in the coming years to include additional uses of IDEA4, the findings thus far demonstrate the ability of IDEA's theoretical framework and its indicators to provide meaningful insights with the proviso that it be adapted to non-European agriculture.

Conclusion

The IDEA4 use tests conducted between 2017 and 2023 – more than 800 diagnoses were carried out by the collaborative community of users as part of the ACTION project – have validated the method in terms of its construction and its capacity to be used for its various purposes. The results show that IDEA4 has the potential to revolutionize sustainability education through its properties-based approach. The action-research approach developed in collaboration with users has validated the use of IDEA4 in a range of production situations (field crops, livestock, market gardening, orchards and viticulture), locations, marketing methods and support processes (individual or collective advice, agri-environmental measures, Economic and Environmental Interest Group, territorial action programmes, etc.). Finally, research studies on the use of IDEA4 have demonstrated that it is capable of generating new knowledge on the sustainability of transitions.

In conclusion, the ACTION project has yielded three major results: i) the finalisation of the development of IDEA4 with its three IT tools, ii) its validation based on a continuous improvement process conducted over six years of testing, and iii) the emergence of a large collaborative community of almost 300 users (as of 2023) who have tested its prototypes during its successive development phases. Today, IDEA4 occupies a unique place in the landscape of international sustainability assessment methods due to four

[12] Literature review carried out in French, English and Spanish on the following keywords: "IDEA + durab*", "IDEA + sustain*" and "IDEA + sosten*".

factors: i) the diversity of its uses; ii) its continuous process of scientific renewal (four versions released between 2000 and 2023); iii) the significant theoretical innovation represented by its dual assessment approach; and iv) its functional, transparent computerised tools, which are freely available. The forthcoming WEB-IDEA 2.0 platform will facilitate the development of open data on sustainability in collaboration with all users and civil society, with the objective of assisting farmers in making sustainable transitions.

Ethics

The authors declare that the experiments were carried out in compliance with the applicable national regulations.

Declaration on the availability of data and models

The data supporting the results presented in this article are available on request from the corresponding authors of the article.

Declaration on generative artificial intelligence and artificial intelligence-assisted technologies in the drafting process.

The authors used artificial intelligence as an initial step in the process to translate this document from French into English. The text was then revised and approved by a professional translator.

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Declaration of interest

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