HANDBOOK FOR THE EVALUATION OF AGROECOLOGY

A method to evaluate its effects and the conditions for its development

GTAE

GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

This document was produced with financial support from:

Editorial committee

This methodological handbook is the result of collaboration between the teams at:

– The Working group on agroecological transitions (GTAE), made up of Agrisud International, Agronomes et Vétérinaires Sans Frontières (AVSF), Cari and GRET,
– the Comparative agriculture and agricultural development teaching and research unit at AgroParisTech,
– the Agroecology and Sustainable intensification of annual crops (AÏDA) research unit at Cirad,
– the Functional ecology and biogeochemistry of soils and agro-systems (Eco&Sols) mixed research unit at IRD.

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The handbook was produced with financial support from Agence Française de Développement (AFD).

To quote this document

L. Levard, B. Mathieu, P. Masse (Coordination), Handbook for the evaluation of agroecology, A method to evaluate its effects and the conditions for its development, GTAE-AgroParisTech-CIRAD-IRD, March 2019.

The Working group on Agroecological Transitions - GTAE

Agrisud International, AVSF, Cari and GRET are 4 French NGOs for which agroecology constitutes a substantial portion of their professional action in terms of sustainable development. They support family farming, and defend and practice agroecology in different contexts to develop territories for rural populations. Together with their partners across the world, they have confirmed practical experience in various fields; they have published on the subject and are often invited to contribute to and involved in the national and international public debate on agroecological transition.
In January 2016, Agrisud, AVSF, Cari and GRET set up a working group focusing on "agroecological transitions", GTAE. The objective was – together with the world of Research and based on their own experiences in cooperation with their partners in developing countries, farmers' organisations and NGOs – to carry out work to validate the conditions for family farming's successful agroecological transition and evaluation of the effects and impact of agroecology to contribute, ultimately, to the desired change of scale. From these analysed experiences and their findings, the group speaks in a singular voice and has an advanced capacity for political dialogue, which it wants to conduct to strengthen existing collective advocacy led by French International Solidarity Organisations (ISOs) on agroecology nationally and internationally.

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INTRODUCTION

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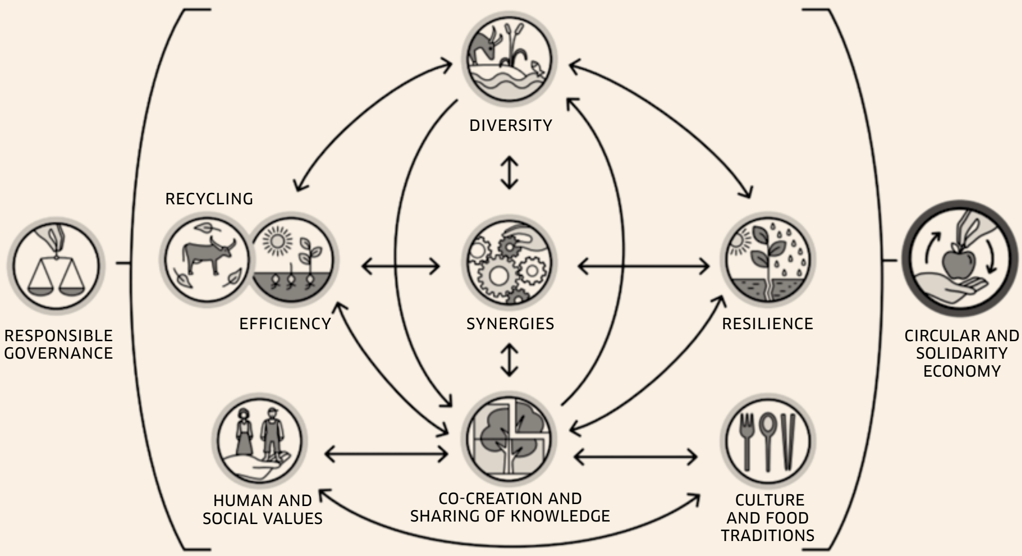
BACKGROUND AND OBJECTIVES OF THE HANDBOOK

Agroecology is increasingly evoked at the core of international discussions on the future of food and agricultural systems across the world, emerging as one of the pertinent responses to major global challenges in terms of economic & social development and the environment, largely reflected in the Sustainable Development Goals (SDGs): improvement of food and agricultural systems' performances, food and nutrition security, the environment, climate, employment, migration, and vulnerable rural populations' resilience and adaptation to climate change.

AGROECOLOGY AND ITS PRINCIPLES

Diagram n°1: The 10 elements of agroecology according to the FAO



Faced with the dual reality of agrarian systems in crisis and the limits and damage of the Green Revolution, agroecology responds to several fundamental principles. On the one hand, the principle of optimising ecosystems' full potential, in terms of harnessing abundant external resources and in terms of stimulating physical, chemical and biological processes and flows within the ecosystem. Application of this principle responds to objectives related to agricultural production in terms of quantity, regularity and quality (nutritional quality, food safety, taste), and also responds to an objective targeting autonomy. These objectives contribute in turn to development objectives such as food and nutrition security and generation of income. In addition, the principle of preservation, or even restoration of agro-systems responds to objectives targeting sustainability, generation of various benefits for the environment, adaptation to climate change and mitigation of the latter (*recycling, efficiency, diversity, synergies and resilience* in diagram n°1). Agroecology also responds to broader objectives in terms of responsible, inclusive and sustainable economic development (*responsible governance, circular and solidarity economy*). Lastly, agroecology includes social and cultural dimensions (social movement, societal project on autonomous family farming, reappropriation of traditional knowledge, farmer-consumer relationships) and dimensions relating to the transformation of food systems for sustainable modes of production and consumption (human and social values, co-creation and sharing of knowledge, culture and food traditions).

* *The 10 elements of agroecology, Guiding the transition to sustainable food and agricultural systems,* FAO, 2018

An increasing number of initiatives – by NGOs, farmers' & professional agricultural organisations, research centres, academic institutions, public companies or institutions – are now supporting transition processes via promotion and support of agroecological practices and systems. However, the majority of these stakeholders do not yet have tools to evaluate the effects of the development of agroecology. On the other hand, there is a certain degree of scepticism about the pertinence and feasibility of agroecology as a response to the issues mentioned. This reticence concerns the agronomic, socio-economic and environmental effects and impacts of agroecology, and it exists both in farming circles and decision-making circles. Some agroecological practices have existed since ancient times and on considerable scales. Numerous one-off studies and evaluations have been conducted in recent years, but these only cover a limited spectrum of agrosystems, territories and practices. They are sparse, partial, incomplete, and conducted using different methods and tools. There is still a lack of systematic references produced using a reliable common methodology, and this is a major handicap for decision-makers.

In this context, GTAE's member organisations – Agrisud International, AVSF, Cari and GRET – undertook the development of this handbook in partnership with AgroParisTech, Cirad and IRD: it is intended as a common methodological tool for the evaluation of agroecology and aims to be easily useable by development stakeholders, with possible support from research or training institutions, making it possible to:

- on the one hand, evaluate the agronomic, socio-economic and environmental effects of these practices and systems
- on the other hand, evaluate the conditions for development of agroecological practices and systems, i.e. favourable factors and obstacles for their development.

The objectives of this common methodology making it possible to obtain comparable evaluation results from various regions are:

- Evaluation by development stakeholders of the results and effects of their agroecology interventions, thanks to methods and indicators adapted to the objectives of these interventions.
- Creation of references on the economic, social and environmental performance of agroecology in order to have solid, objective arguments to convince donors and decision-makers, in particular public decision-makers, of the benefits of supporting and promoting agroecological practices and systems.
- Identification of conditions for the development of agroecology that could be considered in the design of public interventions and policies in favour of agroecology.

GTAE drew from its previous work, in particular re-using the method for evaluation of agroecological practices and systems implemented in 2017 in three West African regions (Burkina Faso, Senegal and Togo) in partnership with AgroParisTech and various universities and NGOs, with support from ECOWAS and AFD (CALAO[1] project), enriched and completed with nine other approaches and methods for the evaluation of agroecology implemented by other stakeholders, which were presented and discussed at a methodological workshop organised in Paris in December 2017, with support from AFD and FFEM[2].

This handbook is a first methodological document, which will be improved and adjusted based on findings when the tools and methods proposed are implemented in future evaluation work conducted by GTAE and its partners.

1. Levard L., Mathieu B., 2018 – *Agroécologie : capitalisation d'expériences en Afrique de l'Ouest. Facteurs favorables et limitants au développement de pratiques agroécologiques. Evaluation des effets socio-économiques et agro-environnementaux.* Document de capitalisation CALAO, ECOWAS-AFD. 80 pages.
2. GTAE, 2018. *Agroécologie : méthodes pour évaluer ses conditions de développement et ses effets. Actes de l'atelier d'échanges et construction méthodologique. 14-15 December 2017.*AFD/FFEM, 52 pages.

HOW TO USE THE HANDBOOK

This handbook is made up of different parts:

- A general introduction.
- A first part, on the general methodological principles, i.e.:
    - the principles and challenges of evaluation,
    - the different situations of use and the various evaluation objectives,
    - the effects and evaluation criteria proposed in this handbook. The criteria to evaluate in each case must be identified in advance based on the type of situation, the specific objectives of the evaluation and the means available,
    - the link between these criteria and the sustainable development objectives (SDGs).

– A second part presenting the two methodological approaches structuring evaluation, i.e. diagnostic analysis of agrarian systems and the monitoring and evaluation system.
– The third and fourth parts focus respectively on evaluation of the agro-environmental and socio-economic effects of agroecology. Each of these two parts is made up of fact-sheets corresponding to the different types of effects.
– The fifth part focuses on the evaluation of transversal criteria in the agro-environmental and socio-economic fields.
– The sixth part covers the evaluation of the conditions for development of agroecology (favourable and unfavourable factors).

READING THE FACTSHEETS ON EFFECTS

1. A table summarising criteria, sub-criteria and indicators making it possible to evaluate the type of effects the factsheet covers. For each criterion, the table also indicates the following:
   – a. the scale of evaluation: plot (P), SoP (set of plots), H (herd), farm (F), territory (T), value chain (VC);
   – b. an assessment of the technicity required for the collection and measurement of information and for analysis and valorisation of information, thanks to a colour code (green: moderate technicity, orange: high level of technicity, red: superior technicity);
   – c. specific material resources required to evaluate the criterion, thanks to a colour code (green: no material resources, orange: moderate quantity of resources, red: higher quantity of resources).

2. The contribution to the sustainable development objectives (SDG objectives and targets) the type of effects focused on in the factsheet.

3. The pertinence of the evaluation:
   – a. on the one hand, pertinence from the farmer's, the community's or (and) the public interest point of view (the national community, humanity);
   – b. on the other hand, a summary table making it possible, for each criterion, to assess whether evaluation is always necessary or only for some situations and in response to specific objectives justifying evaluation.

4. The approach and methodological tools for characterisation of a situation. An explanation is given on the meaning of each criterion (or sub-criterion) and indicator (or indicators) proposed, and then the evaluation method is described in detail. For various criteria and indicators, the methodology is not detailed. This is the case when they only seem pertinent for some situations and in response to specific objectives and when the method is complex and would be too long to present. In this case, documentary references are proposed.

5. A methodological complement in the case of evaluation in a monitoring and evaluation system.

6. Additional details are given if necessary on the levels of technicity and means required.

A text box entitled "Further reading" gives additional documentary references.

Prior reading and assimilation of the introduction and part 1 are an essential preliminary stage in the use of the handbook. Subsequently, according to the type of situation in which it is used and specific evaluation objectives, the user can use the handbook based on the indications given. Numerous cross references between parts and factsheets make it possible to globally apply the evaluation method proposed.

In practice, the handbook can be used in two possible situations:
– to characterise a situation, independently of an intervention, at the start of or at the end of an intervention,
– as part of an intervention's monitoring and evaluation system.

In the case of an **evaluation intending to characterise a situation**, the main methodological tool is diagnostic analysis of agrarian systems adapted to agroecology, presented in part 2. As part of this diagnostic analysis, a certain number of effects must or can be evaluated. In this case, different factsheets in parts 3 and 4 will be used. To evaluate the conditions for development of agroecology, part 6 will be used.

In the case of **evaluation conducted as part of a monitoring and evaluation system**, in part 2, the general methodology corresponding to this approach and the methodology for diagnostic analysis of agrarian systems will be used:

- at the start of an intervention, to define a baseline situation and possibly to guide the content and method of intervention,
- at the end of an intervention, in order to evaluate the effects of the implementation of agroecological practices and systems by some farms because of the intervention.

Using parts 3 and 4 will be useful to evaluate the effects, and part 6 to evaluate the conditions for development, whether at the beginning (baseline situation), during (monitoring and evaluation) or at the end of an intervention (final evaluation).

LINKS WITH OTHER METHODS FOR EVALUATION OF AGROECOLOGY

An increasing number of scientists, academics and development stakeholders are interested in the evaluation of agroecology; they are developing, testing and seeking to implement evaluation methods[3] in order to reduce all types of uncertainty in terms of knowledge on agroecology. However, centres of interest, specific objectives and methodological principles can differ from one method to another. This handbook draws on the various methodological tools that exist, with a view to enabling evaluation both of effects and conditions for the development of agroecology, and making it possible to look at various types of effects, in the agro-environmental and socio-economic fields. However, it does not claim to be exhaustive:

- on the one hand, for a single evaluation objective, it was necessary to choose methods. We prioritised methods:
  - based on indepth analysis of the reality via purposive sampling of plots or farms rather than on statistically representative samples,
  - that can be implemented relatively easily and in a relatively short time,
  - coherent with each other, in particular that can be used in a more global methodological framework for diagnostic analysis of agrarian systems and monitoring and evaluation systems.
- on the other hand, we do not cover, or only mention, the evaluation of certain effects and impacts when this evaluation corresponds to more specific objectives or seems too complex to implement.

3. See in particular proceedings of the workshop for exchange and methodological construction to evaluate the effects of and conditions for the development of agroecology, organised by GTAE on 14 and 15 December 2017.

The FAO's programme for the development and implementation of a method to evaluate agroecology merits special mention. This programme was initiated in 2018, when GTAE had already made significant progress with its own methodological development initiative. Apart from the fact that GTAE participates in the FAO's work, in particular in the technical group, it also makes the results of its own work available to the FAO. Furthermore, GTAE and its scientific partners sought to include, as far as possible, the methodological proposals developed as part of joint work with the FAO. This means that an evaluation conducted on the basis of this handbook can also contribute to work on construction of references coordinated by the FAO. Generally speaking, almost all of the FAO method's criteria and indicators for evaluation of effects are common to the method proposed in this handbook, as indicated in the table below. For certain criteria, our approach differs slightly. Neither do we include the FAO's objective in terms of characterisation of agroecological practices, aimed at assessing the extent to which different production systems respond to the criteria of agroecology. There is nothing to prevent adding to the method proposed, to include the FAO's additional criteria and the characterisation of systems.

INCLUSION OF THE FAO'S EVALUATION CRITERIA IN THE HANDBOOK[4]

INDICATEURS FAO				MÉMENTO
Dimension	**Criterion**	**#**	**Essential performance indicators**	**Factsheets**
Environment and climate change	Soil health	1	Soil organic matter	Soil health
		1b	Soil health	
	Biodiversité	2	Agro biodiversity	Soil health, Effectiveness of pest and disease regulation
Health and nutrition	Food and nutrition security	3	Dietary diversity	Food and nutrition security
		3b	Experience of food insecurity (Food Insecurity Experience Scale -FIES)	
	Health	4	Exposure to pesticides	
Culture and society	Gender and equity	5	Empowerment of women	Empowerment of women
	Decent employment, migration and well-being	6	Opportunity of employment for young people	Partially included in Appeal of agriculture for young people
Economy	Income	7	Net income	Estimate and evaluation of performance
		7b	Stability of income	
	Inequality	8	Spread of income	
		9	Productivity	Yields (direct measurement and according to stakeholders)
		9b	Stability of productivity	
Governance	Access to land	10	Land tenure security (or mobility for pastoralism)	Considered as a condition for development and not as an effect

4. Adapted from *Global Analytical framework for the multidimensional assessment of agroecology and guidelines for application*, FAO, 2019.

The method proposed in this handbook also makes it possible to add to, and further develop, the FAO's method for various aspects and also to include: i) evaluation of the conditions for development of agroecology, ii) specificities of an evaluation as part of a monitoring and evaluation system.

I. GENERAL METHODOLOGICAL PRINCIPLES

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PRINCIPLES AND CHALLENGES OF EVALUATION

1 COMPARATIVE METHOD

Evaluation of the effects of agroecological practices and systems is based on comparison between farms (or plots/herds) where certain agroecological practices and systems are, and "reference" farms (or plots/herds) where these practices and systems are not implemented ("control group").

– In the case of **evaluation of practices and systems independently of an intervention**, the method is based on the tool for diagnostic analysis of agrarian systems which draws on this comparative approach (Cf. *Diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology*).

– In the case of **evaluation of practices and systems promoted by a project** (or programme, or policy), the objective is to compare, at the end of (or during) a project, the trajectory of farms having implemented these practices and systems with the trajectory of farms that were similar at the outset but that did not benefit from the project. It is not sufficient to simply compare the situation of beneficiary farms "after a project", with the same farms "before a project", because some changes made between these two periods may not be attributable to the project, but to other factors (climate, economic and institutional environment, agricultural policies). Basing an evaluation on a simple comparison of beneficiary farms "before" and "after a project" would therefore create a bias in the evaluation (see diagrams n°2 and n°3). When a monitoring and evaluation system relating to a project (or policy or programme) is implemented, it is possible, upstream of the intervention, to identify a comparable group of farms which supposedly will not be beneficiaries of the project and which will serve as a reference group for the evaluation at the end of the intervention. If there is no monitoring and evaluation system, the reference group must be defined carefully, there is a risk of choosing farms that were not identical at the start to the project beneficiary farms as a reference group. This would create another type of bias (see diagram n°4).

With regards evaluation of conditions for the development of agroecological practices and systems, it is also largely based on the comparative method, using the approach consisting of diagnostic analysis of agrarian systems (Cf. *Evaluating the conditions for development of agroecology as part of a one-off evaluation*).

Diagram n°2: Simplified representation of the differential to be measured between the situation resulting from the implementation of the project and that which would have prevailed without the project (with – without project differential)

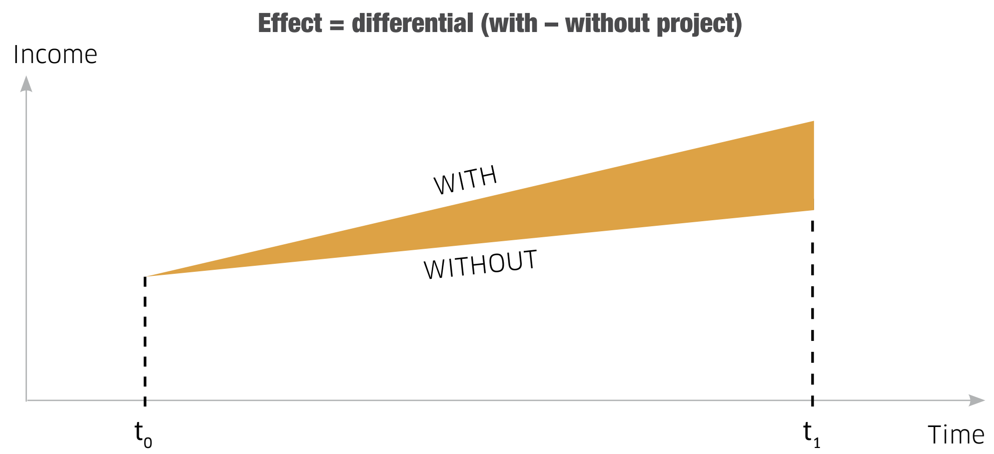


Diagram n°3: The mistake to avoid: using the baseline situation as a "reference" situation

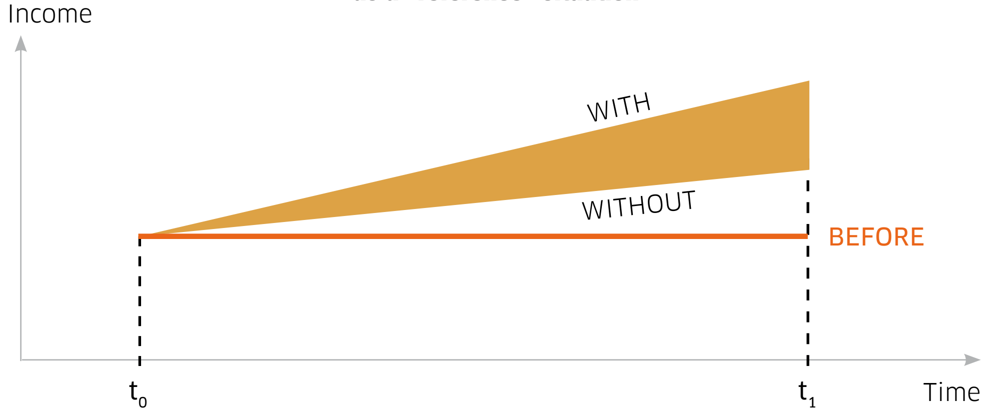
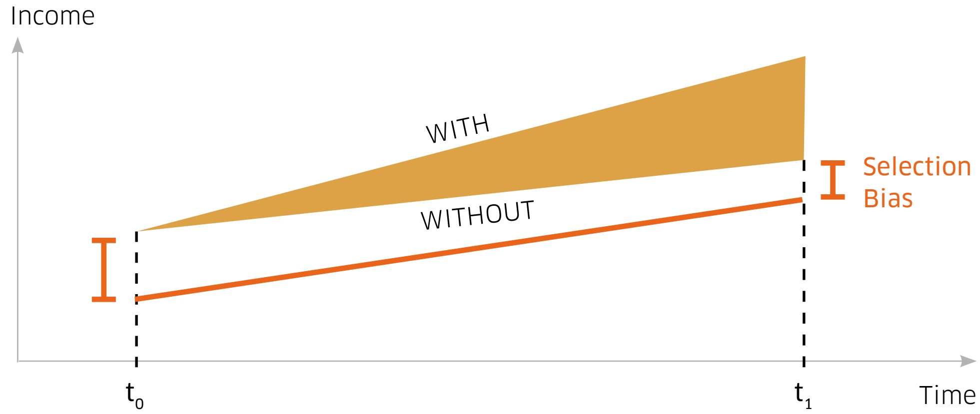


Diagram n°4: The importance of comparing what is comparable: avoid a selection bias in the choice of comparison group



2 AN APPROACH IN TERMS OF SYSTEM WITH DIFFERENT SCALES OF ANALYSIS

We talk about agroecological "practices and systems" because a practice is generally not isolated and accompanied by other changes either at field, herd, or farm level; or at territorial or regional level. These scales of analysis must therefore be taken into account. To do this, the evaluation uses concepts making it possible to understand the links between the various elements of the reality at these different scales, i.e.:

- the cropping system and livestock system on the scale of the plot (or group of plots) and on the scale of the herd,
- the agricultural production system on the scale of the farm,
- the agrarian system on the scale of the small agricultural region.

The effects of agroecological practices and systems are of interest to different types of stakeholders: producers, farming families, livestock production families using communal grazing land, the entire population in a local community, the entire national community, or even all of humanity, for example, with regards effects in terms of contribution to mitigation of climate change.

Furthermore, each type of effect is generally measured at a given scale, the scale at which the measurement has meaning: for example, soil fertility is measured at plot level and agricultural income is usually measured at family level. Measurement of some effects may however be conducted at several scales. For example, food and nutrition security can be evaluated at farming family level or more globally at regional population level. The result of the evaluation in this case may depend on the scale considered. For example, an agroecological practice based on transfers of organic matter between farms could be beneficial for the fertility of plots in farms receiving the organic matter and negative for the fertility of plots transferring the organic matter. For plots from the first type of farm, the conclusion will point to a positive effect, while the overall effect for the territory can be neutral (with beneficiaries and people who lose out).

3 A PARTICIPATIVE APPROACH

The evaluation proposed is based on an approach that is participative in several regards:

– the evaluation work must start by presenting the approach to the various stakeholders involved (farmers' organisations, NGOs, public authorities, research stakeholders) and must make it possible to collect and consider their questions and expectations, and to coordinate the approach with existing evaluation systems and monitoring & evaluation systems,

– the individual interviews with the different types of stakeholders, in particular with farmers, make it possible not only to collect information from interlocutors, but also to ask for their opinion and share issues and questions identified with them,

– farmers must also be fully involved in monitoring and evaluation systems at plot or herd level. This requires indepth prior discussions for mutual understanding of technical management of plots or herds by the farmers and of the indicators one is seeking to compile. This subsequently facilitates collection of information, which can, at least partially, be conducted by the farmers,

– the evaluations' provisional conclusions are presented to the stakeholders concerned, in particular the farmers, at collective sessions, for debate, possible revision, completion and validation. Farmers directly involved in monitoring and evaluation systems can be asked to present evaluation results themselves,

– as part of a project monitoring and evaluation system (or policy, or programme), the conclusions can also be used as a basis to involve stakeholders concerned in reflection and proposals on content (in particular the agroecological practices and systems promoted) and the project's methods of intervention,

– the approach must also aim to strengthen stakeholders' evaluation capacities: an initial stakeholders' meeting; participation in certain phases; provisional conclusions and report that must include a point on methodology; any training.

4 EVALUATION OF AGROECOLOGICAL PRACTICES AND SYSTEMS AND EVALUATION OF AN INTERVENTION

Evaluation of agroecological practices and systems must be differentiated from evaluation of an intervention (project, programme or policy):

– evaluation of agroecological practices and systems can be conducted independently of any intervention,

– classic evaluation of an intervention includes various other aspects (pertinence, effectiveness of actions not specifically related to agroecology, efficiency of use of budget, sustainability of organisational and institutional systems implemented, etc.).

However, evaluation of agroecological practices and systems promoted as part of an intervention such as a project or policy contributes to evaluation of the latter:

– in so far as one of the intervention's objectives is the promotion of agroecological practices and systems, evaluation of the effects of these practices and systems contributes to evaluation of the effects of the intervention itself,

– analysis of conditions for the development of agroecological practices and systems promoted by the project contributes to analysis of the intervention's effects, i.e. to explaining the extent of its pertinence, efficiency and sustainability.

SITUATIONS OF USE AND EVALUATION OBJECTIVES

Evaluation of agroecology can, on the one hand, be conducted in different situations of use and, on the other hand, target different types of general objectives. Evaluation criteria (and indicators) depend on the general and specific objectives of the evaluation.

1 THE DIFFERENT TYPES OF SITUATIONS FOR WHICH EVALUATION IS USED

Evaluation of agroecology (practices and systems) can be conducted in one of two possible situations of use:

– "Characterisation of a situation" (whether independently of, during or after an intervention). There can be certain specificities if this characterisation takes place after an intervention.

– Evaluation of agroecology through a monitoring and evaluation system related to an intervention and including the construction of a baseline situation. In this case, the baseline situation (the situation that would have prevailed if the project had not taken place) is characterised. This characterisation can be compared with that of the situation resulting from the implementation of the intervention (Cf. Diagram n°2). It is necessary to have the means to monitor the intervention's results over time, including with more indepth elements to support it and any specific mechanisms enabling measurements beyond what was reported by farmers.

2 THE GENERAL OBJECTIVES OF THE EVALUATION

Evaluation of agroecology can meet several types of general objectives:

– Create references on the conditions for development and sustainability of agroecology (favourable or unfavourable factors) and on its agro-environmental, economic and social performances. These references are useful for better assessment of the benefits of agroecology and for ensuring its promotion,

– Enable development stakeholders to better design their interventions (projects, programmes, policies) in favour of agroecology (particularly with regards identification of agroecological practices and systems to be promoted, and systems to be implemented with a view to supporting, advising and working with farmers), whether this be upstream of an intervention, to implement corrective or incentivising measures in an operation underway (adjustments to the intervention system) or with a view to future interventions,

– Enable farmers to better analyse and evaluate the results of their practices and thereby provide them with help on decision-making for possible technical and economic changes that would be more or less strategic.

We can observe that:

– several types of objectives can be pursued in a given situation of use,

– a single objective can be targeted in different types of situations.

EVALUATION CRITERIA PROPOSED

Different criteria for evaluation of agroecology can be used according to the specific objectives of the evaluation:

– On the one hand, favourable or unfavourable factors enabling assessment of the conditions for development and sustainability of agroecological practices and systems. By development of agroecology, we mean:

• innovation and testing of practices and systems (testing of new or already existing and old practices and systems having already demonstrated their effectiveness in other contexts) by farmers,

• their sustainable implementation on part of the farm,
• their extension to other parts of the farm,
• their extension to other farmers.

Sustainability corresponds to continuation of their implementation in the medium and long term, in particular after the existence of interventions by external agents with a view to their promotion.

– On the other hand, the performance of practices and systems, which includes:
  • Socio-economic performance, i.e. the effects in social and economic terms,
  • Agro-environmental performance, i.e. the effects in terms of the productive potential of the farm's agro-ecosystem, and the other environmental effects on key elements of ecosystems (effects on soil, water, cultivated and natural biodiversity, landscapes).

Performance criteria can be pertinent at several levels: from the farm's point of view (agricultural production system, the family and men and women in the family), the community and a territory broader than the farm, the national community or on a much larger scale (regions, humanity as a whole).

A single evaluation criterion can sometimes be subdivided into sub-criteria. Each criterion or sub-criterion has one or several corresponding indicators, for which data is provided based on variables measured, calculated, evaluated according to feedback from stakeholders or qualitatively assessed.

The handbook does not include an evaluation of human health as such. Several criteria evaluated do however have an impact on health: food and nutrition security criteria, economic evaluation from the farmer's point of view (better income contributes to better healthcare possibilities), and arduousness of work.

A more comprehensive evaluation of effects and impacts in terms of human health would involve evaluation relative to the presence of chemical residues (fertilisers, pesticides) in the environment, the effects of the use of certain pesticides on workers' health, the presence of residues on food products and products' nutritional quality.

PERFORMANCE CRITERIA

	EFFECTS	CRITERIA
Agro-environmental evaluation	Direct measurement of yield and of yield regularity	Yield for crop production
		Regularity of agricultural yield
		Livestock production yield
	Soil health	Retention of physical properties
		Decomposition of organic matter
		Recycling of nutrients
		Retention of soil biodiversity
	Mitigation of greenhouse gas emissions through soil carbon sequestration	Carbon storage by the farm
	Efficiency of the use of water resources and nutrients	Efficiency of the use of water
		Efficiency of the use of nitrogen
	Effectiveness of pest and disease regulation	Effectiveness of the fight against pest and disease
		Retention of biodiversity
		Farmers' capacities

	EFFECTS	CRITERIA
Socio-economic evaluation	Agricultural yields according to stakeholders	Average agricultural yield
		Average zootechnical yield
		Regularity of yields
		Dynamic of yield over time (evolutionary trend)
	Economic performance from the farmer's point of view	Economic performance of cropping systems
		Economic performance of livestock production systems
		Profitability of cropping and livestock production systems
		Economic performance of the agricultural production system
		Generation and evaluation of family agricultural income
		Profitability of capital
		Graphic representation and interpretation of agricultural income
		Regularity of agricultural income
	Economic performance from the overall national interest point of view	Added value, including the upstream and the downstream of agricultural production
	Appeal of agriculture for young people	Economic sustainability
		Liveability on the farm
		Security
	Value chains and Trade organisations	Outlets for farmers
		Development and functioning of value chains
		Creation of wealth and employment
	Autonomy	Decision-making autonomy
		Economic and financial autonomy
		Technical autonomy
	Empowerment of women	"Technical" empowerment: access to and control of productive resources by women
		Economic empowerment: management capacity and economic power
		Social empowerment
	Employment and well-being	Creation/retention of employment
		Use of the workforce during the year
		Remuneration of work
		Arduousness of work
	Food and nutrition security	Food supplies
		Accessibility
		Use (food consumption and nutrient intakes)
		Stability
		Other elements influencing nutrition security

LINKS BETWEEN EVALUATION CRITERIA AND THE SDGs

Having come into force in 2016, the United Nations 2030 Agenda for "S*ustainable development – Transforming our World"* put the 17 Sustainable Development Goals (SDGs) on the international community's agenda. This set of universal goals was drawn up with a view to rising to the urgent ecological, social, political and economic challenges facing the world.

Diagram n°5: The Sustainable Development Goals

Source: https://www.undp.org/content/undp/en/home/sustainable-development-goals.html

According to the UN, agricultural production and food systems mainly promoted until now no longer make it possible to eradicate hunger and poverty, nor to face the challenges of depletion of natural resources, environmental degradation, biodiversity loss, and the need to adapt to climate change. It is widely recognised that to achieve these goals, it is urgent that change of these systems be promoted. Increasingly numerous voices, including that of Olivier De Schutter, former United Nations Special Rapporteur on the Right to food, are stating that agroecology is an appropriate method capable of guiding the transformations required in agrifood systems. As concluded by the FAO at a recent symposium[5], "*Agroecology is seen by many to offer multiple benefits, including for increasing food security and resilience, boosting livelihoods and local economies, diversifying food production and diets, promoting health and nutrition, safeguarding natural resources, biodiversity and ecosystem functions, improving soil fertility and soil health, adapting to and mitigating climate change, contributing to women's empowerment, and preserving local cultures and traditional knowledge systems, often in synergy with organic agriculture. Agroecology scaling up is recognized and proposed by many as a way forward in the coming decade as a strategic approach and means to promote and achieve the 2030 Agenda for Sustainable Development*".

By simultaneously achieving economic, social, environmental and political objectives, agroecological transition trajectories contribute to achieving the SDGs.

The criteria for evaluating the effects of agroecology proposed in this handbook contribute to achieving at least 10 of the 17 sustainable development goals proposed. The following table illustrates the link between the evaluation criteria proposed and the SDGs.

5. 2nd *International symposium on agroecology: Scaling up agroecology to achieve the SDGs – FAO, April 2018, Rome.*

EVALUATION CRITERION	1 Eradicate extreme poverty and hunger	2 Eradicate hunger, ensure food security, improve nutrition and promote sustainable agriculture	3 Ensure healthy lives and promote the well-being of all at all ages	4 Ensure access for all to quality, equitable education and promote learning possibilities...	5 Achieve gender equality and empower all women and girls	6 Ensure access for all to water and sanitation and ensure sustainable management of water resources	8 Promote inclusive and sustainable economic growth, full productive employment	9 Build resilient infrastructure, promote sustainable industrialisation for the benefit of all and foster innovation	12 Establish sustainable consumption and production patterns	13 Take urgent action to combat climate change and its impacts	15 Conserve and restore terrestrial ecosystems, ensuring they are used sustainably
Direct measurement of yield and of yield regularity	■	■									
Evaluation of soil health		■							■	■	■
Mitigation of GHG emissions										■	■
Efficiency of use of water resources and nutrients		■				■					
Effectiveness of pest and disease regulation	■	■									
Agricultural yields according to stakeholders	■	■									
Economic Performance from the farmer's point of view	■	■									
Performance from the overall national interest point of view							■				
Appeal of agriculture for young people							■				
Value chains and Trade Organisations		■					■	■			
Autonomy							■				
Empowerment of women	■	■		■	■	■	■				
Employment and well-being							■				
Food and nutrition security		■									

II. THE TWO METHODOLOGICAL APPROACHES STRUCTURING THE EVALUATION

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DIAGNOSTIC ANALYSIS OF AGRARIAN SYSTEMS: A TOOL ADAPTED TO EVALUATION OF AGROECOLOGY

1 DIAGNOSTIC ANALYSIS OF AGRARIAN SYSTEMS: THE OVERALL APPROACH

Diagnostic analysis of an agrarian system makes it possible, for a given region:

- to identify and analyse the **various land use systems***, and,
- to explain **factors influencing the choice** of these land use systems by economic stakeholders, i.e. mainly farmers,
- to measure a certain number of **agro-environmental and socio-economic performances and the overall dynamic** corresponding to these various land use systems and the various types of farmers,
- to identify the main **problems** specific to the various types of farmers and, more globally, concerning social and economic development, and the ecological situation and dynamic in the region considered.

Land use systems are studied at several levels:

- for plots or sets of plots, conducted homogenously, using the **cropping system concept**, and for herds or livestock production, conducted homogenously, using the **livestock production system concept**,
- for the entire farm, using the **agricultural production system concept**,
- for the entire territory, using the **agrarian system concept**.

To understand and analyse diversity at territory level, diagnostic analysis of an agrarian system aims to identify farm types, starting with an initial phase based on agro-socio-economic zoning of the territory and historic surveys. Each type of farm is characterised in particular by:

- access to local resources: various types of land/soil, water, biodiversity,
- the **constitutive elements of the farm:** family composition, own productive resources (land and means of production),
- social relationships determining its access to resources, public services and support where available, markets, alternative employment and income opportunities,
- its **fundamental objectives** (increase of agricultural income, food security, less harsh working conditions, etc…),
- a certain combination of cropping systems and livestock systems (the agricultural production system).

Two hypotheses underly the fact that we can in this way identify **types of farms** defined simultaneously by these various characteristics:

- on the one hand, the hypothesis that the farmer's **fundamental objectives**[6] are largely determined by his/her farm's **historic trajectory** and by his/her **interactions with the socio-economic environment,**
- on the other hand, the hypothesis that the **actual land use system** is largely determined by the **agro-environmental setting, the constitutive elements of the farm, interactions with the socio-economic environment and its objectives.**

Each type of farm also has a corresponding:

- common **historic trajectory**. Reconstruction of farms' history provides a tool for understanding changes over time (in particular links between evolution of the constitutive elements of the farm, of the socio-economic environment and of the land use system),

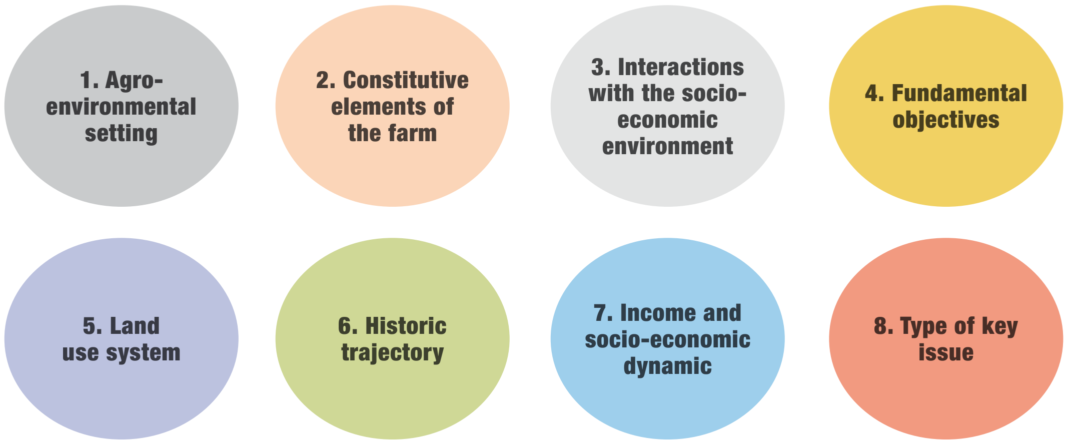
* The term "land use system" corresponds to the French concept of "*mode d'exploitation du milieu*". This concept includes the choice of land uses, which can be called "land use pattern", and all of the agricultural techniques used to valorise the productive potential of the ecosystem.

6. For example, the priority given to an increase in income per hectare or to work productivity, whether or not food self-sufficiency is sought, greater or lesser importance given to risk limitation, and whether or not the objective of maintaining and improving the ecosystem cultivated is integrated.

– level of agro-environmental and socio-economic performance, in particular income. Income determines the capacity to improve the family's standard of living and invest in the agrosystem and operating capital, and therefore, ultimately, the farm's economic, social and ecological dynamic (development, stagnation or crisis),
– a key issue, i.e. a set of factors limiting possibilities for the farmer and the family to reach their objectives and, more generally, limiting development of the farm.

These various interrelated parameters of the farm are illustrated in figure n°6.

Figure n°6: The various parameters characterising farm types



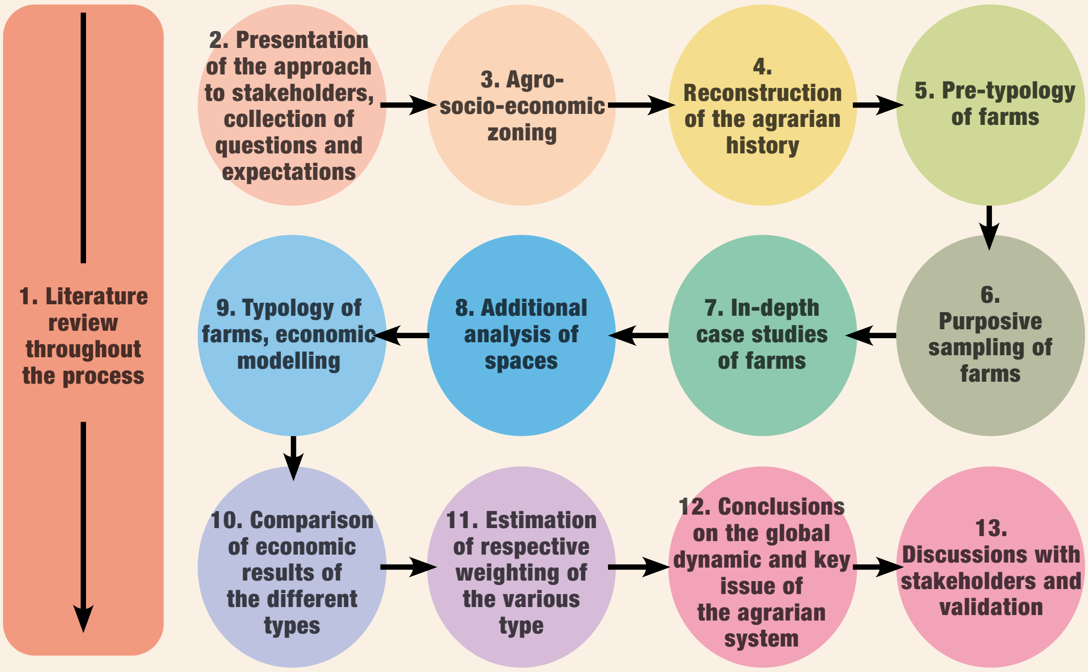
Identification and analysis of the various farm types provide a tool for designing interventions in favour of development that can be adapted to each type in order to ensure their pertinence and improve their effectiveness, their efficiency and sustainability of effects.

Let us specify that a methodological principle in diagnostic analysis of an agrarian system is the systematic attention given to differences between farms, relating to the various parameters of typology, and the search for an explanation of these differences. This is why diagnostic analysis falls within the comparative agriculture approach.

2 THE DIFFERENT STAGES IN DIAGNOSTIC ANALYSIS OF AN AGRARIAN SYSTEM

The different stages in (see figure n°7) are presented below. Although there is a logical succession of stages, the approach must not be interpreted as a strictly linear one. At each stage, specific questions may arise and justify returning to a previous stage in order to specify certain points and develop new hypotheses. For example, during in-depth case studies on farms, practices calling for specification of changes that occurred during the agrarian history may be identified. Such back-and-forths between the various stages are frequent.

Figure n°7: The different stages in diagnostic analysis of an agrarian system



1. Literature review of the territory studied throughout the process.

2. Presentation of the approach to stakeholders, collection of their questions and specific expectations, consideration of existing evaluation and monitoring-evaluation systems.

3. Agro-socio-economic zoning (identification of homogenous landscape units and formulation of hypotheses on links between the various units, their historic and current agricultural uses), based on a reading of the landscape (geomorphology, vegetation, human presence and infrastructures) and on the use of aerial photos and maps.

4. Reconstruction of the agrarian history (land use systems, socio-economic environment, process for differentiating farms) and assessment of the current situation in the territory, based on interviews with resource persons (older farmers, people with a good knowledge of the region and its history).

5. Development of a pre-typology of farms (types and any sub-types) based on understanding of the various trajectories of evolution.

6. Selection of a purposive sample of farms. Good understanding of the way farms operate and reliable calculation of their economic performances requires in-depth case studies that take time (two to three meetings lasting two to three hours for each farm). The sample is therefore necessarily small (30 to 40 farms). In order to ensure that the different types and sub-types of farms are effectively studied, this sample must be purposive. On average, four to six farms are studied for each type. Farms are chosen mainly on the basis of discussions with resource persons previously met with.

7. In-depth case studies of farms, based on semi-open interviews/discussions with farmers, in particular during visits to the farm's plots. Specific interviews with women and young people make it possible to better assess their specific situation within the farm.

8. Additional analysis, where applicable, of the use, management and dynamic of common spaces.

9. Development of the typology, including modelling of each type (archetype) and calculation of its economic performances according to surface area per worker.

10. Comparison of economic results of the different types.

11. Approximative estimation of the relative weighting of the different types using statistical data and interviews with people possessing good knowledge of the territory.

12. Development of conclusions on the global dynamic of the agrarian system and the main problems encountered.

13. Discussion and validation of results through their presentation and a discussion with stakeholders in the territory, which can lead to specifying or changing certain aspects of the typology.

3 USING THE AGRARIAN SYSTEM DIAGNOSTIC ANALYSIS GLOBAL APPROACH TO RESPOND TO QUESTIONS ON AGROECOLOGY

Two elements justify use of the agrarian system diagnostic analysis global approach to respond to questions on agroecology:

Firstly, agroecological practices are above all agricultural practices. They are particular because they adhere to a certain number of principles relating to agroecology. Similarly, crop and livestock farming, and production and agrarian systems can, according to their characteristics, adhere in varying degrees to the principles of agroecology. Agroecological practices and systems therefore correspond to **particular land use systems** among other ways of use. Diagnostic analysis of an agrarian system makes it possible to identify and analyse these more specifically in the context of a more global identification and analysis of land use systems. In particular, it makes it possible to explain farmers' reasons for choosing these practices and systems, and, through the comparative agriculture approach, to explain the fact that other farmers do not put these in place. In other words, the agrarian system diagnostic analysis process makes it possible, in part, to respond to the question of which **factors favour or, on the contrary, limit** the development of agroecological practices and systems – whether these factors are related to the constitutive elements of the farm, its relations with the socio-economic environment or its fundamental objectives.

Secondly, diagnostic analysis of an agrarian system includes evaluation of the socio-economic results of the various land use systems (crop and livestock farming, and production systems). The process therefore enables **comparison of economic performances between the different land use systems, adhering at various levels to the principles of agroecology.** It also makes it possible, according to these various land use systems, to compare the dynamic in terms of farms' development, and impacts on **households' employment and food and nutrition security.** Lastly, it enables comparison of certain **performances or agro-environmental effects** of the various land use systems.

4 ACCURATELY STUDYING PRACTICES AND SYSTEMS USED IN AGROECOLOGY, EVEN WHEN THEY ARE NOT VERY VISIBLE AND/OR NOT WIDESPREAD

Particular attention should be given to agroecological practices and systems. This particular attention is justified by the fact that, in some regions, agroecological practices and systems may only have minority, marginal or non-structural status.

Some agroecological practices and systems can be promoted by organisations (research or advisory organisations, NGOs, producers' organisations) and may only be implemented by a **small number of farms** and, on these farms, only i**n part of the surface area cultivated.** Farmers may consider these **simply as experiments** that will only be more broadly, definitively included in their production system (with possible adaptations) when farmers are convinced of the benefits involved. Implementation of crop practices and systems may sometimes even correspond to opportunistic behaviour by farmers, when the organisation promoting these practices and systems offers advantages (subsidies, loans, access to services) in return. In any event, the existence of these crop practices and systems does not necessarily change the overall land use system.

A diagnostic analysis of an agrarian system aims to identify farm types and, for each type, to describe the most representative land use system and of operation for that type, which requires not taking account of all specific situations within a given type. A classic diagnostic analysis is very likely to **overlook these specific farms** implementing new practices, often on a small scale, quite informally and not necessarily definitively.

Furthermore, farmers who implement these crop practices and systems are **not necessarily all working on the same type of farm.**

Figure n° 8 summarises the **various specific methodological elements** that must be included in the overall process for diagnostic analysis of an agrarian system.

Figure n°8: Summary of specific methodological elements that must be included in the different stages of the agrarian system diagnostic analysis process, with a view to answering specific questions on agroecology

1. Literature review	Particular attention to alleged agroecological practices and to external interventions (promotion of agroecological practices) > initial inventory of these practices and interventions
2. Presentation of the process to stakeholders, collection of questions and expectations	Particular attention to questions and expectations concerning evaluation of agroecological practices and systems
3. Agro-socio-economic zoning	Particular attention to patterns of use of the environment supposed to be agroecological (trees, crop/livestock integration, crop diversity, soil protection work...) > considered in zoning
4. Reconstruction of agrarian history	Particular attention to dynamics of innovation, development, regression and disappearance of agroecological practices. Specific interviews with representatives from organisations promoting agroecological practices
5. Pre-typology of farms	Identification of farm types characterised by the existence of practices or systems. Within a single type, identification of farms implementing agroecological practices or cropping systems and possible grouping in sub-types
6. Purposive sampling of farms	Selection, within a given type, of farms based on "agroecological specificities" (experimentation, implementation or abandonment of agroecological practices, support from an organisation)
7. In-depth case studies of farms	Particular attention to agroecological practices and systems: reasons for their presence or absence, conditions of development, effects and impacts, conditions for sustainability, farmers' assessment of them. Collection of farmers' own analysis of differences observed between their farm and that of other farmers

8. Additional analysis of common spaces	Particular attention to the implementation of agroecological practices
9. Typology of farms, Economic modelling	Characterisation and modelling of production system types that are agro-ecological or adhere in varying degrees to agroecological principles. Within a given type, modelling of "variants" corresponding to the implementation of agroecological practices or systems
10. Comparison of economic results of the different types	Evaluation of the economic effects of agroecological practices or systems by comparison between types or between "variants" of a single type. Qualitative assessment of the effects on variability of yields and income and of impacts on employment, and on food and nutrition security
11. Estimation of respective weighting of the various types	Estimation of weight of types and sub-types implementing agroecological practices and systems
12. Conclusions on the global dynamic and key issue of the agrarian system	Summary of practices and systems, and classification in light of the principles of agroecology. Conclusions on the dynamic of ecosystems and on the dynamic of agroecological practices and systems. Conclusions on factors favouring and limiting the development of agroecology
13. Discussions with stakeholders and validation	Presentation and debate with stakeholders on results relating to questions specific to agroecology, validation of conclusions

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

DESIGN AND IMPLEMENTATION OF AN APPROPRIATE MONITORING AND EVALUATION SYSTEM TO EVALUATE AGROECOLOGY

The monitoring and evaluation system tool is not only used to evaluate agroecology, it is also used for intervention coordination and serve as a decision-making tool for development stakeholders, political deciders and farms themselves. For monitoring and evaluation of the effects of and conditions for development of agroecology, the system focuses on three main areas: key factors in development of agroecology (obstacles and levers), socio-economic results and effects, and agro-environmental results and effects. It must integrate the fact that evolutions in agroecological systems and practices on farms are linked to evolutions in the economic, environmental and sociocultural context of these farms.

1 THE OBJECTIVE OF A SYSTEM FOR MONITORING AND EVALUATION OF AGROECOLOGY

The objective is to monitor evolutions in results and effects produced by the implementation of agroecological systems and practices for farms and their context, in light of a baseline situation. More specifically, the objective is to:

- Monitor and measure farms' performances
  - Support family farms' and professional organisations' acquisition and mastery of knowledge and practices.
  - Measure technical and economic results and effects of practices on farms' performances.
- Characterise evolutions in the environment
  - Economic, agro-environmental and social.
  - Adaptation of the farm to evolutions in the environment to maintain or improve its performances (resilience).
- Analyse differentiated levels of appropriation of agroecological systems and practices, their results and their effects in relation to the environment's (changing) characteristics.
- Make decisions
  - Intervention level: redefinition/adaptation of the intervention actions.
  - Farmer and professional organisation level: technical and economic advice on integration of agroecological practices, advice on farms' management and strategic orientations.
  - Value chain and market level (traders, processors…): dynamic development of value chains and improvement of performances upstream/downstream of production.
  - At the level of stakeholders in the territory (deciders, decentralised technical services…): orientation of global strategies for development of sustainable agricultural systems.

It should be noted that:

- A monitoring and evaluation system can very quickly become complex and particular attention will be paid to effective simplicity rather than counter-productive complexity.
- Too much information is equal to no information and it is preferable to prioritise the quality of information rather than its quantity.

– **Monitoring and evaluation** are not just the responsibility of the monitoring and evaluation manager. It is **a team responsibility.**
– Monitoring and evaluation of the effects of and conditions for the development of agroecology does **not mean monitoring and evaluating the intervention itself.**
– Monitoring and evaluation of the effects of and conditions for the development of agroecology focuses on practices promoted as part of the intervention, but is not limited to these.

2 STAGES IN THE DESIGN AND IMPLEMENTATION OF A SYSTEM FOR MONITORING AND EVALUATION OF AGROECOLOGY

The monitoring and evaluation system is a participative mechanism focused on involvement of the project stakeholders via a co-learning process. The mechanism includes a detailed diagnosis and evaluation of the initial situation (characterisation/baseline situation) and the final situation (comparative evaluation) and of a monitoring phase integrating collection, processing and analysis of qualitative and quantitative information, and of the key stages of presentation and validation by all the stakeholders. The mechanism is implemented at the start of the intervention or of a new phase of intervention. In so far as possible, the same team should implement the intervention and the monitoring and evaluation system, integrating a person dedicated to monitoring and evaluation in order to facilitate actions linked with analysis and advice.

The table below presents the different stages in the design and implementation of the system for monitoring and evaluation of agroecology.

DESIGN		
STAGES	**OBJECTIVES**	**METHODOLOGICAL POINTS**
Draw up the baseline situation	Characterisation of the environment around the farms and of the farms themselves The monitoring and evaluation system makes it possible to have a dual situation of comparison avoiding the risk of attributing all changes in context to the intervention: - Comparison between farms' situations: measures (and explains) differences in results between model farms (not benefitting from the intervention) and farms having implemented (fully or partially) agroecological practices[7]. - Situation at the time of the comparative analysis of the baseline situation at t zero: measures (and explains) evolution of farms' performances compared to their initial situation.	Cf *Diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology* - Description of the local agricultural context - Agricultural speculation, markets and food/nutrition security - Typology of farms - Systemic analysis of constraints - Prospects for development - Analysis of the main value chains - Agro-ecologisation' level of farms

7. *See Principle and challenges of evaluation.*

STAGES	OBJECTIVES	METHODOLOGICAL POINTS
Calibrate the monitoring mechanism	Define: - the purpose of monitoring - what the subject of monitoring should be (the variables): • At farm level • At context level - who will ensure monitoring - frequency of monitoring - which tools to use for monitoring - who will use the information collected - how to present the information The monitoring data is less exhaustive than that of the diagnostic phases (however, monitoring enables some, more in-depth, measures), it must be easily and regularly collected by the monitoring team.	Cf. *Parts III and IV* - Farms: technical and socio-economic data (yields, economic performances from the farmer's point of view, food and nutrition security) - Economic data: access and conditions of access to value chains and markets, evolution of prices in value chains and markets in relation to product quality... - Environmental data: maintenance/restoration of productive natural resources, access and conditions of access to these resources, contribution to preservation of resources that are not productive, participation in mitigation of climate change... - Social data (integration and participation in professional and interprofessional structures, existence and conditions of access to support services, existence or non-existence of conflicts over use of resources...)
	Define agroecological practices implemented by the intervention	Cf. *Part VI* - Scale of implementation - Objective sought and factors behind choice - Results and assessments by farmers - Adaptation
	Define the sample in relation to variables and practices previously identified (farms benefitting from the project or not). It should be noted that for the final evaluation, the sample of farms having benefitted from the project is subdivided into: - farms implementing practices - farms that implemented them and stopped - farms not implementing them Several sampling methods are possible, they can be complementary according to the various objectives sought: - Statistical representativity: need to randomly select representative samples (25% minimum); often difficult to implement in light of means dedicated to monitoring and evaluation - Purposive sample: based on good knowledge of farms and context (cf. Quality of the baseline situation); advised if margins of error can be accepted without distorting future analyses - Mixed: some information can be accessible based on purposive samples (e.g. operating results, yields...), other information will be collected based on statistical samples (e.g. quantities produced at territory level, prices on markets, flow of goods in value chains...)	

IMPLEMENTATION	
STAGES	**METHODOLOGICAL POINTS**
Collection of information	The quality of collection is an essential element in ensuring reliability of the information to be analysed. The data is collected directly (quantitative measurement) or indirectly (stakeholders in interviews). Collection can be conducted by the project officers in the field (technicians, project survey interviewers, monitoring and evaluation manager) or outsourced (farmers themselves, professional organisations…). Regular checks must be carried out by the person in charge of monitoring and evaluation within the project.
Entry and processing	The data collected must be regularly entered into a previously prepared database – an Excel spreadsheet will usually suffice – to avoid lengthy data entry at the end of the collection cycle. Use of automatic lists, filters… is strongly recommended when creating databases. Data processing is carried out whenever necessary (key stages prior to presentations) with the appropriate tools (manual processing is time-consuming and prone to error). Pivot tables and other tools will be used.
Analysis and participative validation	Data analysis is done in teams, because explanations of a result observed often come from the "field". The technicians and survey interviewers in charge of collection can often provide the necessary clarifications to the monitoring and evaluation manager, who interprets the data processed. Validation of analyses is carried out in a concerted manner: project team, farmers' representatives and value chain stakeholders, support services officers. This consultation around results and the effects observed following adoption of practices is essential for the quality of future presentations and contributes to improving the monitoring and evaluation system.
Presentation of data generated by monitoring and evaluation	In order to present data, it is crucial to build tools that are suited to the audience concerned. Visual representations (posters, diagrams, simple tables…) will be used for presentations to farmers and value chain stakeholders. More complex formats can be used for "informed" audiences (NGOs, Technical services, territorial management and planning stakeholders…). - Presentation to farmers and their organisations (management advice): Campaign assessments (collective at PO level or family farm groups in the territory), Interprofessional and value chain workshops - Individual presentations (on samples monitored… enhances collaboration) - Presentation to development partners: Public support organisations (authorities in charge of planning and managing development of territories, decentralised agriculture, rural development, environment and trade services…) Support NGOs, Producers' organisations and Professional organisations (pay attention to the latter, they could get lost in overly complex presentations).

DIAGNOSIS AND EVALUATION OF THE FINAL SITUATION
Use and re-evaluate the criteria and indicators from the diagnosis of the initial situation to conduct comparative evaluation of farms having benefitted from the intervention and farms in the reference group in order to analyse, for each agroecological practice, the reasons, factors or constraints relating to implementation for the various farms.

FURTHER READING:

For diagnostic study of agrarian systems

- Cochet (H) 2011: Comparative Agriculture, Editions QUAE +Springer, 154 pages.
- Cochet (H.), Devienne (S), 2006: "Fonctionnement et performances économiques des systèmes de production agricoles : une démarche à l'échelle régionale", Cahiers Agricultures vol. 15, n° 6, November-December 2006, pages 578-583.
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For monitoring and evaluation

- Management advising to very small family farming enterprises – Agrisud 2015 (English version, 2018).
- FADEAR, Agriculture paysanne, le manuel, September 2014.
- *Analyse des trajectoires d'écologisation des pratiques d'agriculteurs au sein des groupes CUMA : une méthode pour accompagner la transition agroécologique,* Stéphane de Tourdonnet, Capaccita project (Innovation Research Unit – FNCUMA).

III. AGRO-ENVIRONMENTAL EVALUATION

Evaluation concerning agro-environmental aspects involves various levels:

– Identification and characterisation of agricultural practices and systems, with particular attention to a priori agroecological practices present.

This characterisation is based on the core indicators of means and techniques (or structural indicators):

– Description of cropping systems and crop management sequences in crop production: land development techniques for water and soil conservation, choice of species and varieties, rotations/successions and intercropping, main cultivation operations and implementation procedures, use of inputs (organic and/or mineral fertilisers, pesticides) and tools, irrigation systems and water management, etc.

– Description of livestock production systems: species and races present, feeding practices (composition and origin of animal feed), animal health practices (including ethnoveterinarian practices), characterisation of pastoral resources, etc.

Comparison of these indicators over time (in a monitoring and evaluation situation) or between farms with varying levels of agroecological practice integration (one-off evaluation intending to characterise a situation), can be a first measurement of the effects of an agroecology intervention.

Characterisation tools and methods are the subject of factsheets, considered in part 2 of the handbook on "diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology".

– Measurement of the effects and performance of these practices and agroecological systems from the point of view of ecological processes/ecosystem services that one wants to mobilise.

This evaluation considers the following principles:

– Efficiency of use of resources (water, energy, nutrients).
– Closing of cycles (generate the fewest possible losses in the production process).
– Biological interactions (facilitation, synergy, biological regulation of pest and disease).
– Resilience.

These principles are included in the general principle of "realising the full potential of ecosystems", so that agroecological systems can meet the various objectives of ecological sustainability, productivity, fight against climate change, etc.

The factsheets proposed correspond to an area or criteria of evaluation considered in the diagram, with proposed indicators, scales and measurements to be considered.

For each factsheet, varying degrees of accuracy of the evaluation will be considered:

– Analytic evaluation elements with overall performance indicators that are easy to calculate (e.g. water efficiency in kg of product/mm of water) and agro-environmental effect indicators (soil conservation, biodiversity maintenance).

– More specific elements to demonstrate the level of mobilisation of ecological processes sought (e.g. for water efficiency: other indicators such as level of infiltration, quantity absorbed by the plant, rate of evaporation, etc.).

It is not just a question of determining whether agroecological systems or practices are more or less effective (from the point of view of efficiency, production, productivity, recycling of nutrients, etc.), but also why, in order to also be able to produce elements of advice to farmers.

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DIRECT MEASUREMENT OF YIELD AND OF YIELD REGULARITY

The indicators and methods proposed in this factsheet are applicable first and foremost when monitoring and evaluating an intervention.
Furthermore, measurement of overall biomass production seems decisive in agroecological systems, but is difficult to measure, particularly for biomass production in pastures and rangelands. It is not considered in this factsheet. However, references are mentioned for measurement of biomass production by ecological infrastructures (grass strips, hedges, trees combined with annual crops, etc.), whose biomass can be valorised (wood, fodder, picking) or restored to the soil.

1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Crop production yield	Grain/tuber/fruit/wood yield per production cycle (tons or kg/hectare) preferably in Dry Matter	P[8] T	green	green	orange
	Performance of intercropping compared to the same species cultivated separately: Land Equivalent Ratio (LER)		green	green	orange
	Fodder/straw yield or crop residues per production cycle (tons or kg/hectare) preferably in Dry Matter		green	green	orange
	Aboveground and/or underground biomass restored to the soil per year (tons or kg/hectare/year)		orange	orange	orange
Regularity of agricultural yield	Coefficient of variation of the average interannual yield	P[9] E	green	green	orange
Livestock production yield – Numerical productivity – Ponderal productivity	- Fertility rate - Fecundity rate - Prolificacy rate - Rate of animals weaned in % - Annual mortality rate, for the herd or per age category.	T	green	green	orange
	- Average weight at time of weaning or at a given age - Weight and age of animals at time of sale/auto-consumption - Average quantity of milk collected per day - Average duration of lactation - Consumption index = quantity of feed distributed (kg)/body mass gain (kg) - Quantity of manure collected		green	green	orange

8. Crop production yield is measured at plot level, if possible including ecological infrastructures (hedges, trees, plant strips, etc.).

9. Both at plot level for measurement of the effect of practices/systems to buffer against hazards (resilience), and at farm level to measure the regularity of the product offer with regards the family's needs.

2 LINK WITH THE SDGs

1.5. Strengthening of populations' resilience
> Regularity of yield

2.3. By 2030, double the agricultural productivity and incomes of small-scale food producers
> Yields, crop and animal production

2.4. Ensure sustainable food production systems
> Regularity of yield

3 PERTINENCE

Measurement of yield (ratio of a produced quantity of grain in kg, litres of milk, number of weaned young animals, etc. with regards the surface used or the number of livestock), is a means to judge efficiency of use of the production factor (land or livestock resources) in the agricultural activity and to compare it according to techniques practised.

This comparison is primarily useful for farmers, in order to help them to determine the most effective techniques with a view to production, taking care not to judge them solely on yield. Apart from yield, this evaluation must make it possible to consider the overall productivity of t he agro-ecosystem, its stability, its evolution over time, over a set period of integration exceeding the short-term yield related to the production cycle.

Measurement of interannual variability of yields must also make it possible, for farmers in particular, to highlight the cropping or livestock system's capacity or lack of capacity to ensure a certain regularity of production, despite climate hazards or biotic factors (disease, pests, etc.). These direct measurements of yield are crucial when monitoring and evaluating an intervention, to improve accuracy of the estimate data collected during economic surveys and to be able to better judge and explain differences between the production techniques being compared. For a one-off evaluation, estimates expressed by farmers in the surveys at farm level can be complemented, according to the means available, by measurements of a judgement sample of plots or herds, for synchronic comparisons of certain practices.

CRITERIA	INDICATORS	Always necessary	As a complement to estimates via surveys if means available	Necessary for comparison of intercropping vs pure crops
Crop production yield (measured)	Yield of grain/fruit/fodder, etc.	X	X	
	Biomass restored to the soil	X	X	
	Equivalent relative surface areas			X
Interannual regularity	Yield variation coefficient	X		
Livestock production yield	Numerical productivity	X	X	
	Ponderal productivity	X	X	

X For a one-off evaluation / X for monitoring and evaluation

4 METHODOLOGICAL APPROACH AND TOOLS

Apart from specificities relating to sampling, methods and tools for measurement of yields are intended for multi-annual evaluation situations, particularly in monitoring and evaluation systems.

To enable comparisons between yields measured for a single crop or type of livestock production, sampling must be structured according to:

– cropping systems (irrigated/water-catchment, rotations, crop management sequences),
– soils and climate,
– types of animal in the livestock production unit,
– types of farm identified during the agrarian system analysis (cf. *Diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology*), in order to identify a possible influence of types of farmers on procedures for integration of agroecological practices and results obtained.

> Measured yield for crop production

Collection of data for annual crops

Based on identification of the various ecological zones and cropping systems from indepth case studies of farms, a plot that is representative of the zone or system one wants to evaluate is selected for yield measurements.
Various stages must be considered for data collection at the time of harvest.

a. Visit to the plot, brief zoning and reconstitution of crop management sequence
Field tour enabling detection of spatial heterogeneity relating to variations in topography, type of soils reflected in the status of plant communities (waterlogged area, localised pest attacks…) and estimate its surface area. This zoning will include estimation of ecological infrastructures' surface areas (trees, hedges, grass strips, stone barriers, etc.). For multi-species systems, it is also necessary to report on heterogeneity of species spread, to define the elementary surface area being estimated for the produce (can be extrapolated to the plot). This stage must also make it possible, with the farmer, to reconstitute the type and date of the various cultivation operations, and obtain climate data (daily or monthly rainfall, average temperatures) at the station closest to the site of observation.

B. Sampling the various harvest products
The sampling plots or sites chosen must be representative of the zones identified in the plot. Sites can be selected in the best part of the plot and in the worst part, in order to calculate minimum and maximum yields. 3 to 5 sites should be selected by field, according to the heterogeneity and size of the plot (2 x 3 sites if two very contrasting zones are identifiable).
The surface areas to be sampled for each site range from 2 to 10 m^2, according to crops and sowing techniques (drilling, dibbling or broadcasting). Within this surface area, all plants are cut back to the ground and the sample is identified specifically. For staggered harvest crops, the sampling plots are well identified, so that they can be regularly visited throughout the entire duration of harvesting.

c. Processing of samples
All the biomass samples are weighed wet, then kernels, tubers or fruit, and straw/twigs/leaves are weighed separately, 1,000 grains or the average weight of a fruit or tuber. In addition, the number of plants and fruit bodies (tassel, ear, fruit, tuber) is recorded.
All of this data enables calculation of yields and yield components, i.e. grain yield (kg/ha), fodder yield (kg/ha), average weight of a kernel/fruit (g) and density of plants at harvest (Diouf, 1991).

To enable comparisons between plots, if possible, weights must be expressed in kg of dry matter. At best, this implies planning oven-drying of a portion of samples (3 days at 70°C) or allowing the samples to dry for about ten days under shelter, before weighing them dry.

d. Specific evaluation of ecological infrastructure productivity and biomass restored to the soil

These structures (grass strips, hedges, agroforestry park trees, etc.) must be indicated during sampling, particularly to consider the effect of their presence on crop productivity at plot level. Furthermore, if possible, the yield of these structures should be measured in terms of valorisation of resources for biomass production (wood, fodder, picking), but also because growth of the biomass produced and of its diversity is an essential objective of agroecological cropping systems. With regards measurement of wood biomass growth, it is possible to use allometric techniques. To do this, the tree diameter is measured (sometimes diameter and height), and application of an allometric equation enables estimation of biomass by ascertaining the species and its wood density (Picard et al., 2012). For growth estimation, at least two measurements should be taken, at an interval long enough to be able to measure the growth.

If this measurement is too complicated, this aspect must at least be covered qualitatively, by attempting to highlight evolution of tree cover from the point of view of variety of species present and ground cover. Specific indicators are presented in the factsheet entitled *Effectiveness of pest and disease regulation.*

For so-called sown cover crop or service cover crop, their effect on crop yield must be separated from the biomass productivity of these plants (valorised or not).

Here again, the spatial structure of diversity (densities, spatial spread of species…) is important to consider for extrapolation to the plot.

In the case of intercropping, to compare the performance of combined crops to that of the same species cultivated separately, the Land Equivalent Ratio (LER) method is used, defined as the relative surface area in sole crops necessary to have the same level of production as with the combined crops:

LER = (yield of combined crop 1/yield of sole crop 1) + (yield of combined crop 2/yield of sole crop 2) + …

An LER higher than 1 indicates that intercropping is more effective than sole cropping, and vice versa – for example, an LER of 1.15 means that, to obtain the same quantity of sole crops, 15% more surface area would be required.

Specificity of evaluation for perennial crops

In this case, it is important to distinguish market production (fruit, sap, bark …) from growth of biomass. As with agroforestry, allometric techniques enable measurement of this growth.

Data analysis

The analysis will depend on quantitative and qualitative measurements taken and the degree of accuracy. This phase must therefore be considered when designing the evaluation systems, ensuring the pertinence and feasibility of measurements to make the desired comparisons in a sufficiently rigorous manner. The statistic dimension of the comparison must be considered and therefore the comparative method chosen must make it possible to repeat these comparisons, and confront them with a broad variety of situations to see the robustness of differences observed.

Furthermore, with regards analysis of the effects of techniques on yields, it is vital to have measurements of yield components, and of climate and soil characteristics, as well as accurate knowledge of the crop management sequence: this ensures that differences observed are not due to variations in environmental conditions or in cultivation techniques not related to specific agroecological practices.

According to the time and resources available, analysis and interpretation of results can also consider observations and indicators concerning the availability of water and nutrients (cf. *Efficiency of water resources and nutrient use*), and the impact of pest and disease (cf. *Effectiveness of pest and disease regulation*), which makes it possible to go back to the mechanisms through which agroecological practices impact yields differently.

> Livestock production yield

This involves measurement of the effect of agroecological livestock production management/practices (feeding system, alternative animal health practices, etc.) on animal production and zootechnical performance.

Data collection

For indepth studies of farms, characterisation of livestock production systems and practices must make it possible to identify certain management practices (animal care, feeding, housing), use/management of resources (pastures) and valorisation of products.
Zootechnical analysis, which enables better measurement at herd level of the various types of production (milk, manure, meat, work, etc.) and performance, implies complementary surveys for better knowledge of aggregation practices (constitution of groups of animals), reproduction, and herd renewal, and makes it possible to understand the determinant of these practices.
For a one-off evaluation, these elements can be obtained through surveys, by calling on the livestock farmer's memory or his/her monitoring data where applicable. These surveys must be cross-referenced with a minimum quantity of observations, given farmers' reticence sometimes to realistically communicate data on their herd.

VARIABLES AND INDICATORS TO BE CONSIDERED FOR ZOOTECHNICAL AND CATTLE, SHEEP OR GOAT[10] PRODUCTION ANALYSIS

10. Poultry production can also be considered with indicators to be adapted case-by-case, based on poultry being intended for meat, or eggs, or both.

VARIABLES TO BE CONSIDERED	INDICATORS
Reproduction performance	
– number of ♀ pregnant – number of young animals born – number of ♀ put in reproduction – number of ♀ who gave birth – number of animals born at full term – number of losses before weaning – number of losses of other animals	– Fertility rate (number of ♀ pregnant/number of ♀ put in reproduction) – Fecundity rate (number of young animals born/number of ♀ put in reproduction) – Prolificacy rate (number of young animals born at full term/number of ♀ who gave birth) – Rate of animals weaned in % (Number of animals weaned per female per year), – Annual mortality rate, expressed for the herd or per age category
Ponderal productivity	
– Weight of adults – Weight and age of animals at time of sale/auto-consumption – Production of milk per day	– Average weight at time of weaning or at a given age – Average quantity of milk collected per day – Average duration of lactation – Consumption index = quantity of feed distributed (kg)/body mass gain (kg) – Quantity of manure collected

The consumption index aims to judge "feeding efficiency", in particular to compare livestock production systems that can be very different, according to whether complementary feeds are given (fodder or concentrates) as compared to solely grazing.
Measurement must include the type of feed given to the animals, and must in particular distinguish feed that is "not directly consumable by humans" from feed that is "consumable by humans", for which competition exists (Laisse et al., 2017).

5 ADDITIONAL METHODOLOGY IN THE CASE OF EVALUATION WITHIN A MONITORING AND EVALUATION SYSTEM

For crop production, multi-annual monitoring of a network of plots provides various possibilities to strengthen evaluation systems:

- Improve climate data accuracy, in particular by installing rain gauges near the observation sites,
Regular visits to the farm and recording of operations, if possible by the farmer,
- Measurement of succession cropping yield, in comparison to other usual rotation or sole cropping,
- Better understanding of the spread of activities and systems in rotation, and of the links between plot management, available resources and other activities on the farm,
- Monitoring of evolution in yields over time and evolution in trends,
- Monitoring of adaptations of practices with 1) improvement of technical mastery and 2) according to differences of situation (climate, soil, pest and disease...)

With regards animal production, livestock production monitoring, with regular visits and individual observations of animals, enables collection of more accurate information, identified over time (reproduction, care, feeding, mortality, sales, etc.), which makes it possible to highlight seasonal effects (fodder availability, movement of herds) and interannual effects (career of reproductive females, genetic evolution, etc.).

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

This evaluation requires specific technical skills and a rigorous approach in:
- the design of evaluation and sampling systems,
- the development and implementation of data collection protocols,
- the processing of samples and organisation of data,
- the data analysis, including a statistical analysis and interpretation.

It complements the diagnostic analysis of agrarian systems, by seeking to evaluate, on a one-off basis or via a monitoring and evaluation system, the agronomic/zootechnical effects of agro-ecological practices or systems, which requires additional resources, in particular:
- Specific agronomic analysis skills, to be mobilised in partnership with a research institution if possible,
- Material to take measurements: weighing scales, GPS, measuring tape...
- Access to climate data and possibly analysis of soils sufficiently close to evaluation sites, in cases where it is not possible to take measurements *in situ*.

FURTHER READING

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SOIL HEALTH

Soils contribute to ecosystem provisioning, regulation, support and cultural services in agricultural systems, also connected to the sustainable development goals (Keestra et al., 2016). These services are obtained thanks to functions carried out by soils that are themselves determined by assemblages of living organisms interacting with the physical and chemical habitat made up of the soil. Soil health is defined by its capacity to function and therefore by its functions. Evaluating soil health therefore consists of evaluating the functions carried out by soils in an ecosystem.

We will distinguish four main functions (Kibblewhite et al., 2005):

- Maintenance of the soil's physical structure, which contributes to maintaining the physical habitat of organisms and favours circulation of water, air and living organisms e.g. roots; it also defines the soil's resistance to erosion;
- Decomposition of organic matter which contributes to energy flows in the trophic chain of the soil's organisms and to release of nutrients (e.g. N and P), and to structuring of soils via stabilisation of organo-mineral aggregates;
- Recycling of nutrients, which defines conservation and availability of nutritive elements necessary for plant production;
- Regulation of pathogens and diseases by complex biological processes, which implies that diversity of the soil's organisms is a factor in reducing plants' pathogen sensitivity.

These functions can be evaluated by observing and/or quantifying various properties. Evaluation can be based on qualitative or quantitative elements. Soils' properties are related to their use, but also to the physical environment specific to each situation. For an agronomic evaluation, soil health can only be done by a comparative approach. The baseline situation will be designated according to the agronomic context and the question asked: comparison of two cropping systems, comparison of cultivated and uncultivated plots, evolution over time of the impact of agricultural techniques, etc. Other characteristics (type of sol, climate environment, etc.) must be constant in this comparison.

The indicators in the table below are a non-exhaustive list and must be chosen by the evaluator according to their pertinence for a given situation, from a biophysical environment and agronomic point of view. Also listed are indicators ranging from rapid observation to more elaborate measurements requiring technical and human resources.

1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS		SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL RESOURCES
Maintenance of physical properties (water and soil conservation. Circulation of air, water and nutrients)	Soil surface status	Percentage of "open", "closed" and "covered" surfaces for the soil of a plot	P	Green	Orange	Green
		The "ballpoint pen" penetration index	P	Green	Green	Green
	Water infiltration	Average infiltration speed of water poured into a cylinder	P	Green	Green	Green
	Structural status of a soil	Visual index of a soil's structure (VESS)	P	Orange	Orange	Orange
	Stability of aggregates	Manual pressing of aggregates	P	Green	Green	Green
		Indicator of disintegration in water	P	Green	Orange	Green
Decomposition of organic matter	Status of decomposition of plant residues and of macrofaunal activity	Litter index	P	Green	Green	Green
	Mesofaunal activity status	*Teabags test*	P	Green	Green	Green
	Organic matter status	Organic carbon content	P	Orange	Orange	Red
Recycling of nutrients	Quantity and availability of nutrients for plants	Plant colour index	P	Green	Green	Green
	Chemical constraints of nutrient availability in soils	pH, aluminium content, clay content and clay type	P	Orange	Orange	Red
Maintenance of soil biodiversity	Diversity and abundance of harmful or useful macroinvertebrates	Density per unit of surface of traces of macrofaunal activity	P	Green	Green	Green
		Abundance of harmful or useful macroinvertebrates for cultivated plants	P	Orange	Orange	Orange
		Density of traces of attack by harmful macroinvertebrates for cultivated plants	P	Orange	Orange	Green

2 LINK WITH THE SDGs

2.3 relating to increase of agricultural productivity and incomes of small-scale food producers

2.4 relating to ensuring the sustainability of food production systems and implementation of resilient agricultural practices

12.2 relating to achieving sustainable management and efficient use of natural resources

13.1 relating to strengthening in all countries of resilience and capacities to adapt to climate-related hazards and climate-related natural catastrophes

15.1 relating to ensuring conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services

15.3 relating to the fight against desertification and restoration of degraded land and soil

3 PERTINENCE

Evaluation of soil health is essentially pertinent at plot level, because agricultural practices apply at this level. However, it is important to first identify different types of plots in a village *terroir*. Farmers act differently according to the potentiality of soils to produce. For example, they apply organic or chemical fertilisers only in some plots. Furthermore, *terroirs* are often managed collectively, enabling some zones of *terroir* to be kept as pastoral space for domestic animals during the crop season for example. It is therefore necessary to first establish a typology of the agricultural plots and to clearly identify the plot evaluated based on this typology.

Evaluation of soil health is particularly important in high crop pressure zones featuring visible traces of soil degradation. It is also essential in zones with high agricultural intensification, in the conventional sense of the term, such as vegetable-growing zones located in peri-urban areas.

CRITERIA	INDICATORS		Always necessary when evaluating the plot	As a complement to estimates via surveys if means available	Necessary for comparison of intercropping vs sole cropping
Maintenance of physical properties	Soil surface status	Percentage of "open", "closed" and "covered" surfaces for the soil of a plot		X	
		The "ballpoint pen" penetration index		X	
	Water infiltration	Average infiltration speed of water poured into a cylinder		X	
	Structural status of a soil	Visual index of a soil's structure (VESS)	X		
	Stability of aggregates	Manual pressing of aggregates	X		
		Indicator of disintegration in water	X		
Decomposition of organic matter	Status of decomposition of plant residues and of macrofaunal activity	Litter index	X		
	Mesofaunal activity status	*Teabags test*		X	
	Organic matter status	Organic carbon content	X		
Recycling of nutrients	Quantity and availability of nutrients for plants	Plant colour index		X	
	Chemical constraints of nutrient availability in soils	pH, aluminium content, clay content and clay type	X		
Maintenance of soil biodiversity	Diversity and abundance of harmful or useful macroinvertebrates	Density per unit of surface of traces of macrofaunal activity			X
		Abundance of harmful or useful macro-invertebrates for the plants cultivated	X		
		Density of traces of attack by harmful macroinvertebrates for the plants cultivated			X

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

Sampling of soils on an agricultural plot

Several evaluations of indicators require taking a soil sample that is representative of a plot. The depth the sample is taken at should be from the first 30 centimetres, i.e. generally the depth of soil majorly impacted by annual plants and cultivation practices. This depth can be divided from 0 to 10 cm and from 10 to 20 cm to evaluate less indepth impacts for certain practices. If the average surface area of a cultivated plot is considered to be several hundred square metres, it is possible to take at least 3 samples for certain indicators that are not suitable for composite soil analysis. For example, at least 8 observation points will be made for bait-lamina, and 6 for evaluations of macrofauna using the TSBF method. For analyses enabling composite sampling, we suggest at least 6 to 10 samples for a surface of approximately 10 metres. Care will be taken to define the zone most representative of the plot, in particular in terms of microrelief or the way the plot is used. The samples will be mixed in an initially cleaned container and a sample of several hundred grams will be taken from this mix. For analyses conducted outside the field, care will be taken to fully dry the sample in the open air before putting it in a hermetic bag and sending it to a laboratory.

Characterisation of soil quality

Soils possess intrinsic characteristics related to their pedogenesis. These properties evolve naturally very slowly, except in radical situations (e.g. severe erosion or mining). However, as part of agronomic monitoring, certain characteristics are essential, because they explain the dynamic of certain properties. We can mention the following:

- The texture of soils, which preconditions water storage capacities, nutritive elements and organic carbon. Soil texture will also influence the capacity of living organisms to explore soils.
- The type of clay contained in the soil is also decisive for certain functions related to the cycle of nutrients: for example, P, whose adsorption onto clay minerals differ according to their mineral nature.
- The organic matter of soil, i.e. the organic matter contained in soil screened using a sifter with a 2 mm mesh, which is a property including numerous indications on potentialities of soils in terms of production and recycling of nutrients.
- Nitrogen, phosphorous and potassium content, and cation exchange capacity and rate of cation saturation (calcium, sodium, magnesium, ammonium, etc.) are typically properties that will also define a capacity to produce. They are strongly connected to the texture of soils, the nature of clays and the soil's organic matter.
- The pH[11], which defines the level of acidity, neutrality or alkalinity of the soil, is a property that provides a large quantity of information on soil fertility. It is decisive for numerous chemical and biological processes in soils.

Most methods to evaluate these various properties are methods developed by chemical analysis laboratories. These laboratories are not always accessible in terms of cost but also in terms of infrastructure, particularly in developing countries. However, it is possible to obtain qualitative evaluations based on visual observations of the colour and external aspect of the soil, or on assessments made by smelling or touching. Simple techniques also enable quantification of certain indicators, for example the jar test, which evaluates sand, silt and clay content, or the spade test to evaluate the structure of a soil. Numerous videos describing these methods are available on the internet and intended for a broad audience. It is also important to question farmers, who often have good empirical knowledge of the nature of their soil. It is always a good idea to bring these indicators generated by local knowledge together to evaluate these soils. These indicators are often based on soil colour or behaviour in a specific situation, for example in the event of heavy rains or drought, or based on plants indicating the nature of a soil.
All these criteria will be necessary to evaluate the health of a soil via its main functions. It is important to bring these indicators generated by local knowledge and scientific knowledge together. Some of these methods are presented in the following paragraphs.

11. Measurement of soil pH can be done with a laboratory specialising in soil analysis. Measurement systems that can be used directly in the field also exist, these generally require an aqueous soil solution to be prepared, and the use of an evaluation system using coloured indicators (portable spectrophotometer, pH paper).

> Maintenance of physical properties

Soil surface status[12]

Analysis of a soil's surface status makes it possible to evaluate the level of a soil's structural degradation and runoff and erosion risks in soils. Casenave and Valentin (1989) have distinguished the most significant parameters in a large range of soils, cultivated in particular in Sub-Saharan Africa. These surfaces are closed by a crust of sedimentation (thickness > 3 to 30 mm, bedded, FN[13] = 1 to 12 mmh^{-1}), a layer of hardpan (FN = 10 to 30 mmh^{-1}), a sole of compaction (thickness > 5 to 10 mm, but no film structure) or stones taken from the mass (zero infiltration).

Protocol for evaluation of closed surfaces: On a 1 m² sampling plot, define 5 stable transversals starting from marks on the measurement framework. Place a metre stick 5 cm above the soil, and let a knitting needle or pencil drop (systematically, without aiming) every 2 cm leaving a 10 cm border (10-30-50-70-90 cm), i.e. 40 measurements x 5 = 200 points of measurement. At the point of impact with the soil, count the following points:

- layer of hardpan (or erosion): thickness = 1 mm, one layer, generally in high/clod/ridge position,
- crust of sedimentation: thickness 3 to 30 mm, bedded, on low position (= puddle residues),
- sole of compaction, erosion crust: thickness 5 to 30 mm, non-bedded, very compacted, evidence of tyres, workers or animals passing, or of an erosion deposit (mud flow),
- the surface of stones apparent (and large compacted clods) taken from the mass (to be distinguished from those that protect the aggregated soil surface to be classified in "covered surface").

The total % gives the closed surface likely to quickly lead to runoff. The evolution of closed surfaces is an excellent indicator of stability of a soil's superficial horizon and of its physical degradation.

Protocol for evaluation of open surfaces. Using the same framework and the same transects previously defined, count: deep cracks, mesofauna galleries, clods < 1 cm, clods > 1 cm, and clods > 5 to 8 cm. The open surface is the sum of the surfaces defined above, but in very sandy soils, flows of permeable coarse-grained sand not covering the bedded structure are also counted with open surfaces.

Protocol for evaluation of covered surfaces: starting from the framework and transects previously defined, count the impacts where the soil is covered: by litter (crop residues, bare roots, mosses), stones not integrated in the soil mass, weeds + creeping plant ground cover, by a canopy to be defined by strata with different average heights. The sum of the above is the covered surface to be considered in relation to erosion and runoff risks.

The "ballpoint pen" test

Place a taut 5 m rope on the ground and leave it on the soil. Every 5 cm, insert a ballpoint pen using the same pressure each time. If the soil does not (or hardly) resists and the pen easily sinks a few mm into the soil, score 1. If the pen does not sink into the soil, score 0. Calculate the average of all the points to get the simple value of surface soil compaction.

Visual evaluation of soil structure (VESS)

VESS is used to evaluate soil structure related mainly to macrofaunal activity in the soil. VESS makes it possible to evaluate the soil structure in 5 classes. The principle is based on observation of the different horizons of a 20 by 20 cm block of soil. A soil structure score is attributed based on reading of a table defining various soil structure parameters (compaction, shape and size of aggregates, macroporosity, etc.). The final score is calculated based on each score attributed to the layer at each horizon (from 1 to 5), taking into account the thickness of each horizon and the depth of the layer (Guimaraes et al., 2011).

Speed of water infiltration at the surface of the soil

The cylinder test (Roose reference): insert a 1 kg food can (empty and with no lid or bottom) 3 cm into the ground. Place a graduated ruler on the edge of the can, with the 0 touching the surface of the soil. Pour the equivalent of 10 cm of water into the can. With a stopwatch, record the level of water in the can every minute, using the ruler. Record the total time the water takes to infiltrate. Repeat the measurement 10 times along a 10 m transect. Calculate the average.

12. According to Roose 1996 Bulletin – Réseau Erosion, 16 pages 87-97. http://horizon.documentation.ird.fr/exl-doc/pleins_textes/pleins_textes_7/bre/010009063.pdf
13. Rate of stabilised infiltration: FN=Rain-Maximum runoff

Water infiltration speed references according to soil structure

SPEED OF INFILTRATION	REFERENCE VALUE	SOIL CHARACTERISTICS
Fast	Higher than 50mm/hour	Soils that are resistant to heavy rains, with major infiltration. Lumpy structure
Moderate	15 to 50 mm/hour	Soils tolerating moderate rainfall. Average infiltration with presence of runoff. Intermediary structure
Slow	Less than 15mm/hour	Flooded soils with low-level infiltration and major runoff. Puddles of water form. Massive structure

Percentage of stable aggregates
Visual estimation of 1 (absence of aggregates > x cm resistant to manual pressing) to 3 (presence of numerous aggregates > x cm resistant to manual pressing).

Test based on disintegration in water
The principle of the protocol is based on attribution of 1 score according to disintegration or dispersion in water of a previously dried aggregate. Aggregates of 6 to 8 mm are taken from two horizons: 0-2 cm and 5-10 cm deep (Herrick et al., 2001).

> Decomposition of organic matter

Litter Index (C input)
Adapted from Ponge et al., 2006, protocol described in Thoumazeau et al., 2019. This is a measurement resulting from the Ponge "humus index", which describes the decomposition status of the surface litter (whole, fragmented, skeletonised) and measurement, the presence of biological activity at the surface (castings, faeces) and the decomposition status of wood if wood residues are present. It is suitable for agroforestry systems.

Teabags test
This involves monitoring loss of mass in teabags (initial weight known) after 3 months. International comparisons require the use of recommended teabags. Local comparisons can be made using different brands of teabags (however, make sure to use nylon teabags and weigh the average mass of tea they contain well).

Measurement of organic matter content in the soil
To evaluate a soil's organic matter content, little or no direct, easy-to-implement methods exist. This is done through chemical analysis of organic carbon content, using the NF ISO 14235 international standardised method. The level of organic matter is calculated by multiplying the carbon content by a stable coefficient in regional cultivated soils, fixed at 1.72 (MO = Cx1.72).

> Recycling of nutrients

Cultivated plants' leaf colour index

The colour of plants can indicate a state of deficiency in certain nutritive elements, or an excess. These observations can therefore be pertinent to qualitatively evaluate the bio-availability of certain nutritive elements, whether they be macroelements (N, P, K, etc.) or micronutrients. However, these indicators depend on the agroecological context. It is necessary therefore to establish locally with farmers a list of indicators that can be used for broad evaluation of the availability status of nutritive elements for plants according to soil types.

> Maintenance of soil biodiversity

Diversity and abundance of harmful or useful macro-invertebrates Diversity per surface unit of traces of macrofaunal activity
Method using observation of traces of the presence of invertebrates in the soil:

- On a 10 m transect 1m wide, count all traces of presence of soil engineer insects: earthworm castings, termite mounds, sediment left by termites, ant traces, galleries and pores apparent at the surface of the soil).

Abundance of macro-invertebrates

TSBF international standardised method (see SECURE factsheets in *Further reading*). Once sampling of the invertebrates has been done, separate organisms between harmful organisms (root feeders) and others (a priori beneficial).

Density of traces of harmful invertebrate attacks

Traces of attacks by pathogens on underground plant parts, or counting of pathogenic organisms visible to the naked eye (for example white worms). Farmers can be questioned in advance to identify these types of pathogens. Then on a 20 m * 20 m surface, count the number of traces indicating pathogen attacks.

5 ADDITIONAL METHODOLOGY IN THE CASE OF EVALUATION WITHIN A MONITORING AND EVALUATION SYSTEM

The difficulty of evaluation of a soil's health concerns the status one must refer to for a comparison. A soil's health is defined in terms of quality of the soil in question. This quality is defined by the soil's intrinsic properties, which contribute to providing ecosystem services. This quality can be very variable and highly dependent on the local context (sometimes this can mean one metre) and naturally on climate conditions. The baseline soil status with which the status we are seeking to evaluate will be compared, will depend in this case on the objective of the evaluation. For a one-off evaluation, it is possible to evaluate a soil considered a priori to have a low level of disturbance or in a natural situation that is not very constrained. This could be soil in an uncultivated zone, with little grazing, under natural vegetation for example. But this approach necessitates ensuring that both systems compared are located on identical soils. It is also possible to conduct a comparative study between different plots on which soil restoration practices have been applied for a certain number of years. In the case of a monitoring and evaluation system, an initial status taking into account a maximum number of indicators will be determined, and a final status will be compared to this. Given the slow evolution of certain soil properties, some measurements after several years will not provide reliable indications. Indicators changing quickly over several years are pH and exchange capacity, the physical properties of soil surfaces, nitrate or assimilable phosphorous content, and biological properties. To a lesser degree, organic carbon content of the soil evolves over periods of one decade, as well as significant changes in the soil's physical properties.

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

Evaluation of a soil's health can be relatively easy. Some methods are very accessible in terms of technicity, although this sometimes requires calculation of averages. More accurate evaluation of chemical element content or some physical indicators does not necessarily require technicity in itself, because chemical measurements can often be carried out by service laboratories. Although difficulties in interpreting some of these chemical indicators obtained must not be underestimated, the major constraint is the cost of analyses and the presence of a reliable laboratory nearby. However, an increasingly large number of portable tools for measurement of chemical element content exist, with simplified methods and well codified protocols. But these tools are expensive to buy. However, the increase in digital tools means that "low tech/ low cost" methods are currently being quickly developed.

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MITIGATION OF GREENHOUSE GAS EMISSIONS VIA SOIL CARBON SEQUESTRATION

Agriculture as a human activity contributes to greenhouse gas (GHG) emissions that are responsible for climate change. Sources of emissions are mainly:

- Livestock production, mainly due to enteric fermentation from ruminants.
- Changes in land use, primarily deforestation or development of wet zones for agricultural purposes, but also in relation to changes in livestock production systems, ploughing of permanent grasslands.
- Agricultural practices favouring mineralisation of organic matter for example in some ploughing situations, or that favour nitrous oxide emissions, for example badly adjusted nitrogen fertilisation.
- Intensive use of fossil fuels, such as the use of combustion engines in the mechanisation of agriculture, but also production of fertilisers, which requires energy, and lastly all forms of transport generated by agricultural activity.

Agriculture can however reduce its own emissions (CO_2, N_2O, CH_4) and serve as a sink for CO_2 in the atmosphere. It is possible to evaluate agriculture's net balance by calculating over time the difference between GHG emissions (expressed in carbon equivalent) and carbon stock changes in the soil-plant system (Bernoux et al. 2006). Soils contain the largest portion of carbon in terrestrial ecosystems and, consequently, in agricultural systems. Carbon circulates between the atmosphere and the lithosphere via photosynthesis and primary production. Capturing carbon from the atmosphere to store it in the soil over the long term is a means to mitigate GHG emissions. This is referred to as soil carbon sequestration, if all emissions generated that were necessary to store and retain this carbon in the soil are deducted from carbon changes in the soil over time. In agriculture, it is necessary therefore to not lose carbon from the soil by avoiding or minimising inappropriate practices such as deforestation, conversion of grasslands to arable land, excessively intense tillage, etc. Agricultural practices favour the increase of carbon in soils and therefore potentially soil carbon sequestration. For example, increase in the presence of trees, crop-livestock integration, which favours recycling of carbon, etc. Steering agricultural systems towards more carbon in soils and therefore more organic matter, has the advantage of providing other benefits such as soil biodiversity intervening in biological regulation. But managing an agricultural system's carbon is based on trade off farmers will make in soils to satisfy their food, social and economic needs.

In order to facilitate decision-making, it is necessary to address the issue of evaluating the impact of a farm and of agricultural practices on the carbon cycle, particularly on their capacity to preserve stable carbon in organic form.

1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS		SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
The farm favours carbon storage in the various compartments of the system, minimises its GHG emissions and contributes to mitigation of GHG emissions	A farm's soils sequester carbon	Average rate of soil carbon sequestration	P			
	A farm's carbon footprint is positive	GHG sinks and sources balance for all of a farm's compartments	VC			

2 LINK WITH THE SDGs

13.1 relating to strengthening of resilience and adaptive capacity to climate-related hazards and natural catastrophes in all countries

15.3 relating to achieving a land degradation-neutral world

3 PERTINENCE

Evaluation of a farm's carbon footprint has merits, regardless of the cropping system or the production system. Not only will it provide indications on a farm's capacity to preserve carbon, it will also inform stakeholders on conservation of natural resources, particularly soils. Evaluation of the average rate of soil carbon sequestration is not necessary in all cases. It will be of interest if specific focus is placed on mitigation of GHG emissions through soil carbon sequestration.

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATIONN

The average rate of soil carbon sequestration of an agricultural plot

The objective is to establish the carbon balance or carbon footprint of a farm or a set of agricultural plots, i.e. a cropping system. The carbon balance expresses the difference between the system's carbon inputs and outputs. We propose an approach that does not entail fastidious measurements requiring numerous soil samples and carbon measurements in a laboratory.

The approach consists of evaluation via questions put to the head of the farm or of the household, who has good knowledge of the agricultural activities, and of all of the plots' incoming and outgoing flows in terms of organic matter biomass. Inflows concern primary production, i.e. the net plant biomass produced over time, but also carbon inputs in organic form, such as amendments or organic fertilisers (manure, compost, litter, etc.) or any other form of organic residues from outside the system, such as household waste. The origin of inflows will be recorded, because it will enable calculation of indirect carbon losses, through fossil fuels related to the use of synthetic fertilisers or means of transport used to move matter that may be combustion engine vehicles producing CO_2. Outflows concern all biomasses and flows exported outside the plot, i.e. harvests, crop residues taken for animal feed or during common grazing. Although accurate knowledge of flows does not exist, it can be approached by using measurement units used by farmers or livestock producers (cart, basin, bunches, etc.). In this case, the objective is to determine conversions of these units into mass by weighing several batches of matter. Similarly, there is literature providing data on transformation of gross matter into dry matter; the latter being the measurement unit used to compare systems. For some flows, estimates will be made based on average data obtained from the literature for a single soil type, for example, the rate of mineralisation of a plant residue entering the soil, litter decomposition rates, or an annual rate of mineralisation of the soil's organic matter, etc. Once all of these flows are recorded, it will be possible to determine the annual balance of an agricultural plot's carbon or carbon equivalent inflows and outflows. For agroforestry plots, the assessment will also focus on the number of trees, their age, and the management dynamic for these trees (pruning, cutting). The literature also provides allometric equations to estimate carbon stored in this compartment. Residues from wood cutting must be quantified, whether they are exiting the system (for example, for cattle feed, wood for heating, etc.) or put back in the soil. This balance will be established for the entire cropping system, taking into account crop rotation, and seasonality of inflows and outflows, and balance over 10 or 20 years will be established. A positive balance will indicate a tendency to sequester carbon in the soil, and a negative balance will indicate a cropping system's tendency to emit carbon.

A farm's Carbon Footprint

The objective is to establish the carbon balance or carbon footprint of a farm or a production unit. The carbon footprint expresses the GHG emissions (CO_2, N_2O, CH_4) balance, expressed in Carbon equivalent, and carbon storage in the soil-plant system for all of the farm's agricultural activities. Direct or indirect emissions are taken into account. For example, direct greenhouse gas emissions related to soil respiration, and those related to manufacture of nitrogen fertilisers and their transport, if the latter are used.

The TropicCfarm tool (Rakotavoa et al., 2017) is a calculator developed in Excel. TropiCFarm is based on methodology featuring inventory and accounting of GHG emissions and storage, as per the guidelines proposed by the IPCC for the agriculture and forestry sector. An inventory of the various GHG sources and sinks per compartment of the farm is conducted (cultivated plots, farm forestry, livestock production, energy consumption). For each GHG source and sink, GHG emission and storage factors are attributed according to levels of data accuracy, accessibility and availability (Tier 1, Tier 2 and Tier 3) and adapted to the context of the study. A positive carbon footprint means a farm is emitting GHG, while a negative carbon footprint indicates a farm is sequestering GHG.

The summary and analysis of results are conducted thanks to an Excel calculation tool. This tool is made up of five components, into which descriptions of the farm, and of agricultural, livestock production, forestry and energy consumption practices are entered. A 6th component carries out the calculations and gives the results.

The general methodology used by TropiCFarm is suitable for various types of farms and agricultural practices. The tool is open, which makes it possible to enter numerous practices adopted at farm level or implemented in a cropping system. However, the tool in itself is highly dependent on carbon storage and GHG emissions factors, knowledge of these and their accuracy in a given context.

5 ADDITIONAL METHODOLOGY IN THE CASE OF EVALUATION WITHIN A MONITORING AND EVALUATION SYSTEM

These various methods for evaluation of the Carbon footprint at different levels of scale can be used indifferently in one-off evaluations or within a monitoring and evaluation process. When first using in a given situation or project, it will be necessary to input information in the calculation modules with various parameters that are known locally or adapted from models recognised by the international community. During projects, it will however be possible to take several measurements that will make it possible to specify certain parameters to improve accuracy of calculations.

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

These methodologies do not require specific material, and the main costs will concern surveys among stakeholders, surveys which could be associated with other evaluation work around plots or farms. However, some knowledge and a literature review (conversion factors, allometric equations, organic matter decomposition dynamic) are necessary. With regards the TropiCfarm tool, a short training session on how to use the tool is sufficient, thanks to an average level of competency in the use of Microsoft Excel. In other words, it can be easily appropriated by the various development stakeholders (NGOs, producers' associations, etc.). However, to calculate balances, it is necessary to know certain carbon storage or GHG emission factors, knowledge of these and their accuracy in a given context, which can require intervention by certain experts.

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

cirad

EFFICIENCY OF WATER RESOURCES AND NUTRIENT USE

1 CRITERIA AND INDICATORS

CRITERIA		INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Efficiency of water use	Elements of water balance for a crop cycle	Sowing calendar based on the onset of the rainy season	P	■ (green)	■ (green)	■ (green)
		Rainwater productivity: Food production-biomass(kg/m^3)	P	■ (green)	■ (green)	■ (green)
		Infiltrated water productivity (available water efficiency)		■ (orange)	■ (green)	■ (green)
		The agrosystem's water "loss" rate (runoff, deep infiltration, evaporation)		■ (orange)	■ (orange)	■ (orange)
		Rate of delivery of water to fields in irrigated systems		■ (orange)	■ (orange)	■ (orange)
Efficiency of nitrogen and phosphorous use	Elements of the nitrogen and phosphorous balance	Food production-biomass per unit of nitrogen or phosphorous used (efficiency in terms of total exogenous nitrogen or phosphorous inputs, of mineral fertiliser phosphorous or nitrogen, and of organic nitrogen according to the various forms supplied)	P	■ (green)	■ (orange)	■ (orange)
		Annual nitrogen or phosphorous balance (N or P input – N or P Output)/Farm surface area	P VC	■ (green)	■ (orange)	■ (orange)

2 LINK WITH THE SDGs

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2.4.1 Proportion of agricultural area under productive and sustainable agriculture
> Nitrogen/phosphorous use efficiency
> Water use efficiency

6.4.1 Change in water use efficiency over time
> Water use efficiency

3 PERTINENCE

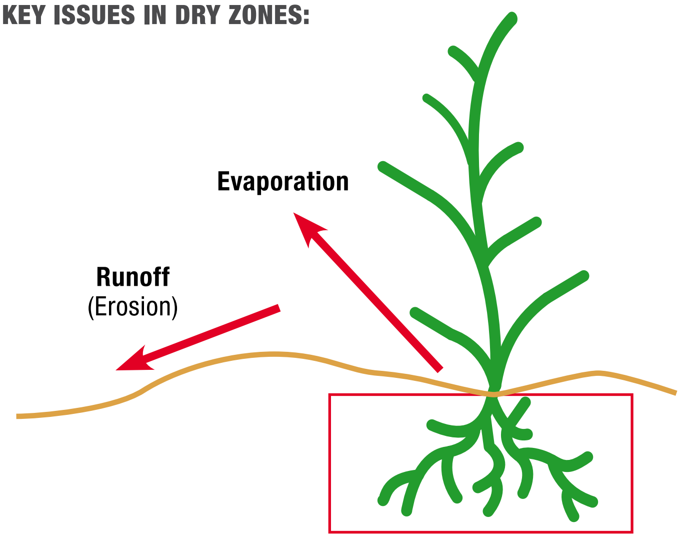
The efficiency criteria focus on the relationship between the result and the means implemented. These criteria enable evaluation of efficiency of the use of a certain number of resources mobilised, according to the ways in which they are used, based on two dimensions:

- positive consequences on production and indirectly on the profitability of this mobilisation, if it has a cost;
- consequences on the environment, both from the point of view of their potential outputs and ecological sustainability.

This evaluation primarily concerns farmers, in order to demonstrate the level of mobilisation of ecological processes, and advise them on the possibilities of optimising water and nitrogen use, especially if they are making an economic investment (fertiliser, development of plots…). From a general interest point of view, these criteria can help to steer infrastructure development policies (water management at watershed level) or policies supporting ecological intensification of agricultural production.

In dry zones, it is considered that losses via deep infiltration (below the root zone of crops) of water and nutrients are not significant. However, the surface runoff/infiltration ratio is crucial in the determination of useful water. An estimate of the average runoff rate is necessary in this case. Any action affecting the runoff/infiltration ratio (surface status, runoff barrier, dead or living plant cover…) will significantly impact rainwater efficiency. In these zones, it can be assumed that nitrogen losses related to the water dynamic are insignificant, especially if sources are organic (plant residues from previous crops and external organic inputs) rather than mineral. Mineralisation of these organic inputs however will be strongly related to soil moisture and therefore to satisfactory rainwater harvesting. Good water efficiency is often related to better efficiency of nitrogen inputs. In these zones, the crop cycle calendar and in particular early sowing are decisive elements for improvement of rainwater and nitrogen efficiency.

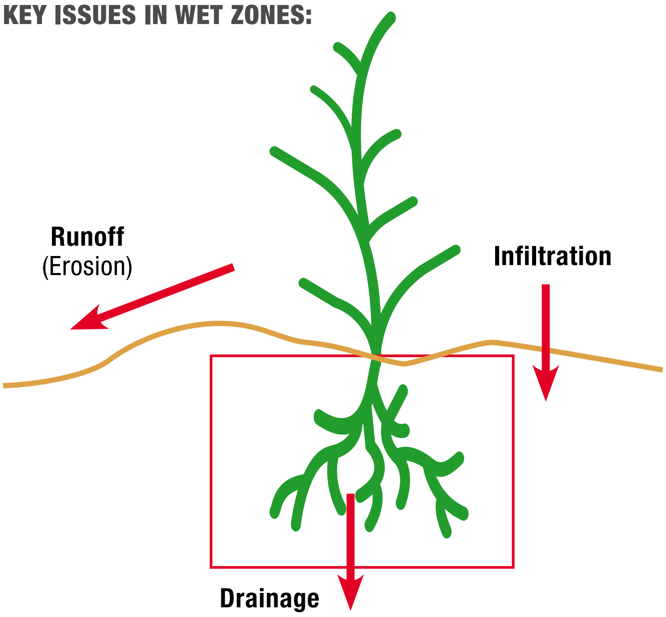
KEY ISSUES IN DRY ZONES:



- Pb: runoff + erosion
- Wetting front boundary root front
- Little or no drainage
- Minimise losses (R+E)
- Short cycles (date of sowing)
- Biomass related to ETR
- Not much biomass for mulching

In wet zones on the other hand, rainwater efficiency will be less impacted by runoff rate, because of the abundance of rain. Reduction of runoff rate still remains important to minimise water erosion, which can have longer term impact on production. Limitation of the runoff rate will generally result in direct increase of deep infiltration and therefore of the risk of mobile nitrogen leaching (nitrates). The nature of (organic) inputs with slower mineralisation speeds than chemical fertilisers, and incorporation (rotation or intercropping) of plants in deeper root systems will minimise nitrate losses and possible degradation of nitrogen efficiency. In these zones, the cycle calendar and sowing dates will be less of an impediment for crop productivity, however, good use of the entire cycle through succession or relay cropping will make it possible to increase the total biomass produced, and therefore global efficiency over the entire rainy season.

KEY ISSUES IN WET ZONES:



- Pb: erosion
- Wetting front >> root front => potential significant drainage
- Long cycles (growth periods)
- Use excesses (D + time slots before and after) => + consumption
- Biomass not determined by ETR and not limiting

CRITERIA	INDICATORS	Always necessary	Necessary in dry zones
Efficiency of water use	Sowing calendar based on the onset of the rainy season	X X	
	Rainwater productivity: Food production-biomass(kg/m³)	X X	
	Infiltrated water productivity		X
	The agrosystem's water "loss" rate (runoff, deep infiltration, evaporation)	X	
Efficiency of nitrogen and phosphorous use	Food production-biomass per unit of nitrogen or phosphorous used	X X	
	Annual nitrogen or phosphorous balance (N or P input – N or P Output)/Farm surface area	X	X

X As part of a one-off evaluation / X as part of monitoring and evaluation

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

Water efficiency:

• Calendar indicator

In rainfed cultivation in dry zones, it is necessary to examine whether certain agroecological practices enable earlier sowing dates and therefore improved water efficiency. Calendar indicator = Sowing date/start date of rainy season

• Estimate of rainwater losses (runoff + deep infiltration + direct evaporation from the soil)

Average runoff rate: it can be obtained using graphs or tables indicating the rate according to soil type, slope and type of plot development practiced (see FAO Bulletins 57 and 69).
Infiltration is equal to 0 in dry zones, and is obtained by deducting the estimated average consumption of a given crop and runoff from water inputs.
Evaporation = potential evaporation (related to soil) regulated by rate of cover.

In dry zones, the focus is on losses due to runoff, which are the main source of inefficiency. Evaporation, which depends on soil texture and cover, has a greater effect at the start of the cycle, when soil is poorly protected by cover.

Runoff rate: An initial indicator of the soil's capacity to effectively infiltrate water at the start of the cycle consists of measuring the speed of progression of the wetting front with the first rains. In zones with substantial dry seasons, the soil is dry over quite an extensive depth at the start of the cycle. For this, after each significant rainfall event, auger drilling will be carried until the dry soil boundary is reached. The depth of this front will be recorded in cm. This will be repeated 4 times per homogenous plot.

Average runoff rate by direct observation: Very lightweight mechanisms can be put in place to estimate the magnitude of runoff coefficients according to practices. To do this, on the lower parts of plots, known surface areas are delineated. These areas will be isolated from superficial flows of runoff on each plot by physical barriers. These physical barriers can be made solely of raised edges of earth, well packed to resist flow of water, or of sheet metal embedded in the soil if the latter does not overly hinder technical management of crops. Small lots will be sufficient here. The surface areas will be between 3 and 5 m^2 (3 X 1.5 m). It will be necessary to have a collector to direct runoff water towards a PVC tube that carries it outside the plot or small recipients (small 50 litre containers = 10 mm of runoff) placed in a small pit, enabling it to be stored for subsequent measurement.

Mulch will modify the rainwater runoff threshold and coefficient. It is also possible to use the runoff coefficient reduction formula based on the following quantity of mulch:
$\sum = -0.0333 * Q + 0.333$, relation valid up to10 t. ha^{-1} of mulch.
Where $\sum$ is the rate of reduction of runoff and Q is the quantity of mulch t/ha

• Rainwater efficiency = production in kg/total rainfall over the crop cycle
• Usable water efficiency = production in kg/(total rainfall – runoff – deep infiltration – evaporation)
• Water efficiency in irrigation = production in kg/mm of water content contributed
• Efficiency of nitrogen and phosphorous
• Overall efficiency of use of nitrogen or phosphorous: production in kg/inputs of N or P
• Efficiency of nitrogen or phosphorous contributed in the form of mineral fertiliser: production in kg/input of fertiliser N or P
• Annual nitrogen balance of the farm: (N input*-N Output**)/Farm surface area

(*)Nitrogen input: total quantity of nitrogen purchased: Mineral fertiliser, manure, animals, cattle feed (**)The system's nitrogen output in the form of products sold or consumed: crop products, animals, milk, manure

Simple models exist for dynamic evaluation of water and nitrogen balances. These models can be used to refine calculation of losses, balances and ultimately efficiency of the various systems and certain agroecological options (mulch, soil cover, contribution of legumes…) (see Allen et al., 1998, Liang et al., 2016, and Steduto et al. 2014). This dynamic approach makes it possible to ascertain when water or nitrogen become limiting in the crop cycle, impacting production efficiency. On the other hand, models giving an account of the functioning of multi-species agroecological systems are as yet too complex for easy use by practitioners in the field.

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

EFFECTIVENESS OF PEST AND DISEASE REGULATION

Pest and disease are all living organisms that can cause damage for crops. These harmful organisms can be pests, in particular insects, mites and nematodes (P), pathogens (mushrooms, virus, bacteria) responsible for disease and pathogens (DP), or adventitious plants (A).
This factsheet concerns effectiveness of pest and disease regulation in food and commercial crops. Measurement of regulation effectiveness must include three types of criteria: control (natural or chemical), biodiversity maintenance and farmers' capacity to adapt their control practices.

1 CRITERIA AND INDICATORS

CRITERIA		INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Effectiveness of pest and disease control	Level of crop infestation (parasitism rate)	P): % plants attacked (DP): % diseased plants (A): % of soil covered by adventitious plants	P	Green	Orange	Green
	Risks of damage	(P-DP-A): % of yield loss risks 1. Damage inferior to cost of treatment (non-dominant pest and disease) 2. Damage higher than cost of treatment	P	Orange	Orange	Orange
	Presence of auxiliary insects	(P): Diversity and number of auxiliary insects	P	Green	Orange	Orange
Biodiversity maintenance	Level of ecological infrastructure development[14]	% of perennial plant communities (density)	VC, T	Green	Green	Green
		Number of natural and cultivated plant species (varietal diversity and crop diversity)		Green	Green	Green
		Infrastructures' length in linear metres		Green	Green	Green
		% of host plants for auxiliary insects		Orange	Orange	Orange
		% of trap plants for pest and disease		Orange	Orange	Orange

14. Contributing to maintenance of useful fauna and flora (hedges, trees, crops and varietal diversity).

Farmers' capacities	Capacities acquired % of farmers able to:	Identify the main pest and disease in their crops (P-DP-A and auxiliary insects)	VC			
		Evaluate risks (preventive capacity)				
		Decide autonomously to treat or not (non-systematic character) according to level of infestation (P-DP-A)				
		Apply alternative control methods and prophylactic measures through cropping practices				

2 LINK WITH THE SDGs

2.3 relating to agricultural productivity and the incomes of small-scale food producers
> Effectiveness of pest and disease control

2.4 relating to sustainability of food production systems and implementation of resilient agricultural practices
> Maintenance of biodiversity

2.5 relating to preservation of genetic diversity of seeds, crops and farmed and domesticated animals and their related wild species
> Farmers' capacities

1. relating to elimination of extreme poverty and hunger

3 PERTINENCE

Pest and disease are a major problem for food security. Whether during crop cycles or after harvest, they can destroy a harvest or food stocks and cause severe food shortages, which is why their regulation is a major challenge to ensure healthy and remunerative agricultural production for producers, and substantial availability of food.

It is recognised that intensive agriculture's cropping practices favour rapid development of pest and disease by generating large surface areas of homogenous crops. Pest and disease are much more plentiful in sole cropping than in intercropping. Systematic application of pesticides has a paradoxical effect: it instantly reduces pest populations but also causes a decrease in populations of competitor, predator and parasite insects, which can sometimes result in an increase of the pest population. Some pests also adapt to products used (adventitious plants that become tolerant of herbicides...).

Among promotors of agroecology, two approaches coexist: on the one hand the emergence of alternatives to the use of synthetic crop protection products, with natural regulation of pest and disease, for the promotion of healthy, sustainable agriculture that respects the environment; and on the other hand, when absolutely necessary, the use of phyto-pharmaceutical products to regulate uncontrollable pest and disease that could destroy a crop.

Regulation of pest and disease through adapted cropping practices and use of natural products makes it possible to significantly minimise farmers' and consumers' risks of being exposed to synthetic chemical products, which are detrimental for health, either directly when they are handled, or indirectly when their residues are consumed in food.
For farmers, alternative pest and disease regulation methods also enable reduction of their dependency on external inputs and thereby their debt levels, because very few producers are able to pay for their inputs in cash.

CRITERIA		Always necessary	Necessary in certain cases
Effectiveness of pest and disease control	Level of crop infestation (parasitism rate)		X
	Risks of damage		X
	Presence of auxiliary insects		X
Biodiversity maintenance	Level of ecological infrastructure development		X
Farmers' capacities	Capacities acquired	X	

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

> Effectiveness of pest and disease control

Level of crop infestation (parasitism rate)

(P) Pest, (DP) Disease and Pathogens, (A) Adventitious plants
The level of crop infestation is measured through observations and accounting on plots. This is an essential stage before measuring damage levels. The main indicators are:

- (P): % of plants attacked
  - Visual observation of leaves, roots, stems and fruits
- (DP): % of diseased plants
  - Visual observation of leaves, roots, stems and fruits
- (A): presence of adventitious plants
  - Visual observation of adventitious plant cover on the plot

Evaluation of risks of damage

The rate of damage observed and the risk of damage encountered in crops by pest and disease is measured by the percentage of crops destroyed or affected. It is the result of observations of the plot and makes it possible to orient the farmers' decisions in terms of intervention, according to their production choices (conventional or agroecological)

– 1. When damage observed or risks of damage are lower than the cost of treatment because pest and disease are not dominant, the farmer can refrain from intervening (manually, mechanically or chemically) and thereby control his/her cropping costs,

– 2. When the damage observed or risks of damage encountered are higher than the cost of treatment, the farmer must intervene to save his/her produce and adopt the most opportune mode of intervention in light of his/her financial and human resources.

Presence of auxiliary insects

The presence of auxiliary insects is an essential criterion in terms of agroecological control and, even more so, biological control of insects. This is carried out through observation of their presence on plots of crops and makes it possible to assess whether cropping and farm management practices favour the development and action of this auxiliary fauna, which is vital in natural pest and disease control. The most common indicators are:

- (R): Presence of auxiliaries (diversity)
    - Harvest of auxiliaries and non-flying pests by threshing of plants chosen randomly on the plot, then visual counting
    - Harvest of auxiliaries and non-flying pests by covering the chosen plants with a fine net

This observation enables producers to easily make comparisons between agroecological practices and conventional practices.

> Maintenance of biodiversity

Level of development of ecological infrastructures

Restoration and maintenance of biodiversity is a major parameter of agroecological practices to favour natural interactions and minimise chemical interventions in pest and disease control. This biodiversity is assessed by the level of development of ecological infrastructures contributing to maintenance of useful fauna and flora (hedges, trees, grass strips, diversity of crops and varieties)

The major indicators that can be retained and used by farming families are:

- Density of perennial plant communities
    - This is measured by counting perennial plants at farm level, relative to the farm's total – surface area
- Number of plant species (diversity)
    - It is also measured by counting at farm level and necessitates lists drawn up in the local language by farmers, then converted to botanical names by agricultural advisers (technicians and engineers)
- Length of infrastructures in linear metres
    - For hedges that often serve as windbreakers, this length is measured with a measuring tape or "calibrated strides", which can be easily converted into metres
- % of host plants for auxiliaries
    - This is measured at farm level
- % of plants that trap pest and disease
    - It is measured at farm level

> Farmers' capacities

Capacities acquired

The basic principle of any pest and disease control intervention is to enable rural families to become more autonomous vis-à-vis external agricultural advice, often related to projects or not featuring sufficient resources to ensure effective permanent presence among farmers.

This is why it is vital to train farmers and then to measure the percentage of people (men and women) able to conduct actions for agroecological control of pest and disease.

The main indicators enable measurement of the percentage of farms with at least one person able to:

- Identify the main pest and disease in their crops (P-DP-A),
- Evaluate risks (predictive capacity),
- Decide autonomously to treat or not (non-systematic character) based on risk (P-DP-A),
- Know and apply alternative control methods and prophylactic measurements by cropping practices.

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

The main aspect is to include the “producers’ capacity” criterion, and the indicators relating to it, in monitoring and evaluation systems. At the end of a project, these producers are supposed to be able to carry out effective agroecological control of pest and disease, with a view to natural protection of crops and of the environment, combined with a reduction, or even elimination, of the use of external inputs generating significant expenses for farmers and often toxic for humans and the environment.

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

Calling on specialists (botanists, ecologists, etc.) is often necessary to train farmers, agricultural technicians and agronomists to identify host plants and crop auxiliaries.
Agroecological or biological pest and disease control is not an obvious choice and is not easy to implement because it requires knowledge and technicity, the conditions for which are often not present. It makes it possible to reduce pressure, but does not always succeed in exterminating pest and disease, therefore the risk remains.
The main costs are those related to specialists for training of agricultural advisers and relay farmers, who will be in charge of supporting producers.

FURTHER READING

- CIRAD: Dispositif en Partenariat DIVECOSYS. Conception de Systèmes agroécologiques par la gestion des bioagresseurs et l’utilisation de résidus organiques. > https://www.divecosys.org/
- INRA: Biocontrôle. Une protection biologique pour une agriculture durable et de qualité > http://presse.inra.fr/Communiques-de-presse/Les-conquetes-de-l-Inra-pour-le-biocontrole
- Écophyto: réduire et améliorer l’utilisation des phytos> https://agriculture.gouv.fr/ecophyto
- RMT: Biodiversité et Agriculture > http://www.rmt-biodiversite-agriculture.fr/
- ARENA: Anticiper les régulations naturelles. Le projet AUXIMORE > https://arena-auximore.fr/le-projet-auximore/

IV. SOCIO-ECONOMIC EVALUATION

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GTAE

GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

AgroParisTech

AGRICULTURAL YIELDS ACCORDING TO STAKEHOLDERS

1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Average agricultural yield	Quantity of agricultural crops(s) per unit of surface area per production cycle during year, average year (generally in tons/hectare)	F, P (1)	orange	green	green
	Quantity of sub-products per unit of surface area per production cycle (generally in tons/ hectare)	F, P (1)	orange	green	green
Average zootechnical yield	Quantity of milk production per lactation (litres/lactation) (and other zootechnical criteria according to type of production)	H (2)	orange	green	green
Regularity of yields	Levels of average yield, standard deviation, yield during a bad year and yield during a good year; deviations between these values; risk of yield being below a certain level	F, P (1)	orange	orange	green
Yield dynamic over time (evolutionary trend)	Average evolution and rate of evolution of the average yield over five or ten years.	F, P (1)	orange	orange	green

(1) In the case of a one-off evaluation, estimate of agricultural yields is conducted:
- For all of the farm's plots where cropping is practiced. An average, representative plot can serve as a reference to facilitate exchanges with the farmer.
- However, if there are significant heterogeneities in terms of agro-climatic conditions or types of practices (irrigated/rainwater, succession cropping, short/long cycles, more or less agroecological practices, etc.), the estimate must differentiate these different types of situation.

In the case of a monitoring and evaluation system, the estimate of yields will also focus on a specific selection of plots for which evolution of the yield will be monitored.

(2) The estimate of zootechnical yields is conducted for the entire herd.

2 LINLINK WITH THE SDGs

1.5. relating to strengthening of populations' resilience
> Regularity of yields

2.3. relating to doubling of agricultural productivity
> Level of agricultural yields

2.3. relating to doubling of agricultural productivity and incomes of small-scale food producers by 2030.
> Yield dynamic over time

2.4. relative to the sustainability of food production systems
> Regularity of yields

3 PERTINENCE

The estimate of average agricultural yield level is essential to evaluate agriculture's economic performance from the point of view of the farm and from the point of view of the general interest (Cf. *Economic performance factsheets*), farms' economic autonomy (Cf. *Autonomy*), and food security (agricultural families, communities and the national community) (Cf. *Food and nutrition security*).
The estimate of yield regularity is also essential to assess interannual regularity of agricultural income (Cf. *Direct measurement of yield and of yield regularity*) and the level of food security (agricultural families, communities and national community) (Cf. *Food and nutrition security*).

Estimating yield dynamics contributes to the assessment of the farm's economic dynamic and viability over the medium term (Cf. *Evaluation of the economic performance from the farmer's point of view factsheets*) and the appeal of agriculture for young people (Cf. *Appeal of agriculture for young people*).
It also reveals evolution of soil fertility, climate change and change trends for the productive potential of the setting. Therefore it enables assessment of the effects of production on ecosystems and evolution of their productive potential.

Estimate of yields vital both for characterisation of a situation and as part of a monitoring and evaluation system.

CRITERIA		Always necessary	Significant presence of livestock production activities
Average agricultural yield	Quantity of agricultural crops(s) per unit of surface area per production cycle during an average year (generally in tons/hectare)	X	
	Quantity of sub-products per unit of agricultural area per production cycle (generally in tons/hectare)	X	
Average zootechnical yield	Quantity of milk production per lactation (litres/lactation) (and other zootechnical criteria according to the type of production)		X
Regularity of yields	Levels of average yield, standard deviation, yield during a bad year and yield during a good year; deviations between these values; risk of yield being below a certain level	X	
Yield dynamic over time (evolutionary trend)	Annual rate of evolution of average yield	X	

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

> Data collection

As part of an evaluation conducted during diagnostic analysis of an agrarian system, estimate of yields is carried out every time there is an indepth case study of farms (Cf. *Diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology*), once the farm's various ecologic zones, cropping systems and livestock production systems have been identified. Questions are asked for the entire farm or, if marked heterogeneities exist, for all plots of each type of zone or system. But, it can be easier to estimate yield based on a specific plot that is representative of the average, during a field visit. In fact, several scenarios exist, according to the degree to which the farmer manages the surface areas, levels of production and yields themselves, keeping in mind that the estimate is carried out first and foremost based on the information provided by the farmer, with possible complementary calculations:

- In the case where a farmer has good knowledge on yields obtained, he is successively asked:
  - what was the yield from the last harvest (or, in the case of intercropping, yields from the last harvests of each crop present),
  - o qualify this harvest/year: is it an average, good or bad harvest,
  - what was the yield in previous years (2 years ago, 3 years ago…. The idea is to start with events for which the farmer's memory should be clearer. If the farmer can provide information on the last five years' yield, it is possible to calculate a standard deviation,
  - his/her assessment of evolution of the yield from one year to the next,
  - The average yield level on this same plot when he/she started working on it, or when he/she started using it with this crop (and the corresponding date), and his/her opinion where applicable on the causes for the evolution observed over time. Comparison with the current average yield makes it possible to calculate an average rate of annual evolution,
  - The yield level of sub-products (straw, etc).

- In cases where the farmer does not have good knowledge on yields obtained, but knows the production volumes and surface area (of the plot, a group of plots or the farm), the same questions are asked but focusing on production volumes. If the farmer only has good knowledge on the farm's total production, calculation for each cropping system is not possible. Regarding the surface area of plots, it should be noted that using a GPS enables easy measurement of their surface area.

When yield or production estimates are not made in CWTs or in tons, but in other units of measurement (including bags, crates, etc.), questions must be asked based on the units used by the farmer, because these are the ones he/she knows and with which he/she can reason. However, it will be necessary to raise the question of equivalence in weight to be able to make comparisons. The same applies to units of measurement of the surface area. In some cases the farmer may not know these equivalences. In this case, during the period of the study, information on these equivalences should be obtained (or take a measurement in some cases).
Yield assessment is more difficult when harvests are spread over time and not stored, but consumed or sold gradually (fruits and vegetables, and especially leafy vegetables). Several methods can be used in this case to evaluate the quantity of crops harvested:

- based on the number of days or weeks of harvesting and harvest quantity per day or per week,
- based on the number of trees and the estimate of number of fruits produced by a tree,
- based on the quantity consumed when production is intended for consumption.

With regards dairy farming, in general the focus is mainly placed on milk production during lactation. For this the farmer will be asked the number of months of lactation for each lactating cow and the daily production from milking per par animal (excluding milk consumed directly by the calf). This data can be compared to data generated by information obtained by asking the following questions: the day's total production and the number of lactating cows; approximate total production curve for the year; month with highest production, total volume and number of cows milked; month with lowest production, total volume and number of cows milked.
With regards other livestock production, the method depends on the type of production.

> Data processing

All of the data obtained during the case studies are subsequently classified in a table according to the type of farm/production system, or, according to the type of specific cropping system. If significant heterogeneities regarding agro-climatic conditions have been identified, it is necessary to differentiate the data. For a given crop (or combination of crops), this data is at least a series of results per farm surveyed and growing this crop (or combination of crops): last yield, average yield, yield for a good year and a bad year, evolution (adjust to average evolution of yield over 5 years). Average results (or ranges of results if there are significant deviations for a single type of system) and standard deviations can be calculated for each type of production or cropping system.
With regards lactation data, it is also classified in a table according to types of production systems and of livestock production systems.
Classification of data makes it possible therefore to compare results for the different types of production, cropping and livestock production systems adhering in varying degrees to the principles of agroecology.

5 ADDITIONAL METHODOLOGY IN THE CASE OF EVALUATION AT THE END OF OR DURING AN INTERVENTION

In the case of an evaluation at the end of or during an intervention, apart from specificities related to sampling, the farmer will also be asked about yields obtained for each year since the beginning of the intervention, starting with the last year (the year for which the farmer's memory is clearest), then going back over time. This can make it possible to evaluate if different evolution trajectories exist for different yields according to farms and plots that implemented agroecological practices and systems following the intervention and farms that did not.

6 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

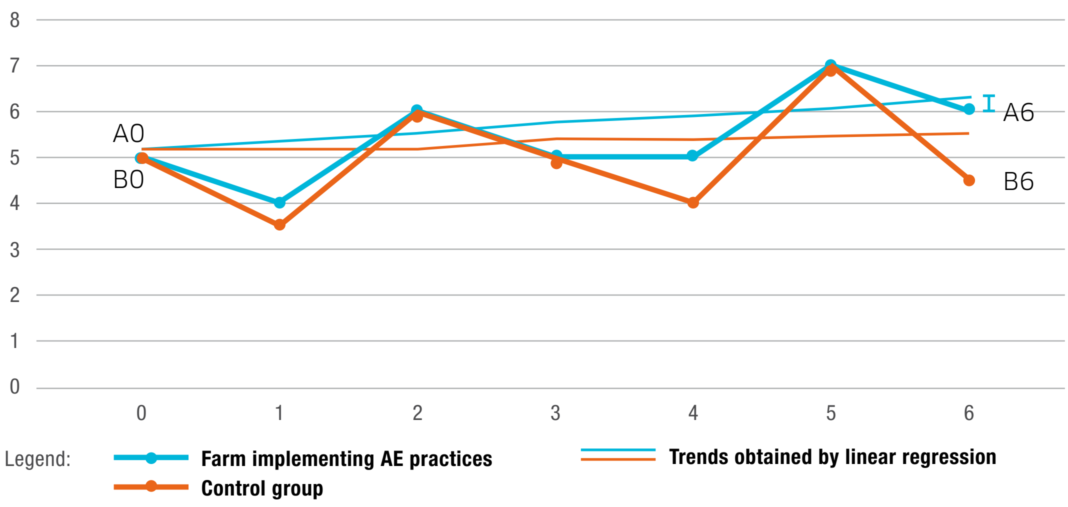
In the case of a monitoring and evaluation system, specificities relating to samplings of farms and plots exist:

- when constructing the baseline situation, and for each plot or set of plots included in the monitoring and evaluation sampling, the farmer will be asked about the yield obtained during the last two harvests, which makes it possible to have a baseline situation including two consecutive years (it should be noted that the harvest following the start of the intervention can generally also be considered as the baseline year, as the effects of the intervention do not yet exist, which makes it possible to have a third year for the baseline situation),
- it is possible to monitor yields on some plots, thanks to measurements of production. This is covered in the factsheet on *Direct measurement of yield and of yield regularity,*
- in the middle of the intervention period (or every year), and at the end of the intervention, all of the data is classified per type of farm/production system, type of plot/cropping system, agro-climatic zone where applicable, and degree of implementation of agroecological practices promoted by the intervention. Several groups can be made up, for which averages and ranges of results are calculated:
  - control group, corresponding, for a given cropping system (and where applicable agro-climatic zone), to plots on which the intervention had no effect (farms not concerned by the intervention and farms concerned but that did not implement the practices promoted),
  - a group corresponding, for the cropping system (and where applicable agro-climatic zone), to plots on which the practices promoted by the intervention were implemented,
  - possibly one or several intermediary groups.

With regards evaluation of effects on yield: for each group, the average yield is calculated (together with a standard deviation, and a range in the case of substantial heterogeneity) for each year (average of the two or three years for the initial reference, then each of the following years). The curves traced based on this data make it possible to assess whether a there is a similar or distinct evolution between the control group and the group(s) that implemented a certain number of agroecological practices. For each group, trace both the curve of annual averages observed and the corresponding straight line obtained by linear regression, which illustrates the evolutionary trend and must be used to observe differences in average yield (see introduction). Calculation every year of standard deviations in yield for each of the two groups is necessary for interpretation of results. In the example in graph n°1, the A6-B6 difference represents the difference in yield (1 ton/ha) between the group that implemented practices and the control group 6 years after the start of the intervention. Furthermore, the question of whether there are other causes that explain the difference should be considered, whether these causes are related to the intervention or not, before attributing the difference exclusively to the implementation of agroecological practices.

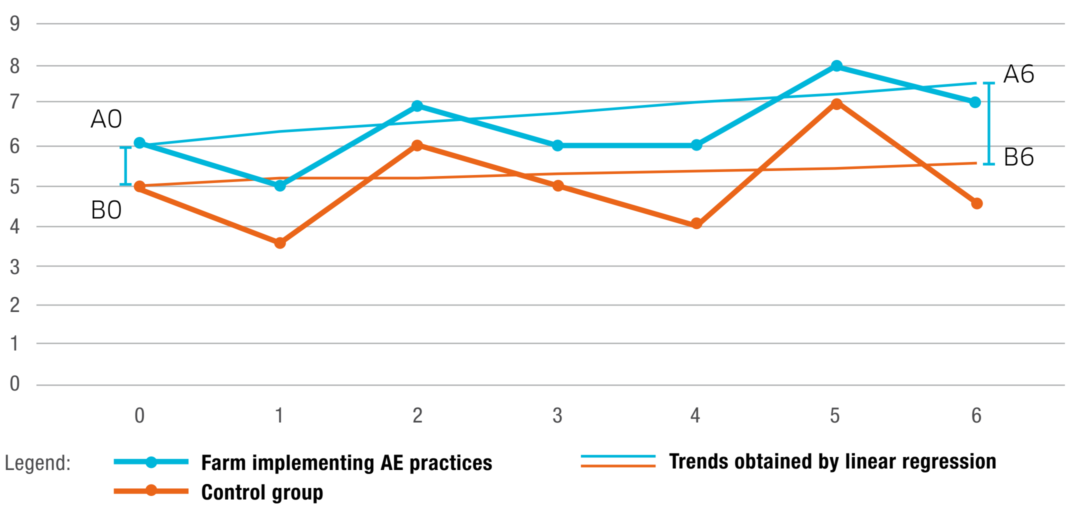
It should be pointed out that the effect of the implementation of agroecological practices is often time-delayed (which is illustrated in graph n°1, where a difference between groups only appears from the 4th year). The longer-term effect, "at cruising speed" can be more important than the effect measured at the end of the intervention.

GRAPH N°1: Evolution of agricultural yield (t/ha) over the years following an intervention



Sometimes there is an initial difference between the average yield of two groups, as illustrated in graph 2. This results from the diversity that exists between farms, soil fertility or cropping practices that can be slightly different (it should be noted that this diversity may not be related to the fact that some farms implemented agroecological practices and others did not). However, the final difference in yield (A6-B6) can be partly due to factors other than implementation or not of agroecological practices (better soil fertility, different cropping practices). In this case, the effect of agroecological practices is not considered to be A6-B6, but (A6-B6) – (A0-B0), i.e. 3-1 = 2.

GRAPH N°2: Evolution of agricultural yield (t/ha) over the years following an intervention



Concerning evaluation of effects on regularity of yield, series of data can make point to an effect of the implementation of agroecological practices on yield regularity. This can be seen in graph n°1 where the yield is more regular with implementation of agroecological practices. Deviations in yield between the two groups are particularly pronounced during years with less good harvests, in this case the decrease in yields is a lot more pronounced in the control group's plots (years 4 and 6). Calculation every year of standard deviations in yield for each of the two groups is also necessary for interpretation of results. The risk of obtaining a yield lower than a certain threshold can be assessed for fundamental food crops (cereals in particular), taking account of the family's food needs. However, assessment is complex because the family's different food supply sources must be taken into account.

Concerning evaluation of effects on yields' evolutionary trends, the evolution observed as such in the group of plots where agroecological practices are implemented must be considered. This evolution, compared to the evolution of a control group, but also to historic evolution prior to the intervention (estimated according to the farmer) corresponds to the short-term effect of implementation of new agroecological practices. To compare medium-term evolution, "at cruising speed", with evolution in plots with no agroecological practices, it would be necessary to have a much longer period of time than the period of intervention.
Ultimately, to evaluate the effect of agroecological practices on the yield's evolutionary trend (which partly reflect evolution of fertility of the setting, but also the capacity to adapt to climate change), it is necessary to consider both the short-medium term effect (which can for example correspond to a phase where the setting's fertility is being restored and yields are being improved, but also to a phase where technical knowledge of agroecological systems is being learned) and the medium-long term effect (which can for example correspond to a phase of simple reproduction of the setting's fertility and of yields' relative stability), by comparing each time with previous evolutions on the same plots and with parallel evolutions on plots not concerned.

7 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

Evaluation of yields is not particularly complex, but requires a high level of rigour in interviews with farmers, reliability of data retained, full understanding by farmers' of the evaluator's expectations and effective cooperation. It takes place as part of diagnostic analysis of agrarian systems. In the case of a monitoring and evaluation system, it is recommended that this information be completed by yield measurements (Cf. *Direct measurement of yield and of yield regularity*).

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

AgroParisTech

ECONOMIC PERFORMANCE FROM THE FARMER'S POINT OF VIEW

1 CRITERIA AND INDICATORS

CRITERIA		INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Economic performance of cropping systems	Efficiency of land use	Gross added value per hectare per year (GAV/S/year)	P, SoP	orange	green	green
	Gross daily labour productivity	Gross added value per day of work (GAV/Md)	P, SoP	orange	green	green
Economic performance of livestock production systems	Efficiency of herd use	Annual gross added value per head (GAV/head/year) or per animal unit (GAV/AU/year)	T	orange	green	green
	Efficiency of land use	Gross added value per hectare of main fodder area per year (GAV/MFA/year)	SoP	orange	green	green
	Daily gross productivity of work	Gross added value per day of work (GAV/Md)	SoP	orange	green	green
Profitability of cropping and livestock production systems	Profitability of land use	Annual gross margin per hectare (GM/S/year)	P, SoP	orange	green	green
	Profitability of family workforce use	Gross annual margin per day of family labour (GM/famWd)	P, SoP	orange	green	green
Economic performance of the agricultural production system	Preliminary stage: creation of wealth	Net Added Value (NAV)	F	orange	orange	green
	Annual labour productivity	Net added value per Agricultural Labour Unit (NAV/ALU)	F	orange	orange	green
	Daily labour productivity	Net added value per Man-day (NAV/Md)	F	orange	orange	green
	Efficiency of land use	Net added value per hectare of usable farm area (NAV/UFA/year)	F	orange	orange	green

Economic performance of the agricultural production system (continued)	Efficiency of use of capital	NAV/(intermediate consumption (IC) + asset depreciation (D))	F			
Generation and evaluation of family agricultural income	Distribution of added value	Distribution (in %) of net added value in: rents, interest on loans, taxes and levies; remuneration of salaried workforce and family agricultural income	F			
	Make-up of agricultural income	Constitutive elements of agricultural income (in %): portion of agricultural added value, subsidies	F			
	Remuneration of family workforce	Agricultural income per Family Agricultural Labour Unit (AI/famALU)	F			
	Profitability of land use	Agricultural income per unit of Usable farm area (AI/UFA)	F			
Profitability of capital	Rate of profit	Agricultural income per unit of capital invested (AI/K)	F			
Graphic representation and interpretation of agricultural income	Graphic representation of agricultural income/family worker based on surface area/ family worker	Function and graphic visualisation	F			
	Situation of agricultural income in light of short- and medium-term simple reproduction thresholds	Comparison and graphic visualisation	F			
Regularity of agricultural income		Deviations between income in an average year, a good year and a bad year	F			
		Risk of generating income below the poverty threshold	F			

2 LINK WITH THE SDGs

1.1. relating to elimination of extreme poverty
> Economic performance and generation family agricultural income

1.2. relating to reduction of poverty
> Economic performance and generation of family agricultural income

1.5. relating to strengthening the resilience of populations
> Regularity of family agricultural income

2.3. relating to doubling of productivity and income of small-scale producers
> Economic performance and generation of family agricultural income

2.4. relating to sustainability of food production systems
> Regularity of agricultural income

3 PERTINENCE

Evaluation of economic performance at farm level:

– this is an essential criteria for evaluation of agroecological practices and systems. From the farmers' point of view, obtaining an agricultural income is a central objective of agricultural activity,

– is also pertinent from the point of view of communities and of the public interest, given the central role of agriculture in economic and social development, food security and environmental preservation in the majority of territories and countries. Wealth created at farm level (added value) measures the production unit's contribution to the creation of value in a territory. Procedures for the distribution of added value and creation of income also make it possible to place creation and/or retention of employment at the heart of debates on agroecology.

Measurement of economic performance from the point of view of the farm is vital for both evaluation when characterising a situation and in the case of evaluation within a system for monitoring and evaluating of an intervention.

CRITERIA		INDICATORS/CONTEXTS	Always necessary	Necessary for most cropping and livestock production systems, especially if concerned by AE practices	Necessary for the main cropping and livestock production systems, especially if concerned by AE practices, except in simplified evaluation	Necessary, except for simplified evaluation	Necessary for capitalist-type farms	Additional option
Economic performance of cropping systems	Efficiency of land use	Gross added value per hectare per year (GAV/S/year)		X X				
	Gross daily labour productivity	Gross added value per day of work (GAV/Md)		X X				
Economic performance of livestock production systems	Efficiency of herd use	Gross annual added value per head (GAV/head/year) or per animal unit (GAV/AU/year)		X X				
	Efficiency of land use	Gross added value per hectare of main fodder area per year (GAV/MFA/year)		X X				
	Gross daily labour productivity	Gross added value per day of work (GAV/Md)		X X				
Profitability of cropping and livestock production systems	Profitability of land use	Annual gross margin per hectare (GM/S/year)			X X			
	Profitability of use of family workforce	Gross annual margin per day of family labour (GM/famWd)			X X			

Economic performance pf the agricultural production system	Preliminary stage: creation of wealth	Net Added Value (NAV)	X X					
	Annual labour productivity	Net Added Value per Agricultural Labour Unit (NAV/ALU)	X			X		
	Daily labour productivity	Net added value per Man-day (NAV/Md)	X					
	Efficiency of land use	Net added value per hectare of usable farm area (NAV/UFA/year)	X X					
	Efficiency of use of capital	NAV/(intermediate consumption (IC) + asset depreciation (D))				X		
Generation and evaluation of family agricultural income	Distribution of added value	Distribution (in %) of net added value in: rents, interest on loans, taxes and levies; remuneration of salaried workforce and family agricultural income	X					
	Make-up of agricultural income	Constitutive elements of agricultural income (in %): portion of agricultural added value, subsidies	X					
	Remuneration of family workforce	Agricultural income per Family Agricultural Labour Unit (AI/famALU)	X X					
	Profitability of land use	Agricultural income per unit of Usable farm area (AI/UFA)	X X					
Profitability of capital	Rate of profit	Agricultural income per unit of capital invested (AI/K)					X X	
Graphic represen-tation and interpre-tation of agricultural income	Graphic representation of agricultural income/family worker based on surface area/ family worker	Function and graphic visualisation						X
	Situation of agricultural income in light of short- and medium-term simple reproduction thresholds	Comparison and graphic visualisation						X
Regularity of agricultural income		Deviations between income in an average year, a good year and a bad year	X					
		Risk of generating income below the poverty threshold	X					

X in the case of a one-off evaluation / X in the case of monitoring and evaluation

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

Evaluation of compared economic performances of systems adhering in varying degrees to the principles of agroecology is conducted as part of diagnostic analysis of agrarian systems for each indepth case study of farms (Cf. *Diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology*).

The evaluation conducted must correspond to year average year, whether in terms of agricultural and zootechnical yields, practices (and therefore costs) or prices. If the previous year can serve as a starting point for collection of technical data from the farmer, it is necessary, for the economic calculation, to use the data (yields, practices, prices) for year average year.

> Evaluation of cropping systems' economic performance

Economic evaluation of the economic performances of a cropping system requires:

- prior identification of the cropping system's characteristic crop succession (for example, sorghum-beans association in year 1 – groundnuts in year 2),
- for each year of succession cropping, evaluation of the economic performances of all crops grown during the year on the plot/group of plots,
- calculation of an average for the different years of succession cropping.

Preliminary stages: calculation of gross product (GP) and gross added value (GAV)

1. Le gross product(GP)

The gross product is the economic value of production. It is calculated by multiplying the quantity of produce obtained during an average year (see factsheet on *Yields according to stakeholders*) by the average unit price. Production can either be sold, or intended for other activities of the production system, or intended for consumption by the family (on-farm consumption). Whatever the end use, part of production can be stored at the end of the year. Different types of products can exist on a single plot during the year, because of the existence of:

- for a single crop, a main product (for example, grain sorghum) and sub-products (for example, straw for cattle feed),
- combined crops (for example, sorghum and beans),
- or several production cycles on the same plot in the same year.

Furthermore, a single product can be valued at different prices according to quality, type of use, or type of market on which it is sold.
Annual gross product therefore corresponds to the sum of each type of product obtained in the year multiplied by its specific unit price:
GP = quantity of product X unit price.

Valuation of agricultural products from the farmer's point of view
Economic calculation at farm level requires a value to be given to products, from the farmer's point of view. If the product is sold, the average sale price is used (the price can vary during the year or according to the type of purchaser or market). If the product of an activity A is intended for another activity (activity B) in the production system (i.e. intra-unit consumption), the opportunity cost is used, i.e. the price the farmer would have paid (market price) if he/she had not produced this product him/herself, to value it either as a product of activity A or a, input in activity B.
If the product is intended for on-farm consumption by the family, the opportunity cost – i.e. the price the farmer would have paid (market price) if he/she had not produced it – is also used.

2. Gross added value (GAV)
Gross added value corresponds to the gross value generated by the productive activity. It is calculated by deducting the value of intermediary consumptions used in the production process (inputs and services) from the gross product. Inputs may have been purchased outside the farm or may come from another activity in the agricultural production system (intra-unit consumptions: grain consumed by animals, manure enabling plots to be fertilised, etc.) It is qualified as gross, and not net, because the value of depreciation of equipment used in the production process is not deducted. So: GAV = GP – IC

Efficiency of land use (GAV/S/year)
Efficiency of land use is measured through the added value obtained per unit of surface per year (GAV/S/year). If there are several crop cycles on a single plot in a single year, it is necessary to take all of these cycles into account.

Gross daily labour productivity (GAV/Md)
Gross daily labour productivity is measured through the added value per day of work devoted to the activity (Man-day, Md). Its calculation therefore requires identification of all the labour devoted to the activity during the year.

> Evaluation of the economic performances of livestock production systems

Economic calculation can be made for each type of animal species, but also for all ruminants, particularly when they are managed jointly and use the same forage area.

Preliminary stages: calculation of gross product (GP) and of gross added value (GAV)
1. Gross product (GP)
The method used for economic evaluation of a cropping system applies. However, it is also necessary to:

- take purchase of animals away from sales,
- take account of the annual variation in the herd's value over the year. This inventory variation during the year (ΔINV) = Year-end inventory – Inventory at start of year corresponds to the year's actual production, even if animals are not sold or consumed. The variation can also be negative. So, in the case of livestock production:
  GP = Sale of animals – Purchase of animals + ΔINV + Other products, with ΔINV = Year-end inventory – Inventory at start of year.

It must be remembered that it is necessary to use data from an average year.

2. Gross added value(GAV)
The same method as that presented for cropping systems applies. Intermediary consumptions used to produce fodder in the main fodder area must not be overlooked (MFA, see below).

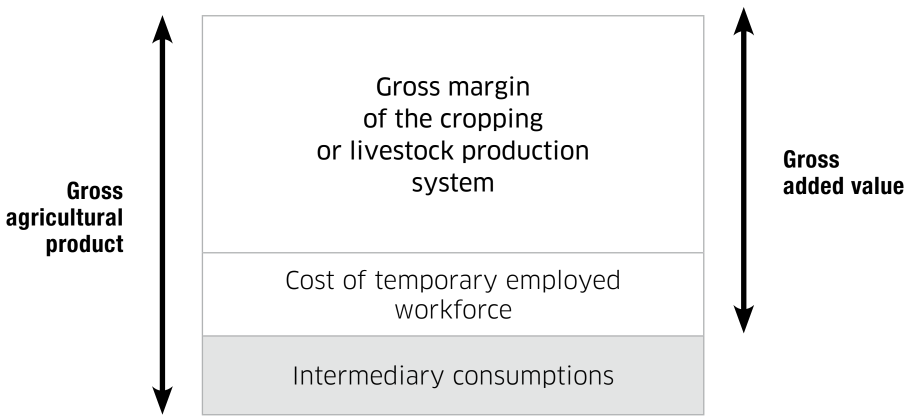
Zootechnical efficiency
A livestock production activity's performance can be evaluated by calculating the annual added value per animal head (GAV/head/year) or per animal unit (GAV/AU/year). Using animal units makes it possible to refer the different types of animals (cattle of different ages, small ruminants) to an adult cow equivalent (an adult cow = one animal unit), by using equivalencies.

Efficiency of land use (GAV/MFA/year)
Efficiency is measured through the added value obtained per unit of main fodder area per year (GAV/MFA). The main fodder area is the surface area intended mainly for fodder production (grazing or harvested with a view to future feeding). Therefore it excludes the secondary fodder area made up of plots where only a minor part of production is intended for feed (crop residues). While this indicator is interesting in some situations, it is of no use in others. This is the case when the herd is fed exclusively from sub-products (straw) and there is therefore no MFA, or when animals are fed in rangelands used jointly by other users.

Daily labour productivity (GAV/Md)
Daily labour productivity is measured through the added value per day of work devoted to the activity, including work devoted to the herd and work devoted to the main fodder area.

> Profitability of cropping and livestock production systems

From the farmer's point of view, the profitability of a cropping system or a livestock production system is evaluated by using the gross margin (GM). Unlike gross added value, the gross margin does not represent creation of wealth, but solely the portion of added value that the farmer gets, once remuneration of temporary employed workforce. The gross margin is therefore a pertinent magnitude from the point of view of farmers' who use a temporary employed workforce.
GM = GAV – Cost of temporary employed workforce
In this case it is possible to calculate the annual profitability of a cropping system (or livestock production system) per unit of surface area (GM/S/year) and per day of family labour (GM/famWd).



> Estimate of the agricultural production system's economic performance

Preliminary stage: creation of wealth (net added value, NAV)
The net added value of the production system (NAV) represents the creation of wealth obtained through this system. Before calculating it, it is necessary to calculate the gross product (GP), gross added value (GAV), and depreciation of equipment (D).

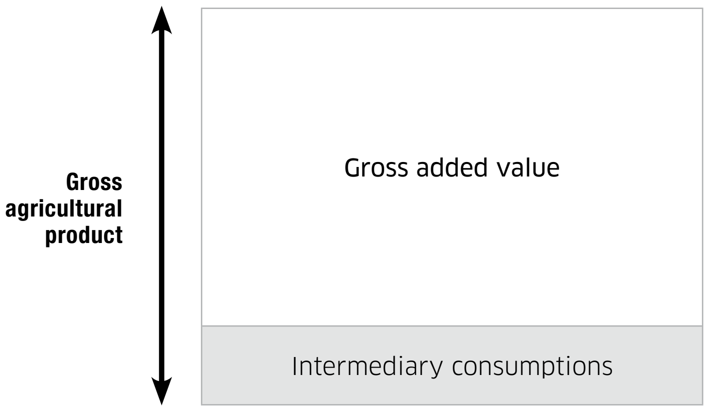
1. Gross product (GP)
The gross product of the agricultural production system (GP) represents the economic value of the latter's final output, i.e. excluding production intended for other activities in the system or intra-unit consumptions (straw intended for animal feed, manure intended for fertilisation of agricultural plots, etc.). It is obtained by adding the gross product of the different cropping and livestock production systems and subtracting production for use within the production system (production of intra-unit consumptions). So:

$$GP = \sum(\text{Cropping and livestock production systems GP}) - (\text{Products intended for use within the production system})$$

N.B. the gross product does however include production consumed by the farmer and his/her family (on-farm consumption)

2. Gross added value (GAV)
Production system's gross added value (GAV) corresponds to the gross value generated by all of the latter's productive activities. It is obtained by deducting intermediary consumption (IC), made up of inputs and services (equipment rental, electricity, etc.) from the production system's gross product. So:

$$GAV = GP - IC$$



In so far as the economic calculation has been previously made for each pour cropping and livestock production system, the production system's gross added value can be calculated more directly by adding the gross added value of each cropping and livestock production system and deducting intermediary consumptions not specifically allocated to these systems (small equipment, electricity, etc.). So:

$$GAV = \sum(\text{Cropping and livestock production systems GAV}) - \text{non-specific IC}$$

3. Depreciation (D)

Annual depreciation of the value of the farm's equipment results from wear and tear during the year. The term Annual consumption of fixed capital can also be used. Depreciation must not be confused with accounting amortisation, which is calculated in reference to current legislation and without taking the actual duration of equipment into account. For a given set of equipment (all equipment, infrastructures, machines, tools), except for small equipment re-purchased every year, depreciation (D) is calculated based on the equipment's purchase value (value when new, Vn), the number of years of useful life (n), value at end of useful life or residual value (resV).

The duration of useful life corresponds to the duration during which it is considered that the equipment can be used without generating significant maintenance and repair costs. It is often considered to have residual value, which corresponds to the fact that it can still be used for a number of years, paying maintenance and repair costs, or that it can be sold or reused for other uses (recovery of wood, spare parts, etc.). So:

$$Am = D$$

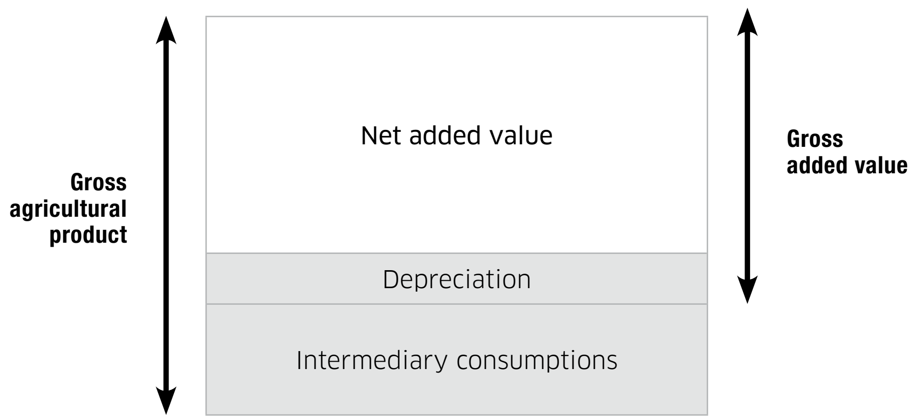
In general, animals are not depreciated. Any variation in the value of an animal (a variation that can be positive or negative in the case of a "depreciation") is already reflected in the inventory variation (ΔINV). In specific cases (in particular draught animals), the calculation of an annual depreciation can be justified for calculation of the variation of animals' value during the year.

It is sometimes pertinent to calculate depreciation of a plantation, during the production phase that represents its "useful life" (n). In this case, the initial value of a plantation (Vn) is calculated by adding all production costs incurred during phase of setting up and developing plantation, before it starts to produce. However, in the case of a regularly renewed plantation, i.e. when every year, the part of the plantation at the end of useful life is cut down and new trees are planted on the corresponding surface, depreciation is not calculated (depreciation of the overall plantation is compensated by annual renewal of one of its parts).

It should be noted that depreciation is generally calculated for the entire agricultural production system and not for each cropping or livestock production system. Equipment is often shared among different systems and it is not easy (or possible) to allocate a portion of depreciation to such or such a cropping or livestock production system. However, calculation of depreciation can sometimes be justified at cropping or livestock production system level, when equipment is specific to such or such a system (livestock production building, etc.). This is also the case for depreciation of a plantation. However, in such cases it is necessary to ensure that depreciation can actually be allocated to the different systems, which is rarely the case. In this case it is possible to calculate net added value (NAV) for each cropping or livestock production system.

4. Net added value (NAV)
The production system's net added value (NAV) is calculated by deducting the total economic depreciation of the different equipment (D) from the gross added value. So:

$$NAV = GAV - D$$



Annual labour productivity (NAV/ALU)

The agricultural production system's annual labour productivity (NAV/ALU) is measured through the added value per agricultural worker (including family and employed workers) or annual labour unit (ALU). An agricultural worker represents a person who is fully available all year round for the farm's agricultural activities. In order to take partial availability (part of the time) or more limited efficiency (children working for the harvest for example) into account, fractions of ALUs can be used. Choosing which ALUs to take into account must be decided on a case-by-case basis (work of children, of older people, notion of availability for agricultural activities). In certain cases, it can be useful to make several calculations according to various possible choices.

Daily labour productivity (NAV/Md)

The daily labour productivity (NAV/Md) is measured through added value per day of agricultural labour (man-day, Md), including the labour of family workers and employed workers. It is necessary therefore to take account of all labour in the different cropping and livestock production systems, including "transversal" labour on the farm (maintenance and repairs, etc.).

Efficiency of land use (NAV/UFA/year)

Efficiency of the agricultural production system's land use (NAV/UAS/year) is measured through the added value during a year per unit of farm surface area effectively used (useful usable farm area, UFA).

Efficiency of use of capital (NAV/(IC+D))

Efficiency of the agricultural production system's use of capital (NAV/(IC+D)) is measured through the added value per unit of capital spent during the year (intermediary consumptions and depreciation).

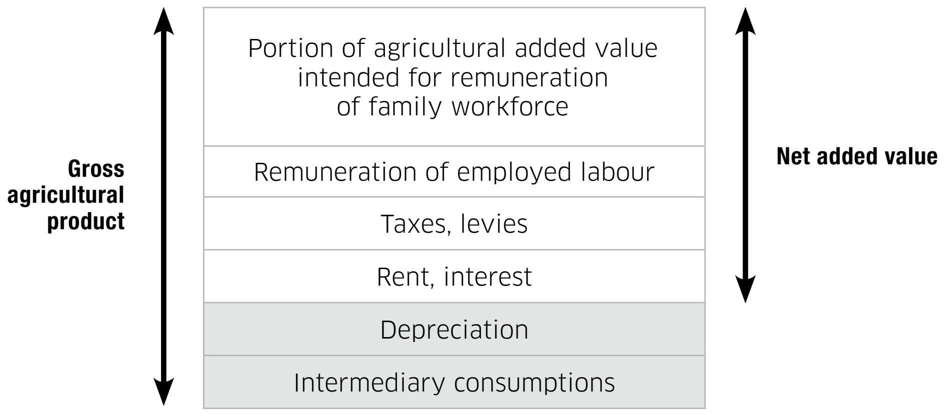
> Generation and evaluation of family agricultural income

Distribution of added value

Agricultural added value is spread between:

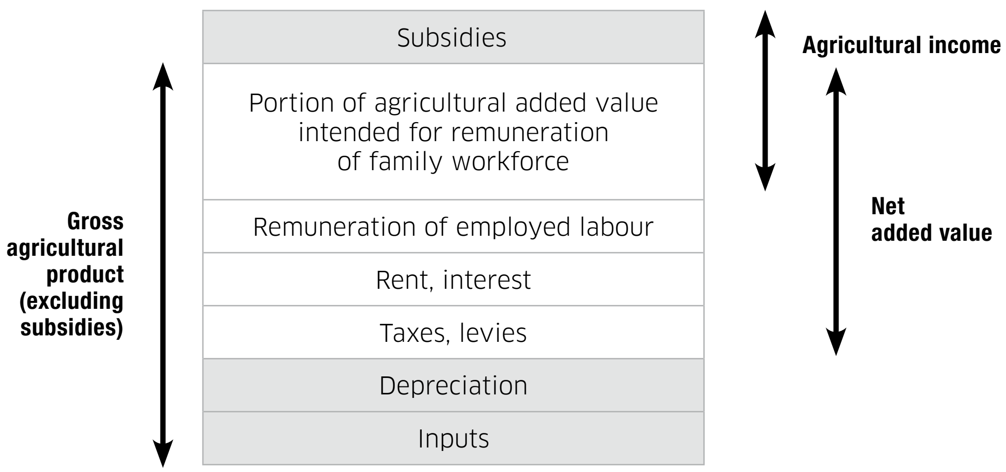
- payment of rent, interest, taxes and levies,
- remuneration of employed workforce,
- remuneration of family workforce. In the absence of subsidies, this corresponds to agricultural income (AI, see below).

Each portion can be calculated in absolute value and in relative value (% of NAV).



Make-up of agricultural income (AI)

Agricultural income (AI) is made up on the one hand of the added value intended for remuneration of the family workforce, and on the other hand of agricultural subsidies received



In the case where part of the family income comes from extra-agricultural activities, it is pertinent to also calculate the family's total income (TI) and the agricultural activity's contribution to the total income (AI/TI).

Remuneration of family labour (AI/famALU)
Remuneration family agricultural labour (RA/famALU) is calculated by dividing agricultural income by the number of family workers or family labour units (famALUs). A family agricultural worker represents a person from the family who is fully available all year round for the farm's agricultural activities. In order to take account of partial availability (part of the time) or limited efficiency (work of children for the harvest for example), fractions of famALUs can be used. Choosing which famALUs to take into account must be decided on a case-by-case basis (work of children, of older people, monitoring work, notion of availability for agricultural activities). In certain cases, it can be useful to make several calculations according to the various choices possible.

Profitability of land use (AI/UFA)
From the farmer's point of view, the agricultural production system's land use profitability (AI/UFA) is measured through agricultural income per unit of the farm's surface effectively used (useful usable farm area, UFA).

> Annual profitability of capital (AI/K)

While in the case of the family farm, agricultural income remunerates the family workforce, this is not the case for the capitalist farm. In this case, agricultural income remunerates the shareholders. Profitability of capital is therefore a criterion of performance for the capitalist farm. Various indicators that can be pertinent will not be expanded on here. However, an initial simple calculation consists of comparing agricultural income quantitatively to the overall value of capital invested in production (K), and therefore advanced by the shareholders: cost of purchase of agricultural land if the company owns it; value of equipment, animals and plantations at start of year; monetary costs for purchase of intermediary consumptions, payment of rent, interest and taxes and remuneration of employed workforce. In this way it is possible to calculate the annual profitability of capital or the rate of annual profit in percentage (AI/K X 100). It should be noted that, in the case of rapid rotation of capital during the year (several production cycles), all of the monetary costs are not necessarily advanced because part of these can be covered by revenue earned by the company during the year.

> Regularity of agricultural income

Based on evaluation of agricultural yields and of their regularity (cf. Measurement of yield and of yield regularity), it is possible to calculate the standard farm's agricultural income, not only during an average year, but also during a good and a bad year. It is necessary however to take account of the fact that a bad year does not necessarily affect all of the farm's crops in the same way. It is also possible to estimate a probability that income for a year falls below the simple reproduction threshold, leading to a situation of extreme poverty (non-satisfaction of fundamental social needs) and to decapitalisation of the farm.

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

Within a monitoring and evaluation system, there are specificities related to sampling of farms and plots (See part 5). Furthermore, annual monitoring can be simplified:

- by only making the detailed economic calculation for crops and livestock production activities concerned by the implementation of agroecological practices,
- at farm level, by only calculating the added value and agricultural income per family worker and par hectare.

For the final evaluation, it is necessary however to include all the indicators from the initial evaluation.

An additional option

An additional option for valuation of the economic calculation consists of graphically representing the agricultural income of a type of farm (construction of an archetype) based on the surface area per family worker, and comparing the curve obtained in light of simple short- and medium-term reproduction thresholds. Although this stage is very useful to assess the economic situation of a type of farm and its economic dynamic over the medium term, it requires specific proficiency in modelling and graphic representation tools used. Poor proficiency can easily lead to erroneous results. Cf. "Further reading".

POSSIBILITY OF GRAPHIC REPRESENTATION OF AGRICULTURAL INCOME BASED ON SURFACE AREA PER FAMILY WORKER

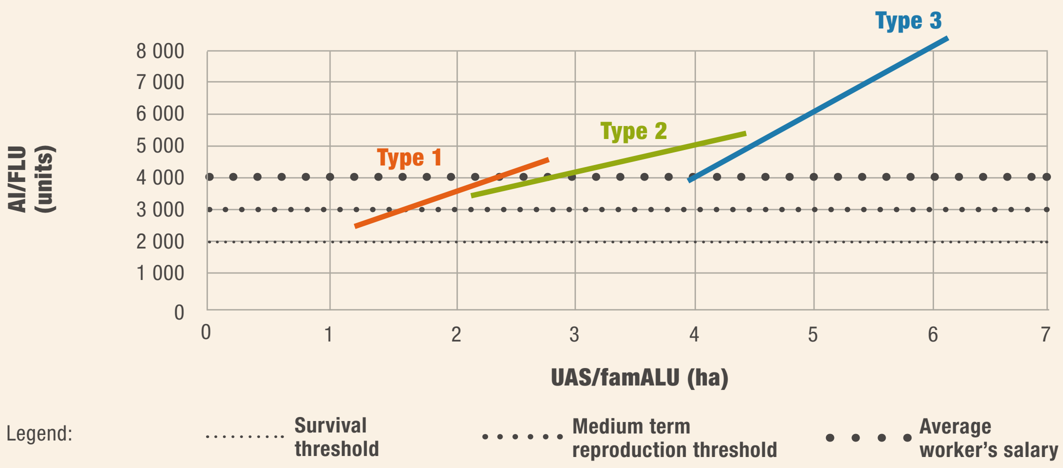
For each type of farm, it is possible de define an archetype, i.e. a standard production system with average technical performances representative of this type. Based on the reality observed in the field and technical parameters (surface area limit/family worker due to technical constraints), a minimum surface area and a maximum surface area are defined per family worker for this type. It is possible to produce a graphic representation (see example below): agricultural income per family worker is calculated for each of these two surface area levels and two points can be marked on a graph whose horizontal axis represents the surface area per family worker and whose vertical axis represents agricultural income per family worker. A straight line can be traced between the two points to graphically represent the link between the two parameters.

SITUATION OF AGRICULTURAL INCOME IN LIGHT OF SIMPLE SHORT- AND MEDIUM-TERM REPRODUCTION THRESHOLDS

In each social context, it is possible to calculate a simple short term reproduction threshold representing the level of income per family worker necessary to ensure that families' fundamental social needs are satisfied. This simple reproduction threshold depends on:

- the nature of fundamental social needs per person and the corresponding monetary amount. For this, references and statistics on the cost of living generally exist in the various countries.
- the ratio between the average number of people in agricultural families (consumption units, CU) and the number of agricultural workers (CU/famALU).

Graphic representation of agricultural income/family worker of each type of farm makes it possible to assess the situation of this income with regards the short-term reproduction threshold (or survival threshold). The average or minimum worker's salary can also be indicated (see example of graphic below).



Another threshold can also be indicated, representing the minimum worker's salary. Another reproduction threshold (medium term threshold) can also be calculated and represented to take account of the farm's need for capitalisation during a generation. Capitalisation (and therefore generation of annual economic surplus) over time is necessary so that children, after the farm has been shared, can in turn have a level of capital equivalent to that of their parents a generation ago.

6 TECHNICITY, HUMAN RESOURCES REQUIRED, COSTS

Economic evaluation is relatively complex. It requires good understanding of indicators and of their meaning, and rigorous data collection from farmers.

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GTAE

GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

ECONOMIC PERFORMANCE FROM THE OVERALL NATIONAL INTEREST POINT OF VIEW

Conducting a comprehensive economic evaluation from the overall national interest point of view, which takes the indirect effects upstream and downstream of agricultural production into account, is a very pertinent exercise for political decision-makers in any given country: the latter are supposed to apply policies responding to the overall general interest, and not solely the specific interest of such or such a social category. However it is a very demanding and complex exercise. And this handbook does not lay out the entire methodology for calculation. However, below we present the main **principles** (see boxed text), which can be included in reflection with a view to evaluation "independently of an intervention", during or at the end of an intervention.

Principles of evaluation of economic performance from the overall national interest point of view

Through economic evaluation from the community's point of view, it is about going beyond farm level and the specific interests of farmers to take account of the impact of agroecology (in terms of advantages or disadvantages) on other stakeholders/agents that could be impacted by these transformations in agriculture, for example: suppliers of synthetic inputs whose business volume would decrease, suppliers of plant material and inputs specific to agroecology whose activities would increase, the upstream processing value chain whose activity would develop (or on the contrary would slow down), and competitor producers.

Taking account of effects upstream and downstream, means including indirect gains in added value upstream (creation of value in a processing value chain/valorisation, for example) in the calculation, as well as the portion of inputs and material, part of whose value is produced locally (rather than imported, for example).

Economic evaluation from the community's "point of view" strives therefore to include in the calculation all of these direct and indirect effects perceived by the various categories of economic agents in the community.

"Community" in the sense of "collective interest", refers to all agents/stakeholders present in a territory (but also in a region, a country, as the economic evaluation can be conducted at several levels) and not a community in the sense of "territorial community" (division of a country/region into administrative units). It should be noted that in this case, the "territorial community" (the municipality, for example) is just one stakeholder among others… An economic evaluation from the community's point of view (= the general interest point of view) can therefore be conducted based on different points of view, for example:

- from the point of view of a territory or a small agricultural region. In this case the objective agroecology's contribution to the development of territory is examined, in terms of creation of added value, creation of jobs, etc…
- from a country's point of view. Here we can refer to the overall national interest. In this case, again, agroecology's contribution to the creation in particular of added value and jobs is examined. It is at this level of analysis that the weight of inputs and equipment in terms of importations, and therefore currency loss, dependency on importations, for example. In such cases, the cost of these inputs is measured at their border price, rather than at their market price (which may include, for example, a subsidy).

An assessment of induced effects (generated effects of income use by stakeholders) can also be conducted.

The factsheet on evaluation of effects on value chains (cf. Value chains and Trade organisations) enables integration of effects in terms of creation of added value upstream of value chains.

With regards agricultural production itself, partial evaluation of effects from the general interest point of view can be obtained by conside ring the fact that certain inputs are subsidised:

An approach to calculating agricultural production's added value from the national community's point of view

Some inputs (in particular synthetic fertilisers) can be subsidised by public authorities. The purchase price for farmers in this case is lower than the actual cost of these inputs (cost of production in the country or cost of importation). It is possible to use the calculation of agricultural production's added value at farm or plot level (see factsheet on *Economic performance from the farmer's point of view*), re-evaluating the cost of subsidised inputs with the amount of the subsidy. The added value obtained, which is lower than the added value calculated from the farmer's point of view, makes it possible to have a better indication of creation of agricultural wealth from the community's point of view.
The same can be done with subsidised purchases of imported equipment. In this case, the calculation of depreciation made to calculate added value underestimates the actual weight, from the national community's point of view, of use of this equipment.
On the contrary, use of inputs locally manufactured equipment can represent an actual cost, from the general interest point of view, that is lower than current market prices if the opportunity cost of resources used to manufacture it (local labour, local materials, etc.) is low.

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GTAE

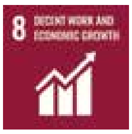
GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

APPEAL OF AGRICULTURE FOR YOUNG PEOPLE

1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Economic viability	Level of agricultural income with regards satisfaction of social needs and other income opportunities	F	Orange	Orange	Green
	Evolution and development prospects	F	Orange	Green	Green
Liveability on the farm	Volume of hours devoted to the farm per family worker	F	Orange	Green	Green
	Possibility of rest	F	Green	Green	Green
	Quality of estimated atmosphere on the farm and with entourage	F, T	Green	Green	Green
	Level of estimated fulfilment	F	Green	Green	Green
	Empowerment of young people vis-à-vis their elders	F	Orange	Green	Green
	Access to essential services and social life	F	Green	Green	Green
Security	Estimate of one's own security vis-à-vis land tenure (and water in the case of an irrigated system)	F, T	Green	Green	Green

2 LINK WITH THE SDGs



8.3. relating in particular to the development of productive activities and creation of decent employment

8.5. relating in particular to the achievement by 2030 of full productive employment and decent work for all men and women

3 PERTINENCE

The appeal of agriculture for young people is pertinent from the family's point of view. It is also pertinent from the community's and the overall public interest point of view, in so far as it is a determining factor in the future of economic activity, and job retention and creation in rural territories.
This evaluation is pertinent in all contexts where numerous young people do not want to take over their parents' farm, whereas there are no real alternative productive employment opportunities in the territory or the country. In such cases there is a real risk of regression of agricultural activity on the one hand, and of social crisis and unemployment on the other hand.
Greater appeal of agriculture for young people therefore enables better transferability of farms between generations, a term used by FADEAR, from whose evaluation method we draw inspiration in this handbook.

Agroecology seeks to ensure sustainability of practices both for the environment and for the community. It is therefore supposed to favour better transferability strengthening social and economic viability.

Evaluation of economic viability, liveability on the farm and security criteria is necessary when agriculture's lack of appeal for young people is identified as a problem.

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

> Economic viability

Level of agricultural income with regards satisfaction of social needs and other income opportunities

The income situation per family worker (AI/famALU) in terms of the reproduction threshold makes it possible to assess to what extent the latter makes it possible to cover satisfaction of fundamental social needs (cf. Economic performance from the farmer's point of view). Comparison with the minimum wage in the country and with other income opportunities also makes it possible to assess the relative economic benefit of agricultural activity.

Evolution prospects

The existence of prospects for evolution and development of the farm, particularly with a view to improving income, is a major element contributing to its appeal and therefore to transferability. These prospects depend on both the farm's resources and its socio-economic environment. It can be assessed qualitatively by questioning the farmer and more particularly young people on their perception of evolution and development prospects enabling improvement of income (no prospects, limited prospects, strong prospects).

> Liveability on the farm

Liveability is a relatively complex notion to evaluate. Income alone does not determine an activity's quality or liveability. It is based on both criteria quantitative and qualitative, taking account of the perceptions of stakeholders themselves.

Annual hourly volume devoted to the farm per family worker: average of family workers' annual working hours

Workload is an essential element of the farm's liveability. It will be compared with the current national legal working hours, which will also provide a barometer for comparison.

Possibility of rest: in number of days

Liveability also depends on the capacity free up time outside of work. The number of rest days per week, month and year will be estimated.

Qualification of the general atmosphere within the farm and its entourage

The producer will be asked to qualify the atmosphere within the farm and its entourage:

- very good
- good
- bad

Care will be taken to question the men and women in the family, and more particularly young people.

Estimate of one's own fulfilment

The farmer's perception of his/her own fulfilment will be recorded. Does the producer feel fulfilled: yes or no?

Empowerment of young people vis-à-vis their elders

A specific interview with one or several young people will make it possible to assess the exist of young people's autonomy with regards their elders: responsibility for managing part of the farm's activities, actual autonomy in terms making decisions about these activities, direct access to part of the farm's income and actual autonomy in terms of managing this income.

Access to essential services and social life

The farm's access to essential services (water, energy, internet, health, education) is also an element influencing the farm's appeal, and therefore transferability. The same applies to possibilities of social life (no isolation, forms of social organisation and social life). Agroecology can sometimes lead to the emergence of new forms of social organisation.

> Security

Estimate of one's own security vis-à-vis land tenure

Security concerning means of production has a direct incidence on the sustainability of the farming system. The farmer's capacity to invest and anticipate will depend on this security.
Concerning sustainable access to land tenure, does the farmer feel secure?

- Yes
- No

More detail will be sought by questioning the farmer on the predominant type of occupancy on his/her farm (tenant farmed, private property, collective land…), the level of formalisation (existence of documents, property deeds) and his/her capacity to make decisions about the use of this land.
In irrigated systems, access to water is also a central means of production. The farmer's sense of security will be estimated in the same way. It will also be necessary to attempt to characterise mode of access to (private, collective) and use of water (regulation underway).

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

The question will be raised during the initial evaluation and the final evaluation. During analysis of perceptions, in particular of the atmosphere and the farmer's fulfilment, particular attention will be given to questioning the comparison with regards the baseline situation, and not just his/her immediate perception.

FURTHER READING

- FADEAR, Agriculture paysanne, le manuel, Septembre 2014.

Written by:

GTAE
GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

VALUE CHAINS AND TRADE ORGANISATIONS

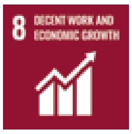
1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Outlets for farmers	Number of outlets	F			
Development and functioning of value chains	Number of value chains (agricultural products and supplies)	VC			
	Stakeholders involved, technical operations, outlets, decision-making and regulation mechanisms	VC			
	Role and weight of farmers decision-making mechanisms	VC			
Creation of wealth and of employment	Turnover, added value in value chains, employment and spread of added value	VC			

2 LINK WITH THE SDGs

2.3. relating in particular to doubling agricultural productivity and incomes of small food producers

2.4. relating in particular to sustainability of food production systems



8.2. relating to achievement of a high level of economic productivity through diversification, technological modernisation and innovation

9.2 relating to the promotion of sustainable industrialisation that benefits all people and increase in the contribution of industry to employment and gross domestic product

3 PERTINENCE

Development of agroecological systems and practices can be accompanied by evolutions at value chain level (agricultural products and means of agricultural production): evolution of outlets for production, functioning and development of value chains, creation of new production and employment, spread of added value in value chains. These evolutions generally have an effect on farmers' income and on the regularity of their income. In this case, evaluation is pertinent from their point of view. Apart from effects for farmers, and because of possible impacts in terms of development of territories and of the national economy, evaluation is also pertinent from the point of view of communities and the general interest of society.

Evaluation must systematically include an evaluation of effects in terms of the number of outlets and the number of value chains involved. When a positive effect relating to the development of agroecology exists, a more indepth evaluation of effects at value chain level is pertinent.

CRITERIA	INDICATORS	Always necessary	Necessary when the development of agroecology is supposed to also have an effect on value chains upstream and downstream
Outlets for farmers	Number of outlets	X	
Development and functioning of value chains	Number of value chains (agricultural products and supplies)	X	
	Stakeholders involved, technical operations, outlets, decision-making and regulation mechanisms		X
	Role and weight of farmers decision-making mechanisms		X
Creation of wealth and of employment	Turnover, added value in value chains, employment and spread of added value		X

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

> Outlets for farmers

Focus here will be on produce sold and diversity of outlets for farmers (direct sales on the farm, direct sales at the client's, direct sale on markets, standing sale, retailers and wholesalers, processors). Diversity of outlets ensures a certain degree of security to face uncertainties in relationships with the various operators and price volatility in certain outlets. Agroecological practices and systems can enable diversification of outlets, because of:

- the existence of new products,
- the possibility of highlighting the agroecological nature of production,
- or new forms of organisation implemented in relation to development of agroecology.

Identification of farmers' outlets is carried out firstly during the general interviews, and then during case studies of farms.

> Development and functioning of value chains

Apart from the number of outlets for farmers, development of agroecological systems and practices can be accompanied by development of new value chains, because of:

- the existence of new products,
- the possibility de of highlighting the agroecological nature of production,
- the existence of new means of production (equipment and inputs) that are specific to agroecological production,
- or new forms of organisation implemented in relation to development of agroecology.

These new value chains can include new processing activities, new distribution channels (including short value chains) and new consumption markets (local, regional, national, international).
Because of the existence of new forms of organisation implemented in relation to the development of agroecology, existing value chains can also experience changes relating to the stakeholders involved, technical operations, outlets, and decision-making and regulation mechanisms concerning volumes, quality of products, prices, and relationships between stakeholders, including through contracts between stakeholders.
Focus will be placed in particular on the way producers are organised within value chains and their capacity to act and influence value chains' functioning and prices.
Evaluation of the effects of developing agroecological practices and systems on the development and functioning of value chains requires a simplified complementary study of the value chains concerned, and particularly of the individual interviews with the main stakeholders centred on questions to be asked.

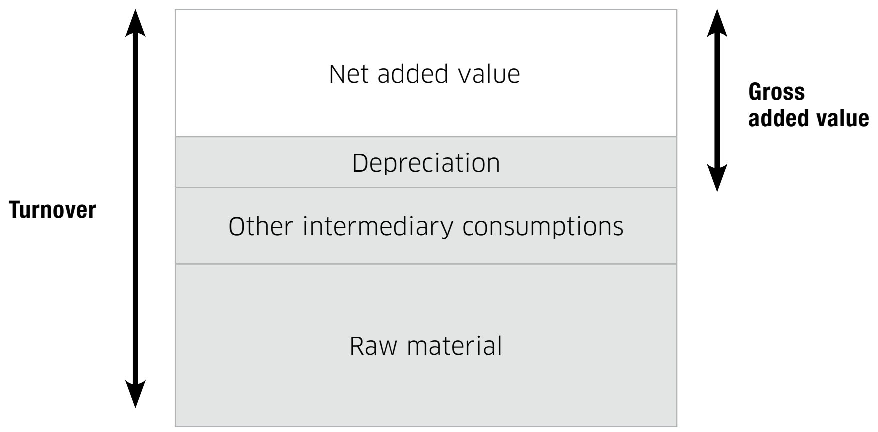
> Creation of wealth and employment

Development and evolutions within value chains can lead to evolutions in terms of creation of wealth and employment:

- overall turnover,
- overall added value,
- employment and spread of added value between stakeholders (farmers' income, remuneration of salaried workers, other stakeholders' margins) at the different stages of the value chain.

Calculation of annual overall added value involves calculation of added value generated at each level of the value chain (collection, processing, storage, transport, distribution) and addition of the values obtained. Calculation of added value at a given level of the value chain is based on the same principles as calculation of added value at agricultural production level, taking into account that, concerning the downstream value chain, an important element of intermediary consumptions is raw material, i.e. the agricultural product or the product generated by the processing of an agricultural product (see diagram n° 9).

Diagram n° 9: Added value at a level of the value chain



For this, reconstitution of a simplified annual profit and loss account for each stakeholder in the value chain is recommended. Added value can then be referred to a product unit. By including the different levels of the value chain, it is subsequently possible to calculate the overall added value per product unit (for example, for a litre of milk, added value created throughout the value chain). Care will be taken in the case of processed agricultural products to use conversion coefficients (for example, processing of cassava into semolina).

If the precise added value generated within the value chain is unknown, it is possible to calculate the ratio between the purchase price and the sale price of the product for each transaction in the value chain.

With regards spread of added value, it is necessary, at each level of the value chain, to determine the portion of added value serving as remuneration of salaried work, the portion paid in taxes to the State (VAT, tax on profits, etc) and the portion making up net income (after payment of the company's taxes). When VAT is applied to an agricultural product (or a product generated by an agricultural product) at different levels of the value chain (for example, processing and distribution), it is necessary to make sure not to record it several times. Therefore, for each level of the value chain, only VAT paid by the company to the State must be recorded, i.e. the difference between VAT received by the company for the sale of a product and VAT already paid by the company (because included in the purchase price of the raw material, of various intermediary consumptions and equipment).

Diagram n°10: Spread of added value in a level of the value chain

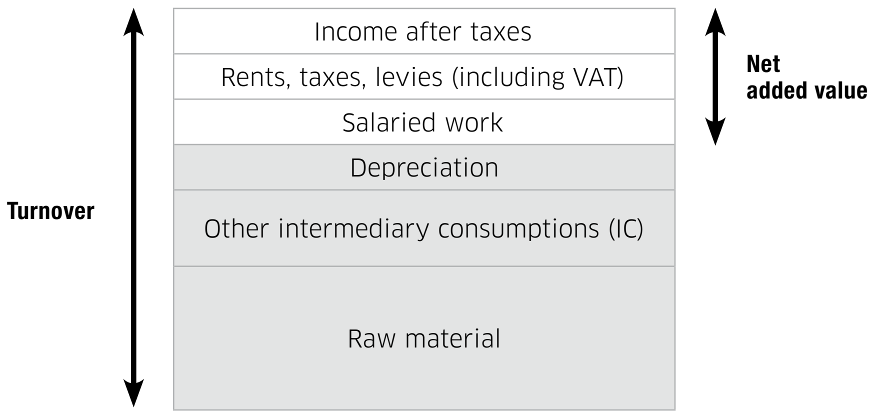
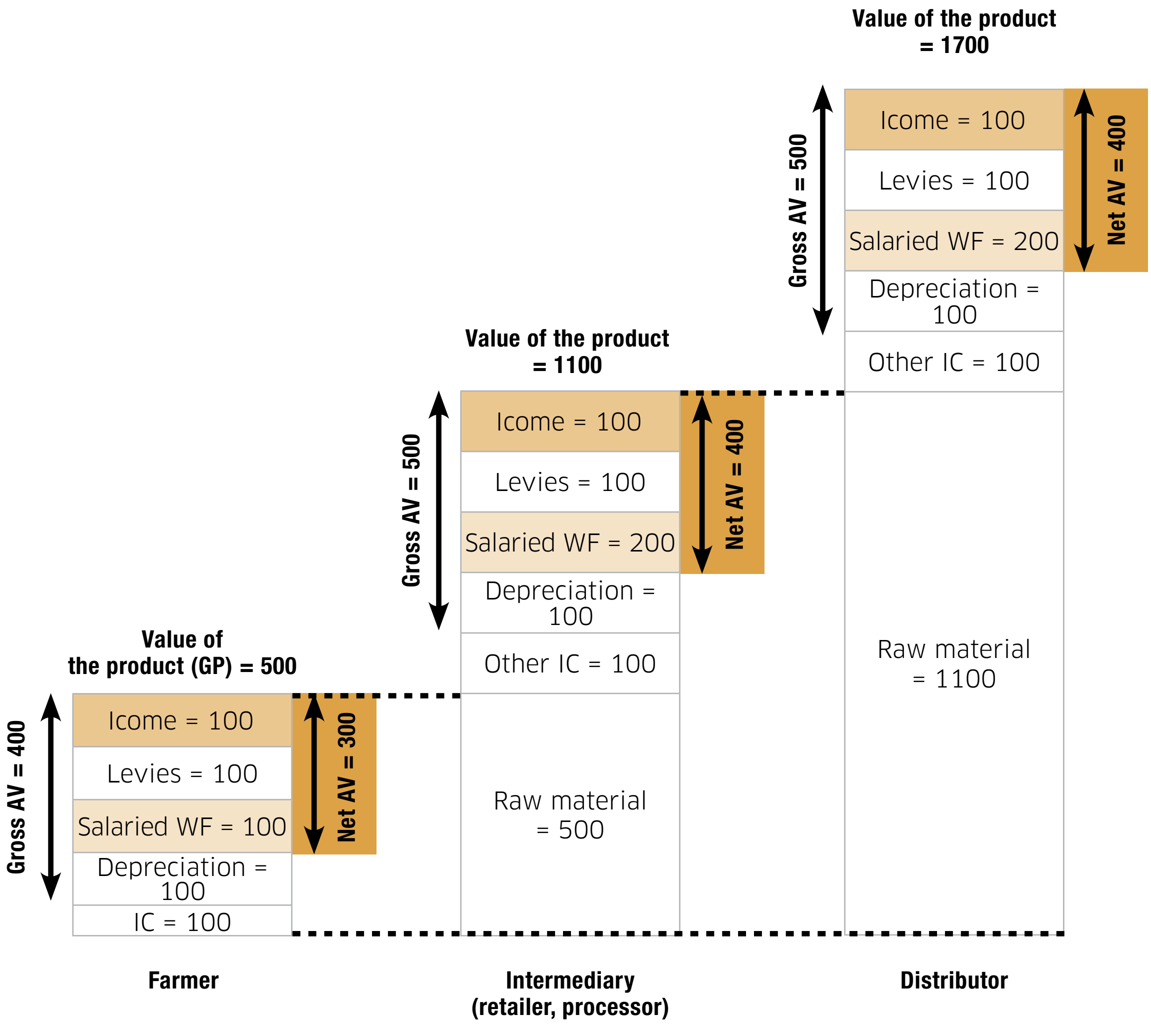


Diagram n°11: Creation of net added value throughout the value chain



To evaluate of the effects of development of agroecological practices and systems on the creation of wealth and employment in value chains and distribution of wealth (added value) a more indepth complementary study of the value chains concerned needs to be conducted, in particular via individual interviews with the main stakeholders or a sample of the main types of stakeholders, including an objective targeting reconstitution of prices (from agricultural production to consumption) and the main constitutive elements of the stakeholders' profit and loss accounts. This evaluation contributes to the economic evaluation from the overall national interest point of view (cf. corresponding factsheet).

However:

– it is necessary to make sure that all of the effects, including effects in terms of destruction of added value, are taken into account. In this way, if the creation of a new value chain leads to a decrease in volume of activity in another value chain (or to its disappearance), the net added value resulting from the change will be obtained by deducting the added value destroyed from the added value of the new value chain;

– comprehensive economic evaluation from the overall national interest point of view includes additional stages, particularly an estimate of creation of added value in the manufacture of production resources (equipment, intermediary consumptions) used and the opportunity costs of the various production stakeholders (labour, production resources) (loss of added value related to abandonment of their former use)

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

More indepth evaluation of value chains is only conducted at the beginning and at the end of an intervention. A lighter evaluation of evolutions that occurred can however be conducted as part of monitoring.

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

Component 1 of the evaluation (number of outlets) can be conducted simply during the general interviews and case studies of farms. Components 2 and 3 of the evaluation (development and functioning of value chains, creation of wealth and employment) necessitate a specific study relating to existing value chains (agricultural products and possibly supplies). Analysis of creation and spread of added value within a value chain is data that is generally complex to obtain. It is reasonable to simply identify sale and purchase prices at the different stages of the value chain.

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

AUTONOMY

This factsheet is largely based on the FADEAR[15] "*agriculture paysanne*" (family farming) manual.

15. FADEAR, "*Agriculture paysanne, le manuel*", September 2014.

1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS		SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Decision-making autonomy	At production level	Estimated degree of autonomy	F	■	■	■
		Intergenerational transmission of knowledge	F	■	■	■
		Availability of decision-making tools	F	■	■	■
	At trade level	Estimated degree of autonomy	F	■	■	■
		Availability of decision-making tools	F	■	■	■
	At processing level	Estimated degree of autonomy		■	■	■
	At investment capacity level	Estimated degree of autonomy	F	■	■	■
		Availability of decision-making tools	F	■	■	■
Economic and financial autonomy		AI per family worker/simple reproduction threshold and minimum wage	F	■	■	■
		AI/GP	F	■	■	■
		Debts-subsidy/AI	F	■	■	■
Technical autonomy	Feed autonomy (in the case of livestock production)	Fodder purchased/fodder produced	F	■	■	■
	Seed autonomy	Seeds produced/ seeds purchased	F	■	■	■
	Autonomy in use of fertilisers	Inputs purchased/inputs produced	F	■	■	■

It should be noted that:

- The issue of women's autonomy is covered in the "*Empowerment of women*" factsheet
- The issue of young people's empowerment with regards their elders is covered in the "*Appeal of agriculture for young people*" factsheet

2 LINK WITH THE SDGs

8.3. Relating in particular to the development of productive activities and creation of decent employment

Autonomy is a crucial to ensure a farm's sustainability and therefore retention of viable economic activity in a territory. Its degree of autonomy will determine whether or not the farmer can innovate, and adapt to changes in his/her natural, economic and social environment.

3 PERTINENCE

Autonomy is both the capacity to be in charge of one's technical, economic and financial choices, and the possibility to exercise this capacity. It is based on partnership, i.e. the complementarity between local stakeholders and their capacity to build solutions together. For the farmer, this means valorising human, technical and financial resources that are present locally. Autonomy is therefore evaluated at farm level, but can depend heavily on territorial level.

Autonomy contributes to the appeal of a farm, which is often an essential issue when a lot of young people envisage not taking over their parents' farm. A farm's resilience and capacity to adapt depend on this autonomy: in particular, is it capable of rapidly adjusting its technical choices and its operating model according to opportunities, but also according to constraints?

Agroecological practices can directly impact this autonomy. Preferential valorisation of local resources, diversification of activities, coordination between know-how and scientific and technical innovations, and diversification of modes of trading are all elements that will influence autonomy, particularly with regards decision-making. Similarly, limitation of production costs through valorisation of work invested must influence financial autonomy. Lastly, production of seeds and inputs directly on the farm will also influence technical autonomy.

Evaluation of criteria regarding decision-making, economic and financial, and technical autonomy, is necessary when autonomy is highlighted by the stakeholders concerned (farmers), when it is considered an important element in the resilience and sustainability of agricultural production or in the appeal of agriculture for young people.

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

> Decision-making autonomy

Decision-making autonomy is the farmer's capacity to analyse the farm's advantages and external & internal constraints in order to choose modes of production, trading and funding that will effectively meet his/her objectives (for example: increase income, free up some spare time…). More than quantitative criteria, we will seek to estimate the level of autonomy through the farmer's own analysis and by understanding his/her motivations, and conditions of access to information. This means assessing the feeling of autonomy and evaluating the availability of decision-making tools.

From the point of view of production – estimated degree of autonomy

The farmer evaluates his/her level of autonomy him/herself. Does he/she feel?

- Very autonomous
- Quite autonomous
- Not very autonomous
- Not autonomous

To take things further, we will seek to understand what reasons are behind production choices.

- Is this a deliberate choice?
- To which constraints are the choices made related: agro-environmental constraints related to the environment where he/she carries out his/her activity, constraints related to conditions of access to land (access conditional on certain practices, access not secured over the long term and therefore limiting the possible choices), socio-economic constraints related to external advice or pressure, trading opportunities, or social constraints related to the family's and associates' motivations and capacities.

In this context, we will seek to evaluate the degree of intergenerational transmission of knowledge. This transmission makes it possible to safeguard traditional knowledge and strengthen the farmer's capacity for autonomous decision-making when faced with external pressure. We will ask the farmer whether he/she was able to benefit from all of his/her parents' know-how and he/she is capable of transmitting his/her own know-how to future generations.
We will also examine whether the farmer is equipped with tools that can contribute to better decision-making autonomy:

- Does he/she have access to information (weather forecasts…)?
- Does he/she have tools for technical monitoring, monitoring of expenditure, cropping calendars, etc.

From the trade point of view – estimated degree of autonomy

The farmer evaluates his/her own level of autonomy. Does he/she feel?

- Very autonomous
- Quite autonomous
- Not very autonomous
- Not autonomous

To take things further, we will seek to understand what reasons are behind trading choices.

- Is this a personal choice?
- To which constraints are the choices made related: agro-environmental constraints related to the capacities for access to markets or production capacities, economic constraints related to outlets/markets/value chains that exist in the territory and to negotiation capacities, or social constraints related to the history of the farm, family organisation, or choice of associates.

We will also examine whether the farmer is equipped with tools that can contribute to better decision-making autonomy from a trade point of view:

- Does he/she have access to information on prices?
- Does he/she have financial management tools?

From the processing point of view

The farmer evaluates his/her own level of autonomy. Does he/she feel?

- Very autonomous
- Quite autonomous
- Not very autonomous
- Not autonomous

To take things further, we will seek to understand what reasons are behind processing choices.

- Is this a personal choice?
- Is a family heritage?
- To which constraints are the choices made related: economic constraints related to investment capacities, technical constraints related to availability of working hours or social constraints related to the family, choice of associates or external pressure.

From the point of view of investments – estimated degree of autonomy

The farmer evaluates his/her own level of autonomy. Does he/she feel?

- Very autonomous
- Quite autonomous
- Not very autonomous
- Not autonomous

To take things further, we will try to ascertain investments made on the farm and understand the reasons behind these investments:

- are they deliberate?
- were they forced by an external element?
- what were the main difficulties encountered to make the investment?

To specify constraints influencing these decisions, we will seek to ascertain investments envisaged in the future and what are the factors limiting investment. We will also examine whether the farmer is equipped with tools that can contribute to better decision-making autonomy from the point of view of investments:

- Does he/she have financial management tools?

> Economic and financial autonomy

This is the capacity to generate sufficient available income to remunerate work and ensure the farm's self-financing.

Comparison of agricultural income per family worker with the simple reproduction threshold and the minimum wage

Calculation of agricultural income per family worker (AI/famALU) makes it possible to evaluate the efficiency of work carried out and the farm's capacity to generate income. Comparing income per family worker with the simple reproduction threshold and the minimum wage makes it possible to assess the farm's capacity to ensure the family's autonomy to satisfy its social needs, while repositioning it in the national social reality (see "Economic performance from the farmer's point of view" factsheet).

Agricultural income relative to gross product (AI/GP)

This criterion makes it possible to assess the portion of gross product enabling family labour to be remunerated and, in negative, the portion of gross product that has to be devoted to payment of various production costs. It is therefore an indicator of autonomy relative to the various costs, and of the production system's pertinence from the farmer's point of view: Who does the farer work for? (see "Economic performance from the farmer's point of view" factsheet).

Amount of debts relative to agricultural income

This criterion makes it possible to evaluate the influence of financial commitments on the farm's functioning.

> Technical autonomy

This measures dependency in terms of access to supplies, and economic (dependency in terms of prices) and technical (for example, less control of animal feed composition, etc.) vulnerability. Indicators also take account of energy autonomy. Technical autonomy depends more globally on the capacity to close the cycle of elements.

Quantities of fodder purchased relative to fodder produced
Only applies to farms with livestock production activity. Feed is a key item and often costly. This measurement makes it possible to estimate dependency on external suppliers. In order to better understand the supply logic, it will be useful to analyse the form of supply (distance, type of supplier, capacity to negotiate with this supplier), and the percentage of the supply cost relative to the margin generated by livestock production.

Quantities of seeds produced relative to quantities of seeds purchased
This makes it possible to estimate dependency on external suppliers.
In order to better understand the supply logic, it will be useful to analyse the form of supply (distance, type of supplier, capacity to negotiate with this supplier), and the percentage of the supply cost relative to the margin generated by livestock production.

Quantities of fertilisers purchased relative to quantities of fertilisers produced
The price of commercial fertilisers is high and especially dependent on the external market. It is therefore an additional constraint on the farmer's autonomy. This indicator makes it possible to estimate dependency on external suppliers.
In order to better understand the supply logic, it will be useful to analyse the form of supply (distance, type of supplier, capacity to negotiate with this supplier), and the percentage of the supply cost relative to the margin generated by livestock production.

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

Evaluation of decision-making autonomy within a monitoring and evaluation system will require evaluation not just the farmer's perception of his/her autonomy, but his/her new situation relative to his/her initial perception, evaluated during the baseline situation.
When evaluating technical and financial autonomy, attention will be given to one-off events that could have had an impact on the different data collected (income, minimum wage, cost of inputs…).

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

Evaluation of autonomy is not complex. However, it involves more qualitative interviews on decision-making autonomy, which necessitate more detailed focus on the farmer's own perceptions regarding analysis of his/her own situation.

FURTHER READING

– FADEAR, Agriculture paysanne, le manuel, September 2014.

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

EMPOWERMENT OF WOMEN

1 CRITERIA AND INDICATORS

Gender indicators make it possible to measure changes concerning the situation in terms of relationships between men and women over a given period of time.

12 indicators on empowerment of women in agriculture were defined in the PRO-WEAI[16] method: autonomy of incomes, personal productivity, attitudes in the face of domestic violence, contribution to decisions concerning production, ownership of land and other assets, access to/decisions on financial services, control of the use of incomes, work balance, belonging to a group, belonging to influence groups, and respect between family members.

The existence and development of agroecological practices and systems can have effects on the empowerment of women. The criteria that seem important to retain as part of evaluation of the effects of agroecology are the following:

CRITERIA	INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
"Technical" empowerment: access to and control of productive resources for women	Contribution to decisions concerning production	P, F			
	Ownership of land and other assets	P			
	Access to and decisions on financial services	P, F			
Economic empowerment: economic power and management capacity	Access to own income and control of use of incomes	P			
	Personal productivity	P			
Social empowerment social	Work balance	P, F			
	Belonging to groups	T			

16. A tool to measure empowerment of women in agricultural development projects, developed by IFPRI, OPHI, and USAID, and currently being tested in projects for final validation shortly.

2 LINK WITH THE SDGs

1.1 relating to the reduction of extreme poverty

1.2 relating to reduction if the proportion of men, women and children of all ages living in poverty

1.4 relating to equal right for all to economic resources

1.5 relating to building the resilience of the poor and those in vulnerable situations

2.1 relating to access to safe, nutritious and sufficient food all year round.

2.3 relating to agricultural productivity and incomes of small-scale food producers

2.4 relating to sustainability of food production systems and implementation of resilient agricultural practices

2.5 relating to preservation of genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species

4.3 relating to equal access for all to technical, vocational and tertiary education

4.4 relating to increasing the number of young people and adults who have skills

5.1 relating to the end of all forms of discrimination against women and girls.

5.5 relating to ensuring women's full and effective participation and their equal access to leadership at all levels of decision-making in political, economic and public life

6.4 relating to the increase of water-use efficiency

8.5 relating to access for all to full productive employment and decent work and equal pay for work of equal value

3 PERTINENCE

Taking equality between men and women and empowerment of women into account in the evaluation of agroecology is a pertinent analysis in several regards:

– In family farms, which make up the majority of farms implementing agroecological practices, the involvement of women in production, trade and/or management activities is real and often very intense; it is therefore pertinent to seek to measure it.

– Diversification of produce in agroecology can impact on women's work in agricultural activities and livestock production, in terms of access and control in management of crops, yields and associated incomes, arduousness of work, access to and control of land, etc. Sometimes this diversification generates new incomes exclusively managed by women.

– At community and territorial level, evaluating women's participation and empowerment is pertinent because it strengthens the dissemination of practices between families. It has also been demonstrated that incomes managed by women were invested more for improvement of children's education, health and food.

CRITERIA	Always necessary	Necessary only in some cases
Contribution to decisions concerning production	X	
Ownership of land and other assets	X	
Access to and decisions on financial services		X
Access to own income and control of use of incomes	X	
Personal productivity	X	
Work balance	X	
Belonging to groups		X

4 METHODOLOGICAL APPROACH AND TOOL FOR CHARACTERISATION OF A SITUATION

The methodological approach used by the PRO-WAEI tool has not yet been disseminated. However, it is possible to refer to the methodologies in the "Autonomy", "Employment and well-being", "Economic performance from the farmer's point of view" and "Food and nutrition security" factsheets, which include evaluation elements enabling specific effects on women to be evaluated.

Evaluation is also an opportunity for women to express themselves. However, the cultural dimension, which can be significant in terms of gender equality in some zones of intervention must be taken into account, and interviews/focus groups must be adapted based on how easy or not it is for women to speak in mixed groups. It may be necessary to propose individual interviews or interviews with only women, if this is more pertinent for the quality of the survey and makes it possible to ascertain women's opinions and visions. Similarly, complementary, specific interviews with men and groups of men can make it possible to cross-reference information and measure changes in men's attitudes to women.

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

It is important to have a dynamic vision of women's empowerment, and therefore to take the process during which women acquire capacities, rights, power and recognition into account, rather than deciding on a state to be reached. It is also necessary to measure changes related to women's empowerment based on the changes made by and for other stakeholders, which will also enable evaluation of evolutions in gender relationships in the family/farm/territory.

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

It is sometimes necessary to involve interviewers of the same gender who speak the same language in order not to influence answers given by the people questioned, in particular when they are women.

FURTHER READING

– *Suivre et évaluer selon le genre* (Monitor and evaluate based on gender): http://www.genreenaction.net/Suivre-et-évaluer-selon-le-genre.html

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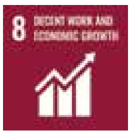
GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

EMPLOYMENT AND WELL-BEING

1 CRITERIA AND INDICATORS

CRITERIA	INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Job creation/ retention	Number of working days, workers and salaried workers per ha	F	🟧	🟧	🟩
Use of workforce during the year	Analysis of work calendars: evolution throughout the year, valorisation of slow periods	F	🟧	🟧	🟩
	Breakdown between men and women	F	🟧	🟧	🟩
Remuneration of work	Gross margin per day of family work, AI per family worker	P, SoP, T, F	🟧	🟧	🟩
	Daily or monthly remuneration of the workforce	F	🟧	🟧	🟩
Arduousness of work	Working hours/day and rest days	F	🟩	🟩	🟩
	Stakeholders' perceptions	F	🟩	🟩	🟩

2 LINK WITH THE SDGs



8.3. . relating to achievement of full productive employment and ensuring decent work for all men and women, and equal salary for work of equal value

3 PERTINENCE

Measurement of the agricultural production system's capacity to provide employment for family members and remunerate family work is pertinent from the farm's point of view. The same applies to its impact in terms of arduousness of work and well-being. This human dimension is essential for the farm and for its sustainability. Beyond the family circle, the effects on salaried work (generation of paid jobs, remuneration, arduousness) are pertinent from the point of view of communities and the public interest.

CRITERIA	INDICATORS	Always necessary	Necessary in situations where creation of employment is a significant issue and where AE practices and systems are likely to create employment	Necessary when reduction of arduousness of work is a significant issue, or when AE practices and systems are likely to have a positive or negative effect on arduousness of work
Job creation/ retention	Number of working days, workers and salaried workers per ha		X	
Use of workforce during the year	Analysis of work calendars: evolution throughout the year, valorisation of slow periods	X		
	Breakdown between men and women	X		
Remuneration of work	Gross margin per day of family work, AI per family worker	X		
	Daily or monthly remuneration of the workforce	X		
Arduousness of work	Working hours/day and rest days			X
	Stakeholders' perceptions			X

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

> Job creation/retention

Number of working days and permanent workers (family workers and salaried workers) per ha over one year

These indicators make it possible to estimate the farm's capacity to generate employment. It is referred to a surface unit in order to compare situations.

Number of working days and salaried workers over one year

The objective is to ascertain the farm's capacity to created salaried employment beyond the family circle. Temporary work is characterised by indicating its periodicity.

> Use of workforce throughout the year

Work calendars

Analysis of work calendars will make it possible to understand how the workforce is used on the farm and to analyse how agroecological practices influence this calendar.

- Is it well spread?
- Are slow periods related to agro-climatic calendars valorised?

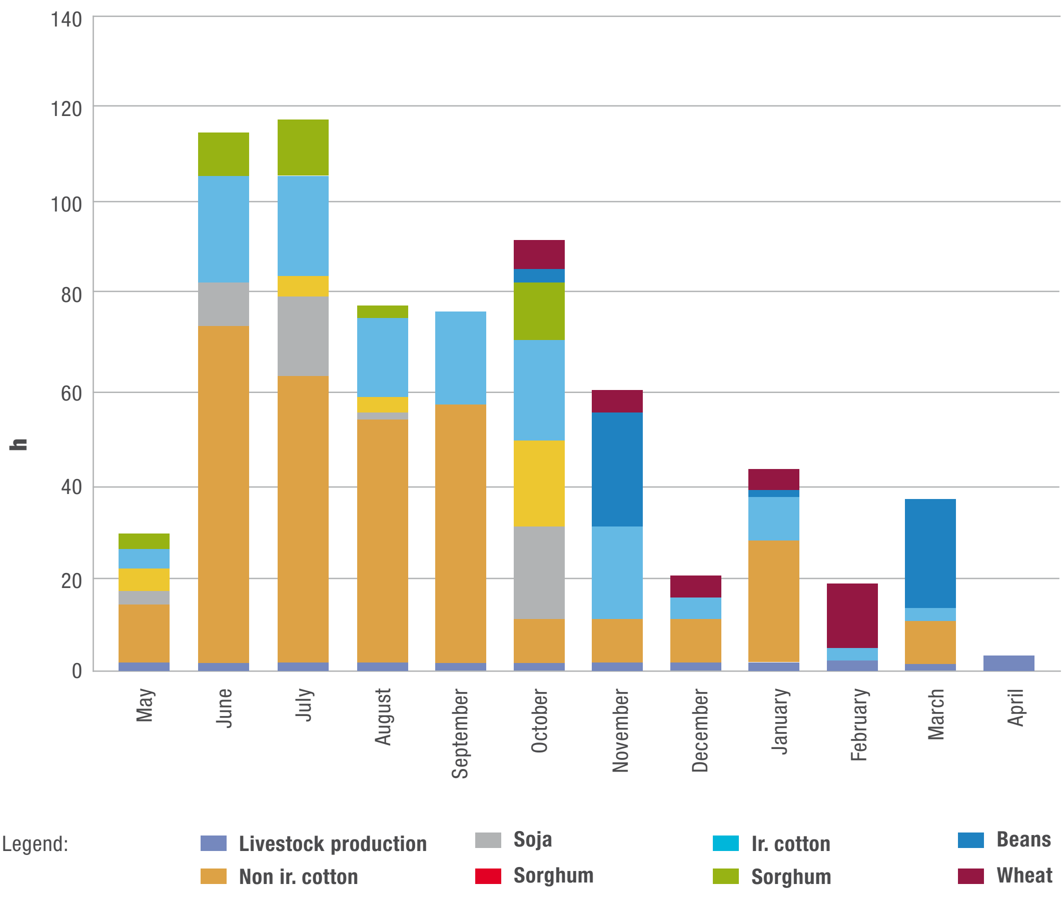
The following will also be examined:

- innovations enabling time to be saved or arduousness to be reduced (animal traction, irrigation systems, mechanisation…)
- agroecological practices and their impact (treatment, weed control…). The implementation of agroecological cropping techniques can have impacts on numerous cropping interventions: decrease of treatments, increase or reduction of weeding time, elimination of ploughing, preparation of fertilisers, etc.

Men/women breakdown

Is the farm's workload fairly spread between men and women, taking into account workloads that already exist for members of the family (domestic workload in particular)?

Diagram n° 12: Example of a work calendar



Remuneration of work

Remuneration of family work can be evaluated for each cropping or livestock production system (gross margin/Family Md) and for the entire agricultural production system (AI/ famALU) (Cf. Economic performance from the farmer's point of view).
Remuneration of family work can be compared to the opportunity cost of the workforce (remuneration in other opportunities of use of workforce).
Evolution of remuneration for women working on the farm is also an interesting indicator.
Remuneration of the salaried workforce can be evaluated based on hourly, daily or monthly remuneration.

> Arduousness of work and well-being

Working hours per day and rest days during the year
The quantity of time spent working is an essential criterion of arduousness. We will seek to evaluate hours worked per day on the farm and ascertain the number of rest days per week or per month.

Niveau de pénibilité vécu
Level of arduousness experienced
Arduousness articulates working hours, physical difficulty and harshness of actual work, but also type of work and the way it is organised, which contributes greater or lesser fulfilment. Stakeholders themselves have a certain perception based on their natural and social environment. Arduousness is therefore evaluated based on what the stakeholders themselves say.

According to the farmer, what is the overall level of arduousness of his/her work?

- The work is fulfilling,
- The work is neither arduous nor fulfilling,
- The work is arduous,
- The work is very arduous.

Is the arduousness due to long working hours or to the physical harshness of tasks? In the latter case, can you mention tasks that are particularly arduous?
It will be necessary to differentiate men's from women's perceptions.

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

Employment, workload and arduousness of work can be determining factors in the development of agroecological practices and systems. It is therefore useful to monitor evolutions as part of a monitoring and evaluation system. In the final evaluation, it will be interesting to compare not just with a reference sample, but also with the baseline situation.

6 COMPLEXITY, HUMAN RESOURCES REQUIRED, COSTS

Calculation of employment and well-being is relatively simple. It is based partly on information used elsewhere (income, working hours…) and described in Employment and well-being. The complete reconstitution of the work calendar can however be quite laborious in some complex production systems.

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

FOOD AND NUTRITION SECURITY

1 CRITERIA AND INDICATORS

CRITERIA		INDICATORS	SCALE	COLLECTION TECHNICITY	PROCESSING TECHNICITY	MATERIAL MEANS
Food supplies	Quantity of foods produced	Agricultural yields	P, F	🟧	🟩	🟩
	Diversity of foods produced	Number of food types produced and available for the family	F	🟧	🟩	🟩
Accessibility	Families' income	Agricultural income/famALU, total income/worker, simple reproduction threshold situation	F	🟥	🟥	🟩
	Jobs	Number of jobs/ha	F	🟩	🟩	🟩
	Choice in use of incomes	Portion of income managed by women; availability and relative prices of products on the market	F	🟧	🟩	🟩
	Food insecurity experienced	Index of food insecurity experienced	F	🟩	🟩	🟩
Use (food consumption and nutrient intakes)	Calorie and protein intakes	Calorie and protein intakes/ Unit of consumption during standard calendar periods	F	🟧	🟩	🟩
	Food diversity	Food diversity score during the year	F	🟧	🟩	🟩
	Nutritional quality	Food consumption score during the year	F	🟧	🟩	🟩
Stability	Risks of food insecurity	Frequency of food crisis periods	F	🟧	🟩	🟩
	Calorie and protein intakes	Calorie and protein intakes/CU during the hunger gap in the worst year of the last five years	F	🟧	🟩	🟩
	Food diversity	Food consumption score during the hunger gap in a crisis year	F	🟧	🟩	🟩
Other elements influencing nutrition security	Households' capacity to look after young children; use of healthcare and healthcare expenditure		F	🟧	🟩	🟩

2 LINK WITH THE SDGs

2.1. relating to the elimination of hunger and accessibility to healthy, nutritious and sufficient food all year round

3 PERTINENCE

Evaluation of the effects of agroecology on food and nutrition security is pertinent:

– from the family's point of view, as food and nutrition security is often a central objective of agricultural activity.

– from the point of view of communities and the public interest, given the importance of local or national agricultural production in the population's food and nutrition security, particularly faced with risks of price surges on world markets.

CRITERIA	INDICATEURS/CONTEXTE	Always necessary	Food insecurity, food security as IO	Nutritional imbalances and deficiencies, improvement of nutrition as IO	High level of pesticide use, sanitary quality of products as IO	High level of pesticide and chemical fertiliser use, improvement of water quality as IO
Food supplies	Agricultural yields		X			
	Number of food types produced and available for the family			X		
Accessibility	Agricultural income/famALU, total income/worker, simple reproduction threshold situation		X			
	Number of jobs/ha		X			
	Choice in use of incomes			X		
	Food insecurity experienced		X			
Use (food consumption and nutrient intakes)	Calorie intake/CU		X			
	Protein intake/CU		X	X		
	Food diversity			X		
	Nutritional quality			X		
Stability	Frequency of food crisis periods		X			
	Calorie intake/CU in hunger gap		X			
	Calorie intake/CU in hunger gap		X	X		
	Food diversity in hunger gap			X		
Other nutrition security elements				X		

IO: intervention objectives

Evaluation of food security is justified in contexts where food insecurity problems exist. Inclusion of the nutritional dimension is justified in situations where families' food is imbalanced and where nutritional deficiencies impacting health exist.
Evaluation in such cases is justified:

- to characterise a situation,
- as part of a monitoring and evaluation system for an intervention, particularly if food and nutrition security is one of the intervention's objectives.

4 METHODOLOGICAL APPROACH AND TOOLS FOR CHARACTERISATION OF A SITUATION

Evaluation of the effects of systems adhering in varying degrees to the principles of agroecology on food and nutrition security is conducted as part of the diagnostic analysis of agrarian systems for each indepth case study of farms (Cf. part 2).

> Availability of food

Quantity of food produced

Agricultural yields

The level of agricultural yields influences the availability of food products and on agricultural income, which can be used partly for the purchase of food products not produced on the farm. (Cf. Yields, direct measurement as expressed by stakeholders).

Diversity of food production

Number of food types produced and available for the family

Diversity of foods produced influences actual food diversity. Two situations can exist:

- Actual food diversity is not evaluated (see "Uses" below). Identification of agricultural produce present on the farm and its type of use (total, partial or non-use to feed the family) makes it possible to determine the number of types of species produced and available for the family. It is also possible to group them together by using the 12 food groups aggregated with the FAO Household dietary diversity score (HDDS): cereals; roots and tubers; vegetables; fruit; meat; eggs; fish and sea food; legumes, nuts and grains; milk and dairy products; oils and fats; sugar/honey; spices, condiments and drinks.
- Or the actual food diversity at the family level is evaluated (see "Uses" below). In this case, inclusion of a question on the origin of products makes it possible to identify foods produced on the farm and, by doing this, to have an indicator on diversity of foods produced (number of food types produced on the farm). This information can be completed by information generated by analysis of agricultural produce present on the farm and its type of use.

> Accessibility

Agricultural income/famALU, total income total/worker and employment

Agricultural income per family worker and its relative level in terms of the simple reproduction threshold (Cf. Economic performance from the farmer's point of view), is a determining element of accessibility to foods. It therefore enables assessment of the family's food security. On farms where other sources of income exist, it is more pertinent to consider total income/worker. Agriculture's capacity to provide paid jobs (number of jobs per hectare, Cf. Employment and well-being) also contributes to food security.

Choice in use of income

Choices in use of income contribute to accessibility to healthy food. In the absence of a more indepth specialised study households' use of income, two aspects must be considered:

– The portion of agricultural income managed by women. This portion often has a positive influence on accessibility to a varied diet and healthcare expenditure, in particular for members of the family most vulnerable to malnutrition (pregnant and breastfeeding women, young children). When the existence of agroecological practices and systems influence this portion, more qualitative questions can be put to women on consequences in terms of use of income.
– Availability and relative prices of the various products on markets. However, this does not depend on the implementation of agroecological practices and systems on the farm, even if the development of agroecology in a territory and new forms of organisation related to this development can also influence these characteristics in markets.

Food insecurity experienced

The FAO developed a method to evaluate access to food entitled the Food Insecurity Experience Scale (FIES)[17]. The latter makes it possible to assess an individual's or household's food insecurity situation over an entire year, based on the lived experience of the people questioned.

17. See "Further reading".

In practical terms, the food insecurity experienced is evaluated by individuals' or households' positions with regards a scale designed to cover a certain range of food insecurity severity. The method is based on direct questions to people about their experience (individual or household) of food insecurity over the last 30 days or the last 12 months. To do this, eight questions are asked, to which people answer yes or no. Each answer "yes" is scored 1 and each answer "no" is scored 0. The overall result global is both a score of 0 to 8 (8 representing the maximum level of food insecurity) and a position of answers "yes"/"no" on the scale. The order of the eight questions coincides with the scale, with successive questions covering growing food insecurity situations.

When evaluating the effects of agroecological practices and systems, it seems more pertinent to conduct an evaluation on the last twelve months at household level.
The eight questions are presented in the table below.

The eight questions of the FIES method

Q1. Have you or other members of your household been worried about not having enough to eat because you didn't have enough money or other resources to obtain food?
Q2. Have you or other members of your household been in a situation where you were unable to eat healthy and nutritious food because you didn't have enough money or other resources to obtain food?
Q3. Have you or other members of your household been in a situation where you ate almost always the same thing, because you didn't have enough money or other resources to obtain food?
Q4. Have you or other members of your household ever had to skip a meal because you didn't have enough money or other resources to obtain food?
Q5. Have you or other members of your household been in a situation where you ate less than you thought you should, because there was no money or other resources to obtain food?
Q6. Have you or other members of your household been in a situation where you ran out of food because there was not enough money or other resources to obtain food?
Q7. Have you or other members of your household been in a situation where you were hungry but did not eat because there was not enough money or other resources to obtain food?
Q8. Have you or other members of your household been in a situation where you went without eating for a whole day, because there was no money or other resources?

Source: FAO, The Food Insecurity Experience Scale – Survey modules

Uses (food consumption)

The criteria relating to food supplies, accessibility and the stability of these parameters enable a global assessment of families' food security. However, analysis of family members' food throughout the year, in both quantitative (calorie intakes) and qualitative (nutrient intakes) terms, enables more accurate evaluation of households' food and nutrition security.

Different methods can be implemented, some involving mobilisation of significant additional human resources. Ascertaining consumption is difficult due to:

- the variability of food availability, and therefore of consumption, according to seasons,
- the variability of food availability and of consumption from one year to the next (consumption over the last year is therefore not necessarily representative of an average year),
- heterogeneity of different family members' food and nutrition needs according to gender, age, activity and physiological stage (pregnant and breastfeeding women), combined with heterogeneity of actual consumption levels, as individuals with the greatest needs are not necessarily the best fed.

We therefore propose here relatively simple methods focusing on average consumption per family member, keeping in mind that more indepth evaluations can be justified in some contexts and according to priorities.

Calorie and protein intakes at different times of the year

Ascertaining the quantity of food consumed throughout the year and the family composition makes it possible, using tables on the nutritional composition of foods, to calculate daily calorie and protein intakes per unit of consumption at different times of the year, particularly in hunger gaps.

To do this, a month-by-month general food consumption calendar should be constructed, with the person who is in charge of preparing meals. The latter is questioned about the most difficult months to ensure food for the family. The months are then grouped into standard large periods, including one or two hunger gaps. For each large period, the usual daily diet, quantities of food used and people present are identified (calculation of units of consumption).

Food diversity

Measurement of a food diversity score at the different times of year enables a more accurate assessment of food diversity at these different times. As is the case with estimation of calorie and protein intakes (see above), a general food consumption calendar should be constructed month by month. Differentiation between foods produced and foods purchased will make it possible to subsequently assess the role of agricultural activity (and therefore possible integration of agroecological practices and de systems) in food diversity. Here again, the months are then grouped into standard large periods, including one or two hunger gaps. For each large period, the types of food usually consumed are identified, based on food groups. This method is inspired by the calculation method of the Household Dietary Diversity Score (HDDS), included by the FAO in the method for evaluating agroecology currently being developed (see "Further reading").

Nutritional quality

However, we advise drawing from the Food Consumption Score (FCS) commonly used by the World Food Programme (WFP). This score includes both an evaluation of food diversity and an evaluation of the diet's nutritional quality. For the latter evaluation, on the one hand frequency of consumption of foods over 7 days is taken into account (with food diversity based solely on the existence of consumption over the last 24 hours) and, on the other hand, foods' nutritional quality is taken into account, attributing a weighting factor to foods. This weighting factor is based on the density of nutrients contained in the foods consumed. So, to calculate this score, 8 food groups are considered. A table is drawn up indicating frequencies, estimated in number of days (for a total of seven days) f consumption of each food group. The food consumption score is thus a composite score based on variety of diet, frequency of consumption of foods and the significance of the nutrients contained in the different food groups. So:

$$FCS = \sum (xi \times fi), \text{ with } xi =$$
Number of days that each food group is consumed over the last 7 days;
fi = Weight attributed to the food group.

This score can be calculated for the different periods of the year.

Food groups and weighting coefficients for calculation of the food consumption score FCS

FOOD GROUPS	COEFF.	FOODS CONSUMED IN HOUSEHOLDS	JUSTIFICATIONS
1. Main staples (cereals, tubers)	2	Millet, sorghum, rice, corn, tubers, etc.	Energy dense/usually eaten in larger quantities, protein content lower and poorer quality (PER17 less) than legumes, micro-nutrients (bound by phytates).
2. Pulses and oilseeds	3	Bambara groundnuts, beans, peanuts, sesame, etc.	Rich in energy, high quantity of proteins but lower quantity than that of animal origin, micronutrients (inhibited by the presence of phytates), low in fat.
3. Vegetables	1	Leaves and vegetables	Low in energy and in proteins, no fat, rich in nutritive micro-elements.
4. Fruits	1	Mango, watermelon, avocado, orange, pineapple, etc.	Low in energy and in proteins, no fat, rich in nutritive micro-elements.
5. Animal proteins	4	Meat, poultry, eggs and fish/shellfish	Rich in good quality proteins, easily absorbable nutritive micro-elements (no phytates), energy-dense, rich in fat. Even when consumed in low quantity, improvement of diet is substantial.
6. Sugars	0.5	Sugar and sweetened products	Rich in empty calories. Normally consumed in low quantity.
7. Dairy products	4	Milk, cheese, yoghurt	Rich in good quality proteins, nutritive micro-elements, vitamin A, energy. However, milk may only be consumed in low quantity and must in such cases be considered as a condiment, which necessitates reclassification in certain cases.
8. Oil and fat	0.5	Cooking oil	Rich in energy but low in nutritive micro-elements. Normally consumed in low quantity.

Source: Food Consumption Analysis, Calculation and use of the food consumption score in food security analysis, WFP VAM, 2008.

The values of scores thus calculated are recorded on a scale whose maximal possible value is 112. Usually, standard thresholds are used to determine the three food consumption classes:

- Low food consumption: from 0 to 28;
- Borderline food consumption: from 28.5 to 42;
- Acceptable food consumption: > 42.

> Stability

Regularity of consumption from one year to the next – particularly consumption levels in years of agricultural crisis – and therefore the risk of not satisfying fundamental food and nutrition needs – can be estimated through qualitative surveys on families' strategies to adapt to these crisis situations and on effects in terms of consumption.

Risks of a food insecurity situation

The household is questioned on the existence of years where family members do not have enough to eat during certain periods of the year, the periods(s), frequency (the majority of years, every second year, one year in three, one year in five, one year in ten).

Calory and protein intakes in the event of a crisis

Calory and protein intake per unit of consumption in this type of situation can be calculated.

Food diversity in the event of a crisis

A food consumption score can be calculated in this type of situation.

> Complementary elements influencing nutrition security

A qualitative interview can be conducted to assess other elements that can influence nutrition security:

- Households' capacity to look after young children: the work of women in charge young children (distribution of time).
- Use of healthcare, healthcare expenditure.

Two types of effects are also likely to influence health and therefore food and nutrition security:

- The sanitary quality of agricultural products, and particularly the presence of pesticide residues below certain thresholds.
- The quality of water.

5 ADDITIONAL METHODOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

In the case of a monitoring and evaluation system, specificities related to sampling of farms exist (cf. part 2).

The choice of indicators and criteria will largely depend on the objectives of the intervention (inclusion or non-inclusion of objectives targeting food security, improvement of nutrition, sanitary quality of products and improvement of water quality).

When the intervention includes objectives targeting food security or(and) improvement of nutrition, it is possible to differentiate:

- On the one hand, the baseline and the final evaluation, with the most comprehensive evaluation and comparison of farms. In addition, for the final evaluation, one or several specific meeting(s) for presentation and discussion of provisional conclusions on the effects of agroecological systems and practices on families' food and nutrition security can be organised, with the participation of the people in charge of family food from farms having implemented agroecological practices and from the control group farms.
- On the other hand, the years of monitoring, with a simpler system and, with regards consumption, focused on the situation during the hunger gap(s).

6 TECHNICITY, HUMANS RESOURCES REQUIRED, COSTS

Generally speaking, evaluation of the effects of agroecology on food and nutrition security requires a rather high level of technicity, particular for collection of information (accuracy when carrying out interviews), while analysis of results is simpler.

Technicity is particularly high concerning calculation of agricultural income.

FURTHER READING

- Compendium of indicators for nutrition-sensitive agriculture, FAO
  http://www.fao.org/3/i6275e/i6275e.pdf
- Food Consumption Analysis, Calculation and use of the food consumption score in food security analysis, WFP VAM, 2008.
  https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf?_ga=2.226330003.864986336.1543409058-1567204395.1543409058
- Guide for measuring household and individual dietary diversity, FAO.
  http://www.fao.org/3/i1983e/i1983e.pdf
- The FIES method: FAO, The Food Insecurity Experience Scale: Measuring food insecurity through people's experience.
  http://www.fao.org/3/a-i7835e.pdf
- FAO, The Food Insecurity Experience Scale, Survey modules.
  http://www.fao.org/fileadmin/user_upload/voices_of_the_hungry/docs/FIES-Survey-Modules_2016_Fran%C3%A7ais_FAO.pdf

V. EVALUATION BASED ON TRANSVERSAL CRITERIA

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ADAPTATION TO CLIMATE CHANGE

Rigorous evaluation of the effects of agroecology on agriculture's adaptation to climate change is complex in that it requires the evaluation of:

– Climate change now underway and its direct consequences (hydrology, biodiversity, frequency and amplitude of periods of drought or flooding, etc.) and indirect consequences (average agricultural yields, interannual variability, animal health, zootechnical yields, etc.). This means having climate data that is contextualised to each region and an assessment of its consequences for farmers, and therefore of the contextualised issues of climate change. It is also necessary to distinguish the actual effects and changes felt by farmers. In addition, climate change can correspond to an evolution in average climate parameters (rainfall, temperatures, shifting seasons), as well as greater interannual climatic variability of these parameters and an increase in the amplitude and frequency of extreme climate events and their consequences (flooding, drought, etc.).

– Future climate change. In this case it is necessary to have projections on the climate and its effects.

– How agroecological practices can contribute to better adaptation of agriculture to climate change.

Although we are aware of agroecology's significant potential both to reduce GHG emissions and to store existing emissions, in this handbook we do not cover the issue of current and future climate change and its consequences, as it is an issue that requires specific methodological tools. However:

– Although studies on the evolution of climate change in the region based on analysis of meteorological and hydrological data have been produced, it is necessary to take these into account in the general characterisation of the region and to consider them in interviews with farmers, in order to confront them with their own perceptions of climate change (see below).

– It is necessary to record farmers' perceptions of climate change, keeping in mind that it is just a perception and it can be biased. Farmers are subjected to a variety of changes (climate, other agro-environmental conditions such as soil fertility or biodiversity, socioeconomic conditions) and it is not always easy to assess the precise responsibility that each type of change bears with regards evolution of agricultural income and of its regularity, or with regards evolution of food security. For example, a farmer may attribute a decrease in yields to climate change whereas in reality the determining factor is the soil's water retention capacity (related in particular to soil depth and fertility and plant communities).

– It is also necessary to question farmers' about their perception of the effects of agroecological practices and systems in terms of agriculture's adaptation to climate change.

As part of the indepth case studies of farms (Cf. *Diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology*):

1) The following questions will be covered:
Have you observed climate changes since you set up the farm? What changes? What are the consequences for your activities? How have you changed your activities to take better account of these changes and to adapt to them? Lastly, were you able to actually adapt to this climate change, compensate for its negative effects?

2) Based on spontaneous answers, we will go into more detail by attempting to identify:
+ whether the issues are due more to average evolution of climate parameters (temperature, level of rainfall, calendar of agricultural seasons) or related to climate changes (hydrology, biodiversity, etc.), greater irregularity in the climate from one year to the next, or an increase in the frequency and amplitude of extreme events,
+ whether the issues are due more to greater risk of climate events or greater vulnerability of farmers when faced with these risks,

+ the type of adaptation strategy implemented by the farmer (protective infrastructures, water management, soil management, crop management practices, agroforestry and reforestation, livestock production management practices, grazing lands and fodder, increase in autonomy vis-à-vis the exterior, seed banks, constitution of reserves that can be mobilised, diversification of activities as a complement to or outside of agriculture, collective solidarity mechanisms, concerted development of the territory) (see "Further reading", Levard L.)
During this interview, it can be pointed out that some agroecological practices mentioned by the farmer contribute to adaptation to climate change.

3) In a third stage, if it has not been spontaneously covered by the farmer, it is possible to question him/her about the specific effect of the agroecological practices implemented in terms of adaptation to climate characteristics, climate variability (which is not necessarily the result of climate change) and, where applicable, climate changes previously mentioned by the farmer.

– Every time it appears that climate change is likely to have negative effects on average yield levels, agricultural income and food and nutrition security, evaluation of the effects of agroecological practices on these same parameters (Cf. *Economic performance, Food and nutrition security*) is also an element for evaluation of farmers' capacity to adapt to climate change.
– Every time it appears that climate change is characterised by higher inter-annual variability of climate parameters and by an increase in the frequency and amplitude of climate accidents, evaluation of inter-annual yield regularity, agricultural income and food and nutrition security (Cf. *Economic performance, Food and nutrition security*) is also an element for evaluation of farmers' capacity to adapt to climate change.

FURTHER READING

- Cochet Hubert, Decourtieux Olivier et Garambois Nadège, coord., *Systèmes agraires et changement climatique au Sud – Les chemins de l'adaptation*, Editions Quae, 2018.
- Côte François-Xavier, Poirier-Magona Emmanuelle, Perret Sylvain, Rapidel Bruno, Roudier Philippe, Thirion Marie-Cécile, editors, *La transition agroécologique des agricultures du Sud*, Editions Quae, 2018.
- Levard Laurent, *Which public policies to promote adaptation of family farming to climate change*, Coordination Sud Agriculture and Food Commission, 2017.

RESILIENCE

Populations around the world are increasingly exposed to natural hazards and health, economic or security crises. The latter have a particularly severe impact on those who are poor and experiencing food insecurity, 75% of whom depend on agriculture and natural resources to survive (FAO). Repercussions on households are often devastating, whether losses are sudden or due to erosion over time of living conditions and livelihoods, while ecosystems are depleted, degraded or even destroyed.

Prevention of and preparation for catastrophes makes it possible to reduce their impacts. This can be achieved in particular by improving the resilience capacities of individuals, communities and ecosystems to reduce their exposure to risks, give them the means to be more resistant to damage, and to recover and adapt. Resilience is a complex notion and can have varying definitions according to areas of application. Resilience is defined by the United Nations as "The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure". *Resilience can be perceived as a combination of capacities: the capacity to recover (capacity to absorb, capacity to learn and adapt (capacity to adapt), and the capacity to anticipate and prevent (capacity to transform). In all these approaches, resilience is a characteristic that is "latent, multi-dimensional and not directly measurable"* (Rébéna, 2017).

As analysis of resilience is complex in itself, we do not cover the issue of its direct measurement in this handbook. However, agroecology is considered to contribute to improvement of resilience.

Through their diversity, agroecological systems can contribute to a greater capacity to adapt to a multitude of possible disruptions, including extreme climate events. Evaluation of effects in terms of adaptation to climate change therefore contributes to evaluation of resilience.

At farm level, diversification and integration of different types of production, and implementation of systems that are less dependent on external inputs contributes to improving socio-economic resilience and reducing vulnerability to uncertain food security and economic risks. Evaluation of the effects of agroecology on agricultural yields and their variability, on economic performance from the family farm's point of view, on farms' autonomy and on food and nutrition security contributes to evaluation of its effects in terms of resilience.

Lastly, agroecological systems also aim to achieve functional biological balances at plot and territorial level that are more likely to resist attacks by pest and disease, and climate hazards. Evaluation of the effects of agroecology on soil health and on pest and disease contributes to evaluation of its effects in terms of resilience.

VI. EVALUATION OF CONDITIONS FOR THE DEVELOPMENT OF AGROECOLOGY

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GROUPE DE TRAVAIL SUR LES TRANSITIONS AGROECOLOGIQUES

REFERENCES FOR THE DEVELOPMENT OF HYPOTHESES AND EVALUATION QUESTIONS ON POSSIBLE FAVOURABLE OR UNFAVOURABLE FACTORS FOR THE DEVELOPMENT OF AGROECOLOGY

The development of agroecology means a change of agricultural model to comply with a certain number of agronomic, economic and ecological principles and objectives. It also has a social and cultural dimension. The position in favour of one system or another is the result of global reflection that exceeds a simple change in practices. Involvement of individuals, and their organisations, in favour of a system and in its implementation is based on their convictions and perceptions which themselves result from various factors. These factors too are more or less favourable, according to people's interests and objectives on the one hand, and according to conditions that make this transition more or less possible on the other hand.
Previous studies[18] made it possible to highlight various types of factors, some of which were limiting, for the development of agroecological models. These factors, which are not exhaustive, can provide hypotheses and questions to be included in the evaluation system. These questions can be asked during interview, observations and surveys in their environment (farm, territory) with farmers who are implementing and those who are not implementing agroecology practices at various levels. This will contribute to evaluation of real or perceived constraints and favourable factors for the implementation of agroecological practices and systems.

18. *Agroécologie : capitalisation d'expériences en Afrique de l'Ouest*, CALAO Project, GTAE, 2017.

1 FACTORS SPECIFIC TO FARMERS AND TO THEIR FARMS

Some factors specific to farmers, their objectives and their farms are more or less favourable to the development of agroecology. A contradiction often appears between farms that would most need agroecological transition (farms that are in crisis, decapitalised, with the poorest soils) but do not have the means to implement it, and farms that most have the means to implement agroecological transition but have less to gain from it.

<table>
<tr><th colspan="3">AGROECOLOGICAL PRACTICES ACCORDING TO FARMERS' OBJECTIVES</th></tr>
<tr><td rowspan="6">Determining factors</td><td rowspan="3">Incentive for farmers to implement agroecological transition</td><td>Competition between short-term objectives (satisfaction of the family's immediate needs) and long-term objectives (improvement of fertility, etc.)</td></tr>
<tr><td>Opportunity of external employment for the family workforce, unavailability for the implementation of intensive AE systems</td></tr>
<tr><td>Diversification strategy (food and nutrition security objectives, objectives in terms of adding value)</td></tr>
<tr><td rowspan="3">Risk-taking for implementation of agroecological practices</td><td>Mobilisation of new knowledge and know-how</td></tr>
<tr><td>Putting crop protection at risk, and therefore of production, income or the household's food security</td></tr>
<tr><td>Confusion between actual and perceived risk</td></tr>
<tr><td>Possible points to consider for the development of hypotheses and evaluation questions</td><td colspan="2">– Farmers' objectives (economic rationality) and workforce opportunity costs
– Reconciliation of farmers' individual interests and the general interest
– Combination of agroecological practices meeting farmers' short-term objectives (food for the household and generation of income) and longer-term objectives (improvement of the setting's fertility, fight against climate change, etc.).
– Time for return on investment of certain agroecological practices
– Portion of on-farm consumption, intra-consumption and marketing of each product, level of coverage of the family's food needs</td></tr>
</table>

<table>
<tr><th colspan="3">WORK</th></tr>
<tr><td rowspan="9">Determining factors</td><td rowspan="5">Use of workforce</td><td>Practices aimed at valorising physical, chemical and biological processes and internal flows within the production system</td></tr>
<tr><td>Practices replacing chemical products by manual or mechanical work</td></tr>
<tr><td>Time spent monitoring crops and animals to prevent disease and infections</td></tr>
<tr><td>Work on soil and water conservation</td></tr>
<tr><td>Planting and maintenance of trees</td></tr>
<tr><td colspan="2">Arduousness of certain work (soil preparation, stone barriers, Zai holes, etc.) requiring the presence of young people, but who aspire to less arduous and better paid work</td></tr>
<tr><td colspan="2">Higher need of work during investment phases for time-delayed profitability, requiring initial acceptance by farmers and limited risk-taking, and sometimes collective forms of work organisation</td></tr>
<tr><td colspan="2">Availability of the workforce within the farm and external opportunity cost. Financial means for salaried workforce</td></tr>
<tr><td colspan="2">Investment/work valorisation ratio</td></tr>
<tr><td>Possible points to be considered for the development of hypotheses and evaluation questions</td><td colspan="2">- Agroecological practices' level of requirements in terms of work and arduousness
- Periods of competition between agricultural work
- Long, short- and medium-term productivitay of work
- Level of workforce remuneration
- Mechanisms for mobilisation and financing of the family and collective workforce (subsidy for investments in favour of the general interest) or the salaried workforce. Technical capacity of this workforce</td></tr>
</table>

<table>
<tr><th colspan="3">TYPOLOGY OF THE FARM</th></tr>
<tr><td rowspan="4">Determining factors</td><td rowspan="3">Farms' capacity and resources</td><td>Availability of resources (land, water, chemical inputs, natural biomass, possibility of combining crops and livestock production)</td></tr>
<tr><td>Technical and financial capacity</td></tr>
<tr><td>Capacity to assume risks related to change</td></tr>
<tr><td colspan="2">Farms' level of involvement in agroecological transition and their evolutionary trajectory</td></tr>
<tr><td>Possible points to be considered for the development of hypotheses and evaluation</td><td colspan="2">- Characteristic of the farm (size, level of equipment, net result and income, livestock production)
- Analysis of vulnerability thresholds (access to production factors, profile of families)
- Level of integration of practices (partial or in all of production) and evolutionary trajectory[19]</td></tr>
</table>

19. See "la méthode d'analyse des d'écologisation CUMA-SupAgro, in GTAE Seminar proceedings, 2017.

KNOWLEDGE AND KNOW-HOW		
Determining factors	Traditional knowledge and know-how	Possible break in transmission (last generation implementing green revolution practices, young people less present on farms)
	New knowledge and know-how	Need to be tested, or changed by farmers to adapt to local conditions and farm characteristics: complexity or lack of adaptation can seem too significant to farmers, who then abandon the new knowledge and know-how
	Possibilities for transfer of existing or innovative know-how according to farmers' profiles (age, gender…)	
	Possibility of transfer and adaption of know-how within producers' organisations	
Possible points to be conside-red for the development of hypotheses and evalua-tion questions	– Level of complexity of practices and know-how – Level of technical change (adaptive, systemic, transformative)[20] – Level of adaptation of practices and know-how to local contexts (agro-environmental, economic, social, cultural) – Degree of mobilisation of traditional and new knowledge and know-how – Level of integration and development of agricultural advice, awareness-raising systems, training and support of farmers, and of exchange of knowledge and know-how between the latter – Level of access and support by external bodies for the implementation of innovative practices (testing, demonstration) –Level of adaptation of systems according to farm types (support with transition for farms in crises, awareness-raising and promotion among the most capitalised farms) –Level of integration and development of training systems (engineers and technicians) and of agricultural research –Profile of head of the farm, distribution of responsibilities and of work within the farming family unit	

20. See la *méthode d'analyse multi dimensionnelle* by CIRAD, in GTAE Seminar proceedings, 2017.

2 PHYSICAL FACTORS AND THE FARM'S ENVIRONMENT

The various components of the farm's environment and its characteristics influence its capacity to implement agroecological practices and systems.

ORGANIC MATTER Including its production, collection, transfer, conservation and re-use within the system		
Determining factors	Availability of organic matter	Initial availability at farm or territorial level
		Priority of land use (cultivable surface, work capacity) for food or market rather than for production of organic matter (competition for production)
	Competition for use of organic matter	Fodder or burial of residues, choice of which plots to fertilise in the case of limited organic manure, sale of residues or manure when money is needed
	Capacity for valorisation of organic matter	Presence or absence of equipment for transport, storage and conservation
Possible points to be considered for the deve-lopment of hypotheses and evaluation questions	– Factors limiting or encouraging production, transport and valorisation of organic matter and pertinence of solutions provided in response to the limits identified – Level of conservation, valorisation and re-use of all organic waste on-site (valorisation of crop residues, animal housing, installation of husking units in villages, etc.)	

ECONOMIC CONDITIONS AND ENVIRONMENT		
Determining factors	External financing availability (loans, subsidies), necessary in particular in the investment phase (equipment, increase in livestock, specific inputs)	
	Availability on the market of specific means of production (improved equipment, specific plant material)	
	Outlets or lack of outlets for varieties or species from agroecological production	Consumption: evolution of food practices
		Marketing: value chains and markets, profitability in comparison with conventional agriculture products
Possible points to be considered for the development of hypotheses and evaluation questions	– Level of availability of financial resources, equipment and inputs necessary for investments and for implementation of practices – Existence of or support for the creation of supply or marketing chains for some new produce (market, possibility and conditions of product flow) – Contribution to evolution of food and nutrition practices	

ACCESS TO LAND AND PRODUCTIVE NATURAL RESOURCES		
Determining factors	Right to common grazing lands	Compatibility with off-season crops (combination with longer growing seasons, catch crops, off-season crops) or tree crops (assisted natural regeneration of trees) that are essential for soil cover, enrichment or feed supplies
		Compatibility with soil cover practices using abundant organic matter (mulching, time-delayed burial of residues)
		Compatibility with practices to secure plots (hedging, orchards, well for vegetable growing, etc.) or implementation of local agreements for sustainable management of natural resources, to protect against common grazing land
	Rules for use of commons	Obstacle to agroecological management practices (assisted natural regeneration, reforestation, limitation of use, etc.)
		Non-respect of rules in favour of the implementation of agroecological practices (bush fires, overexploitation of biomass…)
	Security of access/ control of land tenure over the medium/long term	Obstacle or favourable factor for agroecological investments (planting, soil conservation equipment, improvement of organic soil fertility)
	Perception of appropriation	Planting of trees perceived negatively in some zones, or, to the contrary, securing of land tenure through sustainable planting developments
	Social distribution of land	Access to land and to resources unfavourable for the most vulnerable families, young people and women within the family farm
Possible points to be considered for the development of hypotheses and evaluation questions	– Effects of rules for access to land on the implementation of agroecological practices and systems – Action to promote and support the implementation of concerted management of common spaces with a view to implementation of agroecological practices – Involvement of political authorities and local populations to change and respect local standards in favour of implementation of agroecological practices	

AGRO-ENVIRONMENTAL CONDITIONS		
Determining factors	Level and regularity of rainfall and access to water	Influences production of biomass
		Influences production of compost (capacity, quality)
		Limitation or encouragement of agroforestry practices (hedgerows, arboriculture in vegetable garden areas)
		Competition for use between different activities
	Level of degradation of the agro-ecosystem and of productive resources	Determines investment in terms of work and resources necessary for its restoration or its preservation
		Determines the level of farmers' interest in the implementation of new practices (fight against erosion, restoration of fertility)
	Level of climate insecurity	Generates situations of vulnerability and incites search for solutions to sustainably secure production
Possible points to be considered for the development of hypotheses and evaluation questions	– Restrictive environmental conditions (intra- and inter-annual variations in rainfall and temperatures, prevalence and intensity of extreme climate phenomena) and status of the agro-ecosystem (quality and availability of soil and water, erosion, biodiversity) – Consideration/mitigation of restrictive agro-environmental conditions in the identification and implementation of practices – Conditions of access to resources and relationship between activities for access and use of these resources (competition, synergies) at farm and territorial level	

3 POLITICAL AND INSTITUTIONAL FACTORS

PUBLIC POLICIES		
Determining factors	Supply policies, subsidies or facilitation of financing for equipment, biological materials and inputs	Obstacle for agroecology when they favour practices and systems generated by the green revolution (massive subsidies for certain synthetic chemical inputs and hybrid seeds, pro-GMOs and unfavourable for farmers' and reproducible seeds)
		Favourable when they support transition (policies intended to facilitate production, marketing and acquisition of equipment, biological materials and inputs specific to agroecological transition, regulation prohibiting GMOs and favourable for farmers' and reproducible seeds)
	Trade and agricultural policies influencing the price of agricultural products	Favourable for agroecological intensification when they ensure remunerative, stable prices
	Policies for technical support to producers and marketing of products	Favourable when they support production and marketing of agroecology products (public procurement, implementation of markets, promotion targeting consumers, etc.).
	Policies on land tenure and territorial development	Influence whether natural resources are managed sustainably or not, and influence in particular the farmers' interest in investing in agroecological practices

Determining factors	Training policies (engineers and technicians), research policies and policies on agricultural technical advice	Favourable when they include and prioritise agroecology
Possible points to be considered for the development of hypotheses and evaluation questions	- Content and implementation procedures of the various types of public policies	

INTERVENTION METHODS AND SYSTEMS	
Existing determining factors	Relevancy of diagnosis and involvement of farmers in the identification of practices to be promoted
	The role given to testing, co-construction and farmers' adaptation possibilities. Analysis of learning processes[21]
	The role given to discussions between farmers, valorisation of farmers' know-how and knowledge
	Role and positioning of the technician and his/her relationship with farmers (combination of provision of knowledge and facilitation, capacity to create a relationship of trust)
	Duration of support for farmers and of intervention systems
	Conditions for development beyond a small circle of farmers (what leads the farmers' entourage to draw inspiration from their practices)
	Consideration of all favourable determining factors in the approach
	Existence of competent support services that can be mobilised or need for strengthening
	Coherence: between public policies (agricultural, trade, land tenure policies, etc.), between policy levels (national policies vs local policies), between public policies and interventions by non-State stakeholders
Possible points to be considered for the development of hypotheses and evaluation questions	– Methods and intervention systems in actions to promote and support agroecology implemented by public authorities or non-governmental stakeholders (NGOs and producers' organisations) and their effects on the conditions of testing, appropriation, development and sustainability of agroecological changes. – Duration of periods of support for transition and possibility of making support services sustainable

21. See "la méthode d'analyse multi dimensionnelle" by CIRAD, in the GTAE Seminar proceedings, 2017.

EVALUATING THE CONDITIONS FOR DEVELOPMENT OF AGROECOLOGY AS PART OF A ONE-OFF EVALUATION

The evaluation must be contextualised, not all levels of analysis or key elements are necessarily covered, according to the agroecological systems and practices implemented or to be promoted. Once the factors that are potentially most pertinent to consider are identified (Cf. previous chapter) with regard to the context of evaluation, specific methodological elements can be included in the different stages of the diagnostic analysis of the agrarian system (Cf. Diagnostic analysis of agrarian systems: a tool adapted to evaluation of agroecology) with a view to producing in order to produce evaluation questions.

STAGES IN THE DIAGNOSTIC ANALYSIS OF AGRARIAN SYSTEMS	ELEMENTS TO BE CONSIDERED FOR IDENTIFICATION OF DETERMINING FACTORS	METHOD
Literature review	- Identification of supposed agroecological practices - Identification of services and systems supporting agroecology - Policy framework favourable or unfavourable for the implementation of agroecological practices and systems	- Study of previous documents on agroecology in the zone, of public policy procedures - Characterisation of services present (procedures, duration, competency, accessibility…) - As part of an intervention, study of project documents to characterise the system ▸ Development of hypotheses to be discussed with farmers in the following stages
Agro-socio-economic zoning	- Supposedly agroecological land use system - Agro-environmental conditions - Economic conditions and environment	- Identification of supposedly agroecological practices (trees, crop-livestock integration, crop diversity, soil protection…) and modes of tenure - Characterisation of environmental conditions (local climate data) and of the agro-ecosystem's status (level of degradation, cover crop, biodiversity, soil and water quality) and analysis of the effects of climate change on farms' technical and economic results - Identification of markets (market research, in particular niche markets) and sources of available funding (methods of access, conditions) ▸ Development of hypotheses to be discussed with farmers in the following stages

STAGES IN THE DIAGNOSTIC ANALYSIS OF AGRARIAN SYSTEMS	ELEMENTS TO BE CONSIDERED FOR IDENTIFICATION OF DETERMINING FACTORS	METHOD
Reconstitution of agrarian history	- The dynamic in terms of innovation, development, regression and disappearance of agroecological practices	- Specific interviews with representatives from bodies promoting agroecology ▶ **Development of hypotheses related to the various factors previously identified and influence on evolutionary trends**
Pre typology of farms		
Purposive sampling of farms		
Indepth case studies of farms	- Farmers' objectives - Working conditions for implementation of agroecological practices - The farm's capacity and resources vis-à-vis its engagement in agroecological transition - Implementation of production factors (land, work and capital) - Knowledge and know-how (level, access, choice of mobilisation) - Focus on availability and valorisation of organic matter	- Interview with farmers to specify and validate pre-established hypotheses - Farm survey. For each practice, determine the farmer's reasons for implementing practices or not, for the levels of implementation (partial or on all surfaces/or production) and for the phases of change implemented. Estimate the proportion of farms practising agroecology in a sample of farms that is representative of the typology - Diagnosis and monitoring of organic matter sources, characterisation of needs and means of transport - Method for identification and validation of practices[22] ▶ **Develop hypotheses and discuss them**
Complementary analysis of common spaces	- Access to land and productive natural resources	- Interviews with source persons to complete the hypotheses developed
Typology of farms, economic modelling		
Comparison of economic results, estimate of respective weights of the various types		
Conclusions, dynamic and overall issues of the agrarian system	Conclusions on the dynamic of ecosystems and the dynamic in terms of development of agroecological practices and systems. Conclusions on favourable and limiting factors for the development of agroecology	
Debate with stakeholders and validation		

22. *Agroécologie en pratique,* Identifier et valider des pratiques agroécologiques, Agrisud Guide 2010.

It should be noted that:
As part of an intervention (ongoing or ending), it will be necessary, on the one hand, to discuss these specific elements with the members of the supporting body for the development of hypotheses prior to the phase of interviews with farmers and, on the other hand, to question the system (Cf. References) in the last series of interviews with farmers.

The results and effects obtained in the transition processes are not based on the integration of a practice but on the integration of a set of practices making it possible to respect the key principles of agrosystem management (soil, water, plant and animal agro-biodiversity, landscape)[23].

23. Agrisud Guide 2010 – "Les Fondamentaux".

FURTHER READING

- Analyse des forces et faiblesses du contexte pour une transition agroécologique : identification et combinaison des ressources matérielles, techniques, cognitives et socio-économiques, Ten years for Agroecology in Europe (TYFA) Project, IDDRI, 2017
- Analyse des trajectoires d'écologisation des pratiques d'agriculteurs au sein des groupes CUMA : une méthode pour accompagner la transition agroécologique, Stéphane de Tourdonnet, Capaccita project (Innovation Mixed Research Unit – FNCUMA), 2017
- Simple analysis of production systems and relationships between the farm and the setting (agro-environmental, economic and social) with the guidebook on Management advising to very small family farming enterprises, Agrisud 2018

EVALUATING THE CONDITIONS FOR DEVELOPMENT OF AGROECOLOGY IN THE CASE OF A MONITORING AND EVALUATION SYSTEM

In the case of a monitoring and evaluation system, evaluation of the conditions for development of agroecology must:

- Integrate elements of reference of the conditions for development of agroecology deemed pertinent in light of the context Cf. References for the development of hypotheses and evaluation questions) from the launching of the monitoring and evaluation system (Cf. Design and implementation of an appropriate monitoring and evaluation system to evaluate agroecology),
- Apply the recommendations made as part of a one-off evaluation (Cf. previous chapter) in the monitoring and evaluation system's initial and final diagnostic phases.

VII. CHARACTERISATION OF AGRICULTURAL PRODUCTION SYSTEMS' DEGREE OF AGRO-ECOLOGISATION

The scale of characterisation is the agricultural production system (farm), with extension to farms in the immediate neighbourhood when mention V 13 November 2020, updated on 19 Nov (summarised presentation criteria and sub-criteria integrated)

1 SUMMARISED PRESENTATION OF CRITERIA AND SUB-CRITERIA

CRITERIA	SUB-CRITERIA
1. Cultivated biodiversity and livestock production biodiversity	1.1. Crop diversity
	1.2. Livestock production animals
2. Synergies	2.1. Agriculture-livestock production integration
	2.2. Rotation cropping and intercropping
	2.3. Integration of trees in the agricultural production system
	2.4. Contribution of the agricultural production system to connectivity between the various elements of the agroecosystem and the landscape
3. Economy and recycling of elements	3.1. Recycling of organic matter and nutrients
	3.2. Water management
	3.3. Energy
4. Autonomy of the system resulting from valorisation of the ecosystem's resources, synergies, and saving and recycling of elements	4.1. Global autonomy in terms of inputs and other means of production
	4.2. Fertilisation practices
	4.3. Sanitary and phytosanitary protection
	4.4. Genetic resources
5. Soil protection	5.1. Practices to fight against erosion and protect soil
	5.2. Soil cover
6. Contribution to territorialisation and ecological viability of the food system	6.1. Valorisation of local varieties and species and of local know-how for food preparation
	6.2. Products marketed in the territory
	6.3. Relationships with consumers

2 DETAIL OF THE GRID

CRITERIA	SUB-CRITERIA	SCORE	SCALE OF CHARACTERISATION – DESCRIPTION OF THE SITUATION: MAIN VARIABLE	POSSIBLE SECONDARY VARIABLE	COMPLEMENTS	EA SCORE
1. Cultivated biodiversity and livestock production biodiversity	1.1. Crop diversity	0	More than 50% of the cultivated surface is occupied by a single crop or intercropping		*Not including permanent grass. *The "intercropping" dimension of agro-biodiversity is covered as part of criterion 2. *Synergies* (2.2. *Rotation cropping and intercropping*) *The presence of trees and perennial crops is covered as part of criterion 2. *Synergies* (2.4. Integration of trees)	3
		1	Between 33% and 50% of the cultivated surface is occupied by the main crop or intercropping			
		2	No more than 33% of the cultivated surface is covered by the main crop or intercropping	In total, between 3 and 4 crops or crop combinations		
		3		In total, at least 5 crops or crop combinations		
	1.2. Livestock production animals	0	Absence of livestock production			3
		1	One single animal species			
		2	Two or three animal species			
		3	At least four animal species			
2. Synergies	2.1. Agri-culture-livestock production integration	0	No livestock production or no agriculture-livestock production integration. No part of the animal feed is produced on the farm or on a neighbouring farm. Animal waste is not used for crop fertilisation (farm or neighbouring farm).		*Possibilities of variants (for example, a score of 1 can also correspond to "The majority of animal feed is produced on the farm or on a neighbouring farm, BUT animal waste is not used for fertilisation (farm or neighbouring farm)"). *Including aquaculture.	3
		1	Low level of agriculture-livestock production integration. A minor part of the animal feed is produced on the farm or on a neighbouring farm. Animal waste is used for fertilisation (farm or neighbouring farm)			
		2	Average level of agriculture-livestock production integration. The majority of the animal feed is produced on the farm or on a neighbouring farm (including grazing), animal waste is used for fertilisation (farm or neighbouring farm).			
		3	High level of agriculture-livestock production integration. The majority of the animal feed is produced on the farm or on a neighbouring farm (including grazing), animal waste is used for fertilisation (farm or neighbouring farm), animal traction is valorised.			

CRITERIA	SUB-CRITERIA	SCORE	SCALE OF CHARACTERISATION		COMPLEMENTS	EA SCORE
			DESCRIPTION OF THE SITUATION			
			MAIN VARIABLE	POSSIBLE SECONDARY VARIABLE		
2. Synergies	2.2. Rotation cropping and inter-cropping	0	Absence of rotational crops and intercropping		*Permanent grass not included	3
		1	Less than 50% of the cultivated surface is occupied by rotational crops or intercropping			
		2	More than 50% of the cultivated surface is occupied by rotational crops or intercropping			
		3	The totality of the cultivated surface is occupied by rotational crops or intercropping			
	2.3. Inte-gration of trees in the agri-cultural production system	0	Absence or marginal presence of trees		*Commons management is not integrated in this characterisation, which focuses on farm level. *Possibilities of variants (for example, situation 3 can also correspond to “Low level of hedging, but agroforestry practised in nearly all plots”)	3
		1	Low or average presence of trees: some hedges or trees in certain plots			
		2	Average to strong presence of trees: quite significant presence of hedges or trees in plots			
		3	Very high integration of trees: systematic hedging of plots or agroforestry practised on majority of plots			
	2.4. Contri-bution of the agri-cultural production system to connec-tivity between the various elements of the agroeco-system and the landscape	0	Absence of contribution to connectivity: the farm’s agroecosystem is highly uniform, absence of semi-natural zones and of ecological compensation			3
		1	Low contribution to connectivity: presence of some isolated elements contributing to it, such as trees, bushes, hedges, ponds, small semi-natural or ecological compensation zones			
		2	Average contribution to connectivity: presence of several elements contributing to it (trees, bushes, hedges, ponds), these elements are integrated or adjacent to crops and prairies; or significant presence of semi-natural or ecological compensation zones			
		3	Strong contribution to connectivity: the agroecosystem features a mosaic of diversified landscapes; or numerous elements such as trees, bushes, hedges or ponds are integrated or adjacent to crops and grasslands; or significant presence of semi-natural or ecological compensationzones			

CRITERIA	SUB-CRITERIA	SCORE	SCALE OF CHARACTERISATION — DESCRIPTION OF THE SITUATION: MAIN VARIABLE	POSSIBLE SECONDARY VARIABLE	COMPLEMENTS	EA SCORE
3. Economy and recycling of elements	3.1. Recycling of organic matter and nutrients	0	All of the production system's products and co-products are exported from the system or destroyed			3
		1	The production system's products and co-products not exported are recycled on-site (decomposition, burning, consumed by animals, transferred to other crops)			
		2	The production system's products and co-products not exported are recycled on-site (decomposition, burning, consumed by animals, transferred to other crops). Specific practices are implemented to limit losses during carbon and nitrogen cycles (composting of manure, intermediate nitrate-fixing intermediate crops – NFIC, recovery of liquid from manure, etc)			
		3		In addition, practices for recycling ecosystem residues (leaves, branches) or consumer residues (compost from peelings, treated pit sludge) are implemented		
	3.2. Water manage-ment	0	In dry regions, absence of practices to harvest and save water		* Does not apply in zones with no risk of water shortage. In this case apply a score of 3.	3
		1	In dry regions, a single practice to harvest and save water			
		2	In dry regions, two practices to harvest and save water			
		3	In dry regions, a variety of practices to harvest and save water			
	3.3. Energy	0	Absence of production and use of renewable energy			3
		1	The majority of energy used is acquired on the market			
		2	The majority of energy used comes from the farm's renewable energies (animal traction, wind, hydraulic, wood, biogas, solar)			
		3	The totality of energy used comes from the farm's renewable energies (animal traction, wind, hydraulic, wood, biogas, solar)			

CRITERIA	SUB-CRITERIA	SCORE	SCALE OF CHARACTERISATION		COMPLEMENTS	EA SCORE
			DESCRIPTION OF THE SITUATION			
			MAIN VARIABLE	POSSIBLE SECONDARY VARIABLE		
4. Autonomy of the system resulting from valorisation of the ecosystem's resources, synergies, and saving and recycling of elements	4.1. Global autonomy in terms of inputs and other means of production	0	Very low global autonomy: net added value of the production system represents less than 20% of the gross product (NAV/GP < 20%)			3
		1	Low global autonomy: net added value of the production system represents between 20% and 50% of the gross product (20%<NAV/GP < 50%)			
		2	Fairly high global autonomy: net added value of the production system represents between 50% and 80% of the gross product (50%<NAV/GP < 80%)			
		3	Very high global autonomy: net added value of the production system represents more than 80% of the gross product (NAV/GP > 80%)			
	4.2. Fertilisation practices	0	Synthetic fertilisers are used regularly in all crops and grasslands; or absence/ low use of synthetic fertilisers is the result of absence/poor access and accompanied by absence of an alternative system for management of fertility		*Excluding permanent grasslands.	3
		1	Fertilisation of crops and grasslands is based mainly on synthetic fertilisers, but also on organic fertilisers (dung, manure, compost, green manures, plant residues)			
		2	Fertilisation of crops and grasslands is based mainly on organic fertilisers (dung, manure, compost, green manures, plant residues), but also on synthetic fertilisers			
		3	Fertilisation of crops and grasslands is based solely on organic fertilisers (dung, manure, compost, green manures, plant residues)			

CRITERIA	SUB-CRITERIA	SCORE	SCALE OF CHARACTERISATION — DESCRIPTION OF THE SITUATION — MAIN VARIABLE	POSSIBLE SECONDARY VARIABLE	COMPLEMENTS	EA SCORE
4. Autonomy of the system resulting from valorisation of the ecosystem's resources, synergies, and saving and recycling of elements	4.3. Sanitary and phy-tosanitary protection	0	Sanitary and phytosanitary protection of livestock production animals is based exclusively on the use of pesticides and synthetic veterinarian products			3
		1	Sanitary and phytosanitary protection of livestock production animals is based on the use of both pesticides and synthetic veterinarian products and biological control practices or/and biological products			
		2	Sanitary and phytosanitary protection of livestock production animals is based exclusively on the use of biological control practices or/and biological products			
		3	Sanitary and phytosanitary protection of livestock production animals is based exclusively on the use of biological products and a wide variety of biological control practices, including in terms of prevention, as part of integrated biological protection			
	4.4. Genetic resources	0	All plant genetic resources (seeds, plants) and animal genetic resources (animals, animal semen) are acquired outside the farm for each production cycle			3
		1	The majority of plant genetic resources (seeds, plants) and animal genetic resources (animals, animal semen) is acquired outside the farm for each production cycle			
		2	The majority of plant genetic resources (seeds, plants) and animal genetic resources (animals, animal semen) comes from the farm or from exchanges between farmers			
		3	The totality of plant genetic resources (seeds, plants) and animal genetic resources (animals, animal semen) comes from the farm or from exchanges between farmers			

CRITERIA	SUB-CRITERIA	SCORE	SCALE OF CHARACTERISATION		COMPLEMENTS	EA SCORE
			DESCRIPTION OF THE SITUATION			
			MAIN VARIABLE	POSSIBLE SECONDARY VARIABLE		
5. Soil protection	5.1. Practices to fight against erosion and protect soil	0	In zones with erosion risks, absence of practices to fight against erosion and protect soil		*Does not apply in zones with no risk of erosion. In this case apply a score of 3.	3
		1	In zones with erosion risks, presence of some practices to fight against erosion and protect soil			
		2	In zones with erosion risks, significant presence of some practices to fight against erosion and protect soil			
		3	In zones with erosion risks, integrated system to fight against erosion and protect soil, using a combination of practices			
	5.2. Soil cover	0	The totality of soils is ploughed or left bare (absence of residues or plant covers) after harvests			3
		1	Less than 50% of the cultivated surface is protected in the months following harvests with residues or plant covers			
		2	More than 50% of the cultivated surface is protected in the months following harvests with residues or plant covers			
		3	The totality of the cultivated surface is protected in the months following harvests with residues or plant covers			
6. Contribution to territorialisation and ecological viability of the food system	6.1. Valorisation of local varieties and species and of local know-how for food preparation to fight against erosion and protect soil	0	Absence of valorisation of local varieties and species and local know-how to prepare food. Whether food comes from the farm or is purchased, its preparation is based exclusively on exogenous varieties and species		*Some varieties and species were introduced over time. These will be considered as “local” in so far as they are integrated in practices and can be locally reproduced	3
		1	Preparation of food is only sometimes based on valorisation of local varieties and species and local know-how. Whether food comes from the farm or is purchased, its preparation is based mostly on exogenous varieties and species			
		2	Preparation of food is based mostly on valorisation of local varieties and species and local know-how			
		3	Preparation of food is based exclusively on valorisation of local varieties and species and local know-how			

CRITERIA	SUB-CRITERIA	SCORE	SCALE OF CHARACTERISATION — DESCRIPTION OF THE SITUATION — MAIN VARIABLE	POSSIBLE SECONDARY VARIABLE	COMPLEMENTS	EA SCORE
6. Contribution to territoria-lisation and ecological viability of the food system	6.2. Products marketed in the ter-ritory	0	There is no local market or no product from the farm is marketed in the territory		*By territory, we mean the territory of the community, of neighbouring communities and of nearby urban centres	3
		1	A minor part of production marketed is done so on the local market or in the territory			
		2	A major part of production marketed is done so on the local market or in the territory			
		3	All of the farm's production is valorised in the territory			
	6.3. Relation-ships with consumers	0	Absence of links with consumers			3
		1	Direct links with consumers exist but are relatively limited (small part of products marketed)			
		2	Significant direct links with consumers exist (significant portion of products marketed)			
		3	Strong links with consumers exist (majority of products marketed)			
					TOTAL	54

General remarks:
*The terms "totality" and "exclusively" should be understood as "totality or near-totality" and "exclusively or almost exclusively"
*The term "absence" should be understood as "absence or near-absence"

3 OVERALL CHARACTERISATION OF THE PRODUCTION SYSTEM'S DEGREE OF AGRO-ECOLOGISATION

AGRO-ECOLO SCORE	NUMBER OF POINTS	CHARACTERISATION
E	0 to 10	Non-agroecological production system
D	11 to 21	Production system integrating some principles of agroecology
C	22 to 32	Moderately agroecological production system
B	33 to 43	The production system's degree of agro-ecologisation is quite high
A	44 to 54	The production system's degree of agro-ecologisation is very high

NOTES

NOTES

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Translated from the original text in French: Mémento pour l'évaluation de l'agroécologie
Coordinators: Laurent Levard, Bertrand Mathieu, Prémila Masse
Artistic direction and layout: Laétitia Lafond
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Printed in France, May 2019

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This handbook is a methodological tool to evaluate the conditions for development of agroecology and the agro-environmental and socio-economic effects of agroecological practices and systems.

Intended mainly for development stakeholders, it is designed as an easy-to-use tool with a reliable common methodology enabling systematic production of references, which are still lacking today, with a view to promotion and support of the development of agroecology.

The handbook provides methodological benchmarks for evaluation of agroecology, whether as part of a one-off evaluation (during, at the end of, or outside of an intervention) or in the case of implementation of a monitoring and evaluation system within an intervention.
Its objective is to help development stakeholders to evaluate the results and effects of their agroecology interventions, proposing various evaluation criteria, together with indicators and methods presented in the form of factsheets. Furthermore, the creation of references on the economic, social and environmental performance of agroecology will make it possible to inform arguments in favour of agroecology via-à-vis donors and deciders, while identification of conditions for the development of agroecology can be considered in the design of interventions and public policies in favour of agroecology.

This handbook is a first methodological document, which will be improved and adjusted based on findings when the tools and methods proposed are implemented in future evaluation work conducted by GTAE and its partners.

This methodological handbook is the result of collaboration between the teams at:

- the Working group on agroecological transitions (GTAE), made up of Agrisud International, Agronomes et Vétérinaires Sans Frontières (AVSF), Cari and GRET,
- the Comparative agriculture and agricultural development teaching and research unit at AgroParisTech,
- the Agroecology and Sustainable intensification of annual crops (AÏDA) research unit at Cirad,
- the Functional ecology and biogeochemistry of soils and agro-systems (Eco&Sols) mixed research unit at IRD.

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