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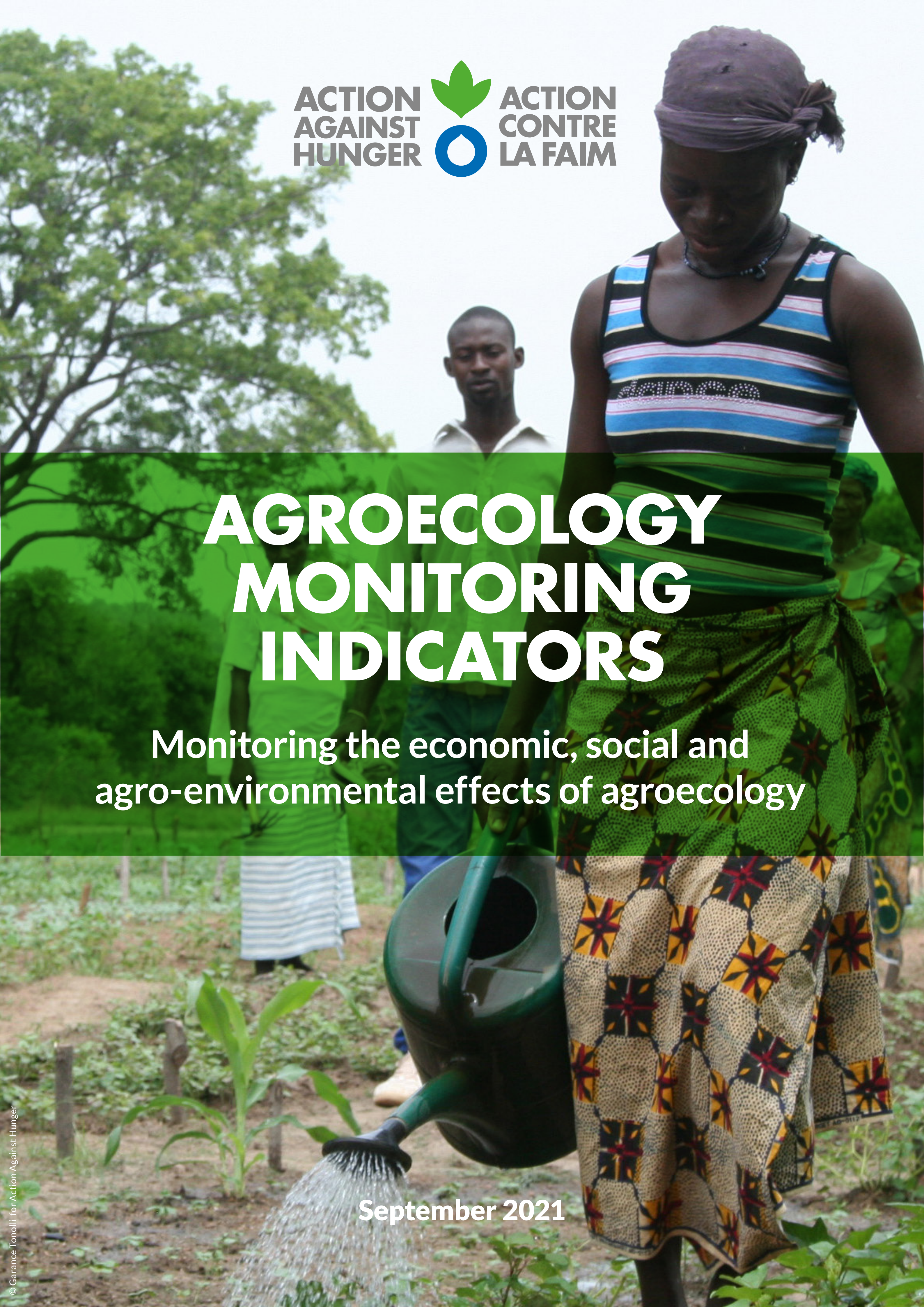

AGROECOLOGY MONITORING INDICATORS

Monitoring the economic, social and agro-environmental effects of agroecology

September 2021

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INTRODUCTION

Agroecology promotes sustainable agricultural production practices and methods, combining the agricultural practices implemented with the environmental and socio-economic performance of farms. The production of a quantity of food items in quantity and quality, while respecting the environment and being economically and socially sustainable and reliable, requires the combination of particular agroecological techniques: water management on the plot, management of soil fertility, integration of agriculture and livestock, combination of crops, pest management, etc.

OBJECTIVE

Monitoring the effects of agroecology requires **prior definition of an evaluation framework**. The main objective is the **monitoring of economic, social and agro-environmental impacts** of the programmes implemented by AAH and its partners, using a certain number of specific indicators. It is in no way a matter of comparing the obtained results against those of control groups, nor of demonstrating the interest in agroecological practices versus conventional practices. **Strictly operational**, this monitoring is not aimed at operational research, which requires more precise protocols. However, if you wish to embark on operational research, please contact your **Operational Technical Advisor at AAH headquarters**, who will be able to assist you.

SELECTION OF INDICATORS

- The selection of indicators is based on a **review of the existing literature** on the subject.
- The different indicators are proposed according to **crop and animal production systems** as well as according to the **agro-environmental, social and economic effects**. *The table below* presents the different indicators.
- The proposed indicators were chosen according to several criteria: they must be **SMART**, **relevant** to Action Against Hunger's agricultural projects, depend on the **availability of data**, and **ease of data collection** and their **measurement or calculation methods**. Emphasis is placed on indicators that are easy to understand, collect, calculate, estimate or observe.

- The data needed to calculate the indicators are **collected exclusively by Action against Hunger technicians or their technical partners**, previously trained in these indicators and their method of collection and interpretation.

- In addition, the proposed indicators were chosen so that they are a**s relevant as possible to the various contexts of Action Against Hunger's intervention areas** and meet the **needs of agricultural production systems** predominant in these areas. The aim is to **provide a simple monitoring tool** to facilitate its adoption by colleagues and partners staff in the field.

- The main objective is **to offer a simple MEAL tool** to guarantee its adoption and implementation.

Indicators for monitoring the economic, social and agro-environmental effects of agroecology

Monitoring type		Indicators	
Monitoring of economic effects	**1**	Average crop yield	Yield estimation by the method of nominal baseline
			Yield estimation by the method of yield per square
	2	Average livestock yield	Number of animals
			Herd expansion
			Meat production
			Milk production
			Egg production
	3	Income from agricultural production	Income from crop production
			Income from livestock production
Monitoring of social effects	**4**	Employment, workload	Employment and workload
	5	Women's empowerment	Contribution to decision making related to agricultural production
			Group participation and leadership
			Leisure time / rest
Monitoring of agro-environmental effects	**6**	Soil quality and health	Invertebrate population
			Signs of soil erosion
			Vegetation cover / mulching
			Levels of organic matter

INDICATORS OF ECONOMIC EFFECTS

CROP YIELD

Crop yield is one of the performance indicators of a farm. It is defined as *yield reduced to a unit of area* (yield per area, per hectare).

The different factors that can influence crop yields are: soil fertility, seed variety, crop maintenance and environment (climate, temperature, rainfall) as well as the used agricultural area.

The data and information necessary for its calculation are based on crop type, harvested product harvested, volume of production and the used agricultural area.

COLLECTION PERIOD

- **Before-project collection (Baseline):** Necessary for the collection of baseline data.
- **Collection during the project:** If the production cycle is shorter than the project cycle, the collection is organized at the end of each production cycle. This will make it possible to have harvest data over several years and make comparisons.
- **End-of-project collection (Endline):** Necessary to make comparisons and assess project performance.

DATA COLLECTION MANAGERS

- Programme managers
- Agricultural technicians
- Project surveyors
- Monitoring and evaluation officer
- Farmers
- Professional organizations

PERFORMANCE DATA COLLECTION METHODS

Data collection can be carried out in **three ways**:

1. **Harvest monitoring:** Collection of the data available in the farm management record books (production logbook, for example) kept by the farmers.

2. **Yield per square (field measurement):** Calculation of the average of at least three yield per square measurements on the same plot.

3. **Estimated yield** in comparison to a nominal baseline.

In many family farms, they do not have production records; it is therefore recommended to use the most commonly used methods, which are the **yield per square method** and **producer's estimate**, using the nominal baseline method yield estimation.

RECOMMENDATIONS

- If possible, identify a few **lead farmers** (+/- 10), train them and involve them in the collection of yield data by specifying their **role and responsibility** in data collection.

- Use existing **secondary data** from community agents and technical services agents, previously trained in methods of collecting performance data.

- If possible, estimate yields by weighing **the entire production** (annual planting) by providing producers with the **necessary equipment for weighing** (scale, bag, etc.).

- Since the methods of estimating yield in vegetable production are **very diverse** (yield per crop plant, yield per square meter, yield in bunches, yield in units, etc.), it is necessary to **train a small number of people** (technical agents, producers) on these different yield estimation methods.

YIELD CALCULATION BY THE YIELD PER SQUARE METHOD

The method of estimating yields from yield per squares consists of placing small yield squares on a sample of plots and then calculating output based on the size and estimated yields.

DATA COLLECTION MANAGERS

- Programme managers
- Agricultural technicians
- Previously trained project surveyors

PROTOCOL FOR LAYING OUT THE YIELD SQUARES

1. Select a **sample of plots participating in the AAH project** to place the yield squares.

2. **The number of squares** to place depends on the **size of the plot**. But it is recommended to place **at least 2 yield squares** in the plot to be able to calculate the **average yields**.

3. **The dimensions of the square** depend mainly on the t**ype and density of crops** in place. For example, the **corn** yield squares have an area of **25 m²** while those of **rice** are **1 m²**.

4. Yield squares are usually set up at the **earliest stages of the plant's growth cycle**, and yield estimates in the squares are made at **harvest time**.

5. Record yield per each square: **(Total harvest weight in the square / area of the square)** (see *table 1*).

6. ***Total the yield of all the squares*** and calculate the ***average yield per square***.

7. **Extrapolate** to ha, then reduce the yield to the **actual area** as follows:

   *For example, if the yield square is a **1 x 1 m square**, then the area of the square is **1 m²**. It is then necessary to multiply the result of the yield of the square by **10,000 (1 ha being equal to 10,000 m²)** to obtain the **yield in kg/ha**. If the yield square is a **5 x 5 m square**, then the area of the yield square is **25 m²**.*

*It is then necessary to multiply the result of the yield of the square by **400 (10.000 / 25)** to obtain the yield in kg/ha.*

8. If the **area of the field** is known, based on the average yield the researcher can calculate the total production of the field **(Average yield X Field size)**.

A detailed method of yield per square set up is given in the **appendix 1**.

Table 1. *Estimation of crop yields using the yield per square method*

Plots	Yield per square meter (1)	Yield per square meter (2)	Yield per square meter (3)	Average yield	Yield in Ha	Yield based on the actual plot size
A						
B						

We can then calculate the yields of plots **A** and **B** and compare the results.

Example : *Should there be a plot of corn of **10 ha** on which three yield squares **5 x 5 m side** were set up. The yield squares are as follows:*

- *Square 1: **1 kg***
- *Square 2: **2 kg***
- *Square 3: **3 kg***

*What is the **average yield** of the plot?*

1. *We calculate the **Sum of all yields per square** = 1 + 2 + 3 = 6 kg*
2. *We calculate the **Average yield per square**: 6 / 3 = 2 kg*
3. *We calculate the **Average yield per hectare**: 2 X 400 = 800 kg / ha*

Example of yield calculation on a corn field of 0.25 hectares

No. of square	Surface area Yield/Square (m2)	Harvested Yield/square (kg)	Weight (kg)/m²	Total weight perplot (kg)	Yield in T / Ha
1	16	2.200	0.138	344	1.375
2	16	4.500	0.281	703	2.813
3	16	1.350	0.084	211	0.844
4	16	2.000	0.125	313	1.250
Average yield					**1.5705**

REFERENCES

- Rodriguez, M., 2012. Yield: Calculation and estimate by yield squares
- BEDIYE et al., 2016. *Sample survey on the yield squares for cereals, rice and maize in the 17 communes of the ProSOL and ProCIVA projects*; for more details see HERE.

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ESTIMATED CROP YIELD RELATIVE TO A NOMINAL BASELINE

Under the nominal baseline estimation method, yield is estimated against a nominal baseline to assess changes (change or decrease in yield) resulting from the agricultural project.

EXAMPLE

- *The sample survey is carried out among a sample of farms benefiting from ACF's agroecological project to collect harvest data.*
- *Project beneficiaries are asked to show whether there has been an **increase** or **decrease** in yield because of the project's implementation.*
- *In order to do this, we distribute **10 tokens** to the producers, which they place in an individual basket (**the 10 tokens being the baseline, representing the average yield before the project**).*
- *We then give the producers **10 other tokens** and ask them to show any relative change in performance **following the project**, either by adding tokens to the original basket of ten tokens, or by removing tokens.*
- *For example, if someone were to add 4 tokens to the original basket, that would represent a 40 % increase in yield. However, if someone were to remove 4 tokens, that would represent a 40 % decrease from the pre-project yield.*
- *The results are recorded for the situation "before" and the situation "after" the project*

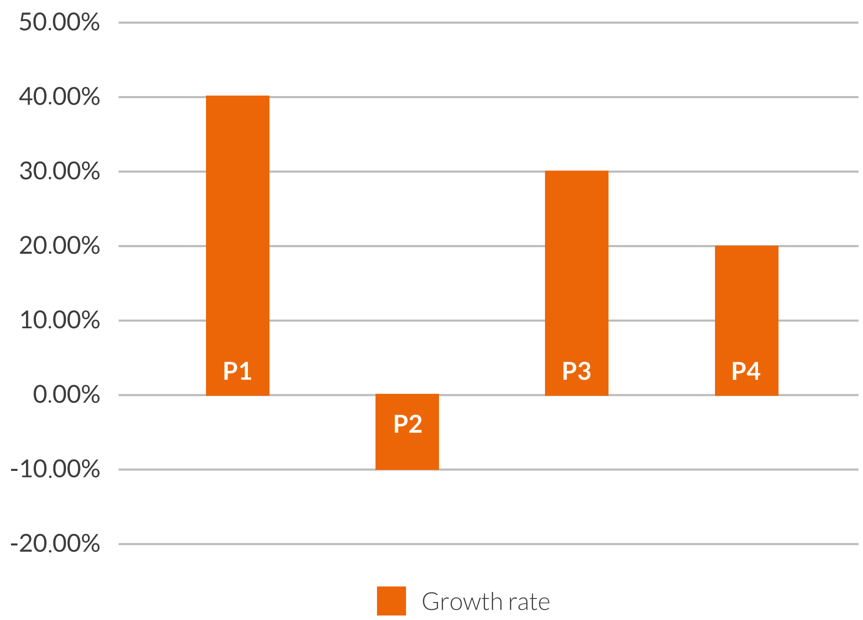
DATA COLLECTION MANAGERS

- Programme managers
- Agricultural technicians
- Previously trained project surveyors

EXAMPLES

The table below gives the **yield rate increase** achieved by **4 producers** noting a total of twenty tokens compared to a baseline of 10 tokens.

Producers (P)	*Yield before the project*	*Yield after theproject*	*Growth rate*
P1	10	14	**40.00 %**
P2	10	9	**-10.00 %**
P3	10	13	**30.00 %**
P4	10	12	**20.00 %**



INTERPRETATION

- The graph above shows positive **yield rate increases** for **Producers 1, 3 and 4** and a **yield decrease** for **Producer 2**.
- **Monitoring changes in yields over time** on plots implementing agroecological practices would allow **better understanding and evaluation of the effects** of agroecology on yields.

INCOME FROM CROP PRODUCTION

Farm income is an indicator of economic performance of a farm operation. It is an essential indicator in the evaluation of agroecological practices and systems because it is the basis for adoption of any agricultural innovation by the farmer (an increase in income being a central objective for the producer). Agricultural incomes vary mainly depending on the people involved (individuals, households), the agricultural area used, the geographical or climatic conditions, the farming methods applied, the crops cultivated as well as the quality of the soil.

COLLECTION PERIOD

- **Before-project collection (Baseline):** Necessary for baseline data.
- **Collection during the project:** If the production cycle is shorter than the project cycle, the collection is organized at the end of each production cycle. This will allow for income over several years and to make comparisons.
- **End-of-project collection (Endline):** Required to draw comparisons and assess project performance.

PERSONS IN CHARGE AND METHODS OF DATA COLLECTION

Data collectors: Programme managers, agricultural technicians, project surveyors, monitoring and evaluation officer, farmers, professional organizations.

Data collection can be carried out in **three ways**:

1. **Production monitoring:** We collect the data available in the farm management record books (production book for example) held by the farmers
2. The production estimate data is collected by the **yield squares method** (see *Crop yield* sheet).
3. Farm household **survey**.

ASSESSMENT BASED ON PRODUCERS' STATEMENTS

Agricultural household survey: If the data are not available, we organize a household survey based on information available in the **survey data** (production survey, etc.). Information relating to production is collected from **statements made by farmers**.

In the absence of data available from the producer, income can be estimated on the basis of the **producer's perception** of the income differential measured as the difference between the income situation resulting from the implementation of the project and that which would have prevailed without the project (differential with - without project). In this case, we will therefore be satisfied with the **income differential** as perceived by the producer b**efore and after the implementation of the project** or the adoption of certain agroecological practices.

The **basic income** can be the average over the three years before the start of the project and as received by the producer.

All methods of income estimation based on the producer's statements involve the use of **semi-structured interviews** and **methods of grading** or **hierarchical ranking**.

It can be carried out by asking a simple **question on changes in income** by type of agricultural activity, before and after the project.

1. Ask the respondents to **answer the question** on changes in income by type of agricultural activity, **before and after agroecology**, choosing from the following answers:

- **(1)** Decrease in income
- **(2)** No change
- **(3)** Increase in income

2. When they are happy with the response, **record the results**.

3. Then ask them to answer for other agricultural activities.

4. If you observe **changes** in income between "before" and "after" ask the respondent to explain the **reasons** for these differences and **record the answers**.

Product type	*Year 1*	*Year 2*	*Year 3*	
Crop 1	(1)	(3)	(2)	
Crop 2	(1)	(2)	(3)	

EXAMPLE OF AN INCOME ASSESSMENT FOR THE RESILAC PROJECT

The income assessment for this project is based on **surveys of producers** who have benefited from the project and on **semi-structured interviews**.

Questions :

1. From last year's harvest to this year's, how much would you estimate the sale of your agricultural production to be for each of your crops (**A, D**)?

2. How much do you estimate the self-consumed production to be (reduced to the price at which it would have been bought on the local market) (**B, E**)?

3. How much do you estimate the production costs for each of your crops (**C, F**)?

Crop income is calculated as follows:

R1 = A + B - C
R2 = D + E - F

Global crop income R= R1 + R2

Responses are recorded according to crop types:

Crops	*Income from sales*	*Production for own consumption*	*Production costs and expenses*	*Income by crop type*	*Overall agricultural income*
Subsistence	A	B	C	**R1** = A+B-C	**R1 + R2**
Vegetable crops	D	E	F	**R2** = D+E-F	

INCOME ESTIMATION IN RELATION TO A NOMINAL BASELINE

Another way of estimating agricultural income (change or decline in income) is by using a nominal baseline to assess changes in income during an impact assessment of an agricultural project. This method is explained by the example in the following table (Catley et al., 2009)[1].

EXAMPLE

*Project participants were asked to show whether there had been an **increase** or **decrease** in **actual income** since the start of the project.*

*To do this, they placed **10 tokens** in a basket that represented their **pre-project income** (the baseline being 10 tokens).*

*Participants were then given **10 more tokens** and asked to show any **relative changes in household income**, either by adding tokens to the original basket of 10 tokens or by removing them. For example, if someone were to add 4 tokens to the original basket, that would represent a 40 % increase in income. But if someone were to remove 4 tokens, that would represent a 40 % drop in income.*

*Participants were then asked to **explain these changes**. The table below shows the **aggregated results** indicating an average increase varying between 15 % and 16 % in the income of the two communities involved in the project.*

Data obtained by counting a total of twenty tokens in relation to a given baseline of ten tokens

Communities	*Variable*	*Mean score (increase) 95 % CI*
Site A (n=117)	Change in household income	16.3 (15.9 ; 163.8)
Sites B (n=145)	Change in household income	15 (14.3 ; 15.7)

[1] Catley, A., Burns, J., Abebe, D., Suji, O., 2009. *Participatory Impact Assessment - Guide for practitioners.* Feinstein International Center https://fic.tufts.edu/assets/Impact-Guide-French.pdf

USE AND INTERPRETATION

Compare the income of farmers generated by the **agroecological system** and the **conventional system**, taking into account the system **before and after intervention**.

CHALLENGES AND LIMITATIONS

The difficulty of the exercise entails identifying **all the specific elements** linked to the **work** and the **situation** in order to obtain a better estimate, i.e. the closest to the farming income of the individual surveyed.

1. The appropriate **time for data collection** (lean season, harvest, etc.).
2. **The number of incomes covered:** Sale of products, sale of by-products, debt repayments, etc.
3. **Actual estimate of costs incurred** in carrying out the work, including production costs (labour) and debts incurred (goods, money).

INDICATORS FOR LIVESTOCK PERFORMANCE (FAO, 2018)[2]

Livestock performance is measured on the basis of livestock production and productivity. Although several types of livestock farming are distinguished, in general, five types of livestock (cattle, sheep, goats, pigs, poultry) represent the majority (99 %) of animal production, including meat, milk, eggs, and skins (FAOSTAT, 2013).

- **Animal production** is defined here as the study of the production of **animals raised and bred** on farms and the production of **animal products**.

- **Livestock productivity** analyses the **relationship** between **animal production** and the **resources it uses**.

The average livestock yield makes it possible to measure the effect of livestock farming practices on animal production and zootechnical performance.

- **Performance analysis** by type of livestock farming, comparisons between livestock systems, etc.

- **Performance gap analysis** on livestock production before and after the implementation of an agroecological project.

WHAT ARE THE INDICATORS OF LIVESTOCK PRODUCTIVITY?

The data and information needed to calculate the **performance of livestock production** is based on the **type of livestock**, the **cycle** or **duration** of livestock production, the **type of livestock** product, the **volume** of production, and the **size** of the farm (the number of livestock).

Different types of livestock farming (cattle, goat, poultry, etc.), products and livestock systems require a **variety of indicators for estimating livestock productivity** including:

- **Total production** (total production per farm: meat, milk, eggs)
- **Production per animal** (production of meat, milk, or eggs per animal)
- **The productivity rate** (birth rate, death rate, operating rate, etc.)

[2] FAO, 2018. *Directives sur les méthodes d'estimation de la production et de la productivité de l'élevage* http://www.fao.org/3/ca6400fr/ca6400fr.pdf

- **Indicators of animal health** (cases of animal diseases and deaths linked to these diseases, vaccination rate, etc.)
- **Efficiency indicators** (productivity per unit of input for inputs such as labour or feed)

Knowing that it will be **difficult to collect all these indicators** within the framework of an AAH agricultural project, the livestock farming indicators to be considered within the framework of this MEAL tool are limited to the following:

- **Stock or herd size** (number of animals, dynamics / increase in livestock population)
- **Meat production**
- **Milk production**
- **Egg production**

The **definition of these indicators** as well as the **collection** and **calculation methods** are given in the *documents relating to each of these indicators*. In cases where the elements necessary for the calculation of the indicators are difficult to collect directly from respondents, these elements should be taken from **other indicators that are easier to measure**.

CALENDAR AND FREQUENCY OF COLLECTION OF LIVESTOCK DATA

The collection of animal production monitoring indicators requires a **calendar** and a **survey frequency** based in particular on the **reference day** and the **collection frequency**.

The reference day refers to when herd size or production data are recorded. It is important to use the **same reference day** for all farms as part of a data collection exercise. Seasonal peaks in production or consumption, as well as transhumance, must be taken into account when setting the reference day, since these **events** can considerably influence the number of livestock or the volume of production recorded.

The reference period is the period over which livestock production and productivity data is collected, for example, the amount of milk produced in the last 12 months, or the number of eggs produced in the last 4 months. .

Collection frequency. The survey may consist of a **single collection period** or **repeated collection periods at fixed intervals**. The frequency depends on the seasonality of production and the breeding cycles of the animals. Livestock productivity surveys are typically carried out over one year and researchers should make field visits at least once per season to collect data on livestock size and / or production.

In general, **one annual survey** is sufficient to measure **changes in livestock size**; in contrast, more frequent data collection (**quarterly or even monthly**) is needed to measure **changes in poultry and egg** production.

LIVESTOCK INDICATORS IN THE GLOBAL SOUTH

Most livestock farms in the Global South **do not keep activity logs**. This makes it difficult for the farmer to answer questions such as *"What is the farm's total milk production in the last 12 months?"* Instead, it is preferable to use a **range of questions**, so that the additional data collected straight from the respondent facilitates the calculation of the necessary indicators.

Face-to-face interviews seem to be the most commonly used method. However, in-person interview techniques have limitations that can **affect the quality of data collected**: a heavy reliance on the farmer's memory, accidental or deliberate overestimation or underestimation by the respondent, due to insufficient knowledge of how to estimate particular characteristics (such as the weight of the animals), or a desire to give a positive image of their farm.

In addition, **repeated data collection** can lead to farmers becoming **frustrated or fatigued**, and can give them the impression that this task imposes an **additional workload** on them.

Finally, if an effective data collection strategy is to be put in place, the collection of livestock data must take into account the **type of livestock farming system** (nomadic, pastoral, transhumant).

NUMBER OF ANIMALS

The number of animals makes it possible to determine the herd size over a given reference period, generally 12 months, broken down by type of animal: cattle, sheep, goats, pigs, poultry, etc. This is a central indicator for animal production because most of the livestock indicators (production of milk, meat, eggs, etc.) are determined by it.

COLLECTION PERIOD

- **Before-project collection (Baseline):** Necessary for the collection of baseline data.
- **Collection during the project:** If the production cycle is shorter than the project cycle, the collection is organized at the end of each production cycle.
- **End-of-project collection (Endline):** Necessary to make comparisons and assess project performance.

NB : To obtain a better estimate of the number of animals, the period of data collection should be **as short as possible** and should avoid periods which coincide with **special events** and consumption peaks (for example Eid or Christmas for some communities).

DATA COLLECTION MANAGERS

- Programme manager
- Zootechnicians
- Project researchers
- Monitoring and evaluation officers

METHODS AND FREQUENCY OF DATA COLLECTION

The **main sources of data** are **censuses** and **household surveys** to produce statistics on the number of herds raised by households.

Data collection can be done in **two ways**:

1. **Production monitoring:** Available data is collected from **farm management record books** (for example a production log), or from **veterinary or administrative registers**, when such documents are available.

2. **Face-to-face interview with the farmer** on the composition of the herd, by declaration.

The frequency depends on the **seasonality of production** and the **breeding cycles** of the animals. Livestock productivity surveys are typically carried out **over one year** and researchers should make field visits **at least once per season** to collect data on livestock size and / or production.

ESTIMATE ON THE BASIS OF THE BREEDER'S DECLARATION

Most of these farms **do not keep records** of their breeding activities, and that is why the number of animals is estimated on the basis of **household surveys** and information available in data from **previous surveys** (if they exist).

The number of animals kept by the breeder is calculated by **adding the number of animals on the farm** as indicated by the breeder, broken down by **type of animal** (cattle, goats, etc.).

- We collect the number of animals at the start of the project (**N1**) and the number of cattle at the end of the project (**N2**).

- The **comparative analysis** of **N1** and **N2** makes it possible to indicate the increase or not in the size of the farm following the implementation of the project (see *Lifestock dynamics*).

- As indicated above, all these data must be **broken down by type of animal** (cattle, goats, poultry, etc.).

LIVESTOCK DYNAMICS

Livestock dynamics (increase in the herd) indicates the "entries" and "exits" of animals from the herd over a given reference period, generally 12 months. Animal entries relate to births, animal purchases, animals donated or otherwise acquired, and animal withdrawals include animals sold, consumed, deceased, or otherwise disposed of.

As part of this module, livestock dynamics will be measured by the rate of increase of the herd. At the same time as we collect information on the number of animals, it is important to collect information on the number of births, diseases diagnosed, number of remissions and deaths, as well as the qualitative assessment of animal health status.

COLLECTION PERIOD

- **Before-project collection (Baseline):** Necessary for the collection of baseline data.
- **Collection during the project:** If the production cycle is shorter than the project cycle, the collection is organized at the end of each production cycle.
- **End-of-project collection (Endline):** Necessary to make comparisons and assess project performance.

DATA COLLECTION MANAGER

- Programme managers
- Zootechnicians
- Project surveyors
- Monitoring and evaluation officer
- Farmers
- Professional organizations

COLLECTION METHODS AND FREQUENCY

Data collection can be done in **two ways**:

1. **Production monitoring:** We collect the data available in the **production log** when one exists.

2. By declaration on the basis of **retrospective surveys** with the breeder.

NB : Knowing that most small family farms **do not keep a register of their breeding activities**, the estimation of the growth rate from retrospective surveys based on the farmer's memory is the most often used means of collecting data; but this method may **not be reliable for small livestock**, pigs, and poultry if the data is collected **only once over the entire reference period** which is usually 12 months.

Samples of farms can be visited more frequently during the reference year (**every three months or twice a year**) to collect data on herd dynamics for these types of livestock. Retrospective data collection is considered to be t**he most economical method**, but it has the disadvantage of relying only on the **breeder's memory**.

ESTIMATION OF LIVESTOCK DYNAMICS BASED ON THE BREEDER'S STATEMENT

The indicator of the **herd increase** must be produced for the **same types of livestock** as those for which the indicator on the **number of animals** is estimated. The number of animals is estimated on the basis of the number of animals as indicated by the breeder, broken down by type of animal (cattle, goats, etc.).

In the context of this module, the **dynamics of the herd** is estimated through **growth rate** as follows:

- We collect the number of cattle at the start of the project (**N1**) and the number of cattle at the end of the project (**N2**) .

- We calculate the **growth rate**: **N2 - N1 / N1**

- The analysis of the comparative growth rate makes it possible to indicate **the increase or not** in the size of the livestock following the implementation of the project.

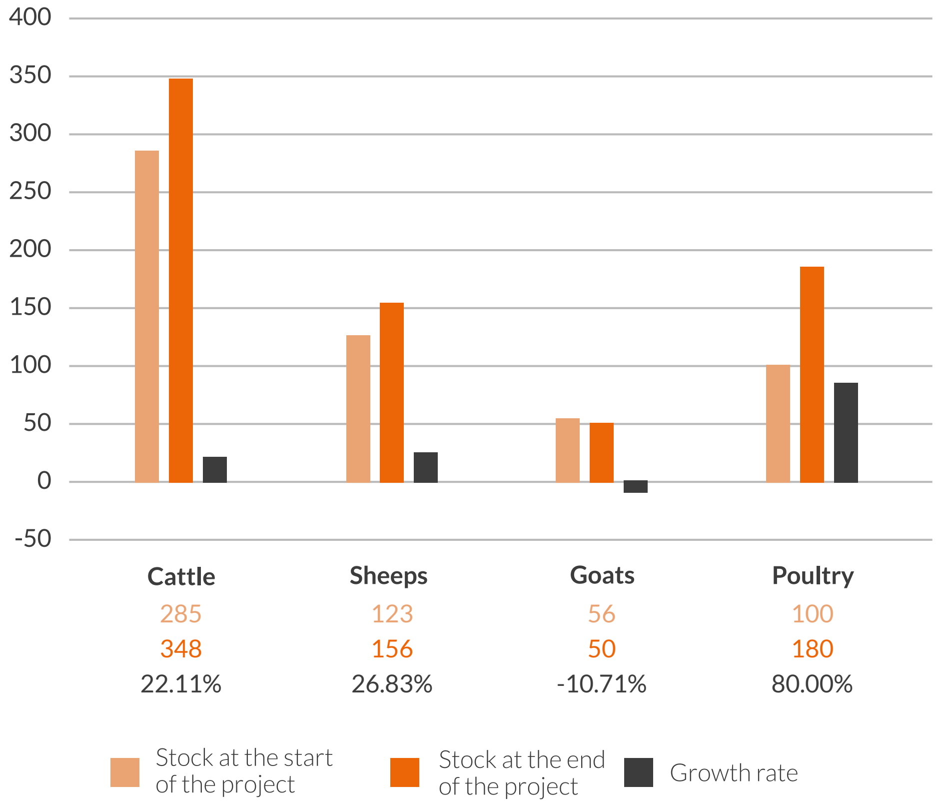
Example of calculation of the dynamics of a cattle herd

Livestock dynamics	Code	Numbre	Calculation mode
Cattle stock at the beginning	N1	285	Growth rate: difference between the stock at the end (N2) and the stock at the beginning, divided by the stock at the beginning (N1): Growth rate = (N2-N1) / N1 or N2/N1 - 1 = 0.22
Cattle stock at the end	N2	348	

The table below illustrates the dynamics of the herd on different types of livestock operations.

Types	*Initial stock*	*End stock*	*Growth rate*
Cattle	285	348	22.11 %
Sheep	123	156	26.83 %
Goats	56	50	-10.71 %
Poultry	100	180	80.00 %

Livestock dynamics



The graph above shows a growth rate of 22.11 % for **cattle**, 26.83 % for **sheep**, a decrease of 10.71 % for **goats** and more than 80 % increase for **poultry**.

REFERENCES

- FAO, 2018. *Guidelines on methods for estimating livestock production and productivity* http://www.fao.org/3/ca6400fr/ca6400fr.pdf

MEAT PRODUCTION (BODY WEIGHT)

The two main indicators for estimating meat production on a farm are meat production from live animals and meat production from slaughtered animals.

In the context of this module, the estimation of meat production will be based on the indicator *Production of meat based on live animal* or *Animal growth* which is the difference between the total body weight at the end and the total body weight at the start of the reference period.

This indicator should be produced for the same types of livestock as those for which the indicator on the number of animals is estimated. Data on the number and average body weight of live animals by type of livestock and, if available, by category of animal, are needed to estimate the total meat production of the farm. The estimate meat production from live animal (the total body weight of live animals) would be more precise if the number and average weight are estimated by category of animals.

COLLECTION PERIOD

- **Before-project collection (Baseline):** Necessary for baseline data.
- **Collection during the project:** If the production cycle is shorter than the project cycle, the collection is organized at the end of each production cycle.
- **End-of-project collection (Endline):** Necessary to make comparisons and assess project performance.

To get a better estimate of meat production, the period of data collection should be **as short as possible** and should avoid periods that coincide with **special events** and peaks in consumption, when large numbers of animals are slaughtered (for example Eid or Christmas for some countries). These events can significantly skew the estimate of meat production.

DATA COLLECTION MANAGERS

- Programme managers
- Zootechnicians
- Project surveyors
- Monitoring and evaluation officer
- Farmers
- Professional organizations

COLLECTION METHODS AND FREQUENCY

Data collection can be done in **three ways**:

1. Collection of data available in the **farm management record books** or in **veterinary or administrative registers** if such documents exist.

2. **Observation or direct measurement** of the animal's weight.

3. **Direct interview** with the farmer on the composition of the herd, by declaration.

Direct measurement is considered to be the **most reliable method** because the operator's knowledge or estimates of the animal's weight are not always reliable. Rather than depending solely on the farmer's estimate, body weight should be measured by a **trained investigator or agricultural extension worker**. Nevertheless, a qualitative based on animal observation can always **complement quantitative data**.

The frequency depends on the **seasonality of production** and the **breeding cycles** of the animals. Livestock productivity surveys are typically carried out **over one year** and researchers should make field visits **at least once per season** to collect data on livestock size and / or production.

LIVE WEIGHT ESTIMATE AND CALCULATION METHOD

At the individual animal level, **body weight** (BW) is measured by subtracting the live weight of the animal at the end and that at the start of the reference period.

BW individual = BW end of ref period. - BW start of ref.

Overall meat production of the holding is measured as the change in total live weight during the reference period.

BW total = BW individual x Number of animals

As stated above, the estimate **meat production from live animals** (the total body weight of live animals) would be more precise if the number and average weight are estimated **by category of animals**.

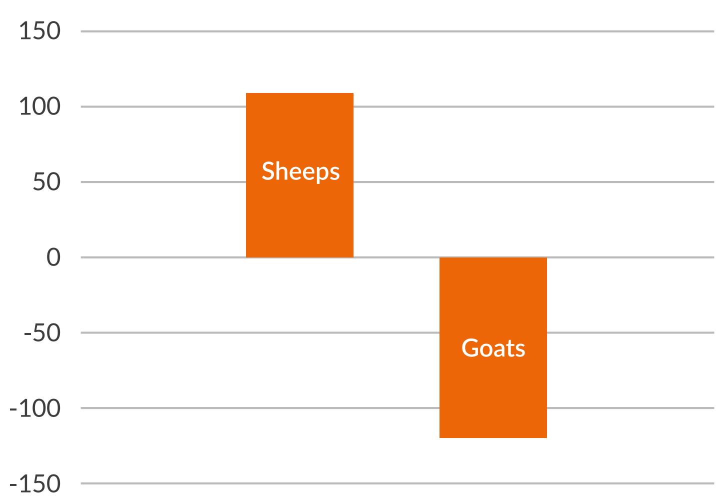
EXAMPLES OF MEAT PRODUCTION CALCULATION

The table below gives an example of the calculation of the animal growth of a herd of **sheeps** and **goats**.

	Start of reference period			*End of reference period*		
Types of animals	*Total number*	*Average Body Weight (kg)*	*Total Body Weight (kg)*	*Total number*	*Average Body Weight (kg)*	*Total Body Weight (kg)*
	a	b	c = a * b	d	e	f = d * e
Sheeps						
Goats						
Animal growth:the difference between the total body weight at the end and the total body weight at the start of the reference period.					**Animal growth = f - c**	

	Start of reference period			*End of the reference period*			
Types of animals	*Total number*	*Average Body Weight (kg)*	*Total Body Weight (kg)*	*Total number*	*Average Body Weight (kg)*	*Total Body Weight (kg)*	*Animal growth*
Sheeps	87	16.2	1409.4	91	16.7	1519.7	**110.3**
Goats	55	20	1100	49	20	980	**-120**

Meat production



While meat production increased for goats (**Caprines**), it decreased for sheep (**Ovine**), meat production at the end of the reference period is negative. This could be explained by the sale of animals, own consumption, or death of animals.

CHALLENGE WITH MEAT ESTIMATION USING ANIMAL BODY WEIGHT

Estimating or measuring body weight of each animal is a **time consuming and costly activity**, in addition to being **impossible to measure in most cases** by smallholder farmers.

RÉFÉRENCES

- FAO, 2018. *Guidelines on methods for estimating livestock production and productivity* http://www.fao.org/3/ca6400fr/ca6400fr.pdf

MILK PRODUCTION

This indicator provides information on the milk production achieved over a given reference period, generally 12 months. This is the net milk production, which includes only fresh milk actually milked, regardless of its future use (animal feed, domestic consumption, sale, donation, etc.); the quantities of milk suckled by young animals, which are difficult to obtain, are excluded.

This indicator should be produced for the same types of livestock as those for which the indicator on the number of animals is estimated.

COLLECTION PERIOD

- **Before-project collection (Baseline):**Necessary for baseline.
- **Collection during the project:** If the production cycle is shorter than the project cycle, the collection is organized at the end of each production cycle.
- **End-of-project collection (Endline):** Necessary to make comparisons and assess project performance.

DATA COLLECTION MANAGERS

- Programme managers
- Zootechnicians
- Project surveyors
- Monitoring and evaluation officer
- Farmers
- Professional organizations

METHODS AND FREQUENCY OF DATA COLLECTION

In the context of **small livestock farms**, **data** on total milk production over the reference period or on milk produced per dairy animal are **often not available**, or are **not estimated reliably** by the farmer because most of these farms **do not keep records** of their breeding activities. This makes it difficult for the farmer to know the total milk production achieved on the farm during the last 12 months.

Data collection can be done in **two ways**:

1. Collection of data available in the **farm management record books** or in **veterinary or administrative registers** if such documents exist.

2. **Direct interview** with the farmer on milk production, estimated by simple declaration.

ESTIMATING MILK PRODUCTION IN RELATION TO A NOMINAL BASELINE

Knowing that most livestock farms in southern countries **do not keep an activity register**, the total milk production achieved by the farm during the past 12 months can be estimated from a **nominal baseline** to assess **changes in milk production** (increase, or decrease in milk production).

- The survey is carried out among a **sample of farmers benefiting from the project**.

- Project beneficiaries are asked to show whether there has been an **increase** or **decrease** in milk production since the start of the project.

- To do this, we distribute **10 tokens** to the breeders, tokens that the producers place in an individual basket (**the 10 tokens being the baseline, representing the milk production before the project**).

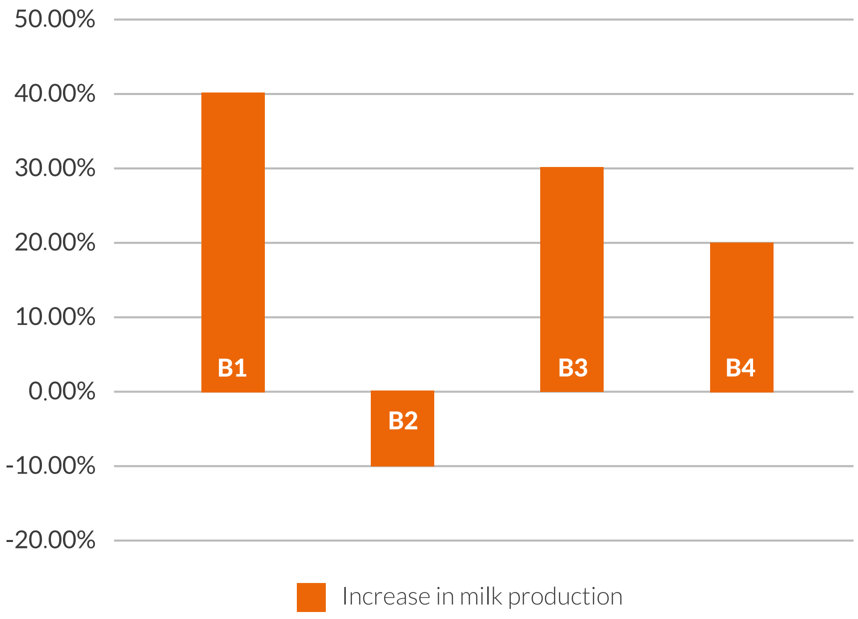
- We then give the breeders **10 other tokens** and ask them to show any relative changes in milk production **following the project**, either by adding tokens to the original basket of 10 tokens, or by removing tokens.

- For example, if a breeder were to add 4 tokens to the original basket, that would represent a 40 % increase in milk production. But if someone were to remove 4 tokens, it would represent a 40 % drop in pre-project milk production.

- The results are recorded for the situation "before" and the situation "after" the project.

The table below gives the milk production from **4 breeders** noting a total of 20 tokens against a baseline of 10 tokens.

Breeders (B)	Milk production before project	Milk production after project	Increase in milk production
B1	10	14	**40.00 %**
B2	10	9	**-10.00 %**
B3	10	13	**30.00 %**
B4	10	12	**20.00 %**



INTERPRETATION

- *The graph above* shows an increase in milk production for **breeders 1, 3 and 4** and a decrease in milk production for **breeder 2**.

- **Monitoring the evolution of milk production over time** with the beneficiaries of ACF projects would make it possible to **better understand and assess the effects of agroecology** on milk production.

REFERENCES

- FAO, 2018. *Guidelines on methods for estimating livestock production and productivity* http://www.fao.org/3/ca6400fr/ca6400fr.pdf

EGG PRODUCTION

This indicator informs about the production of eggs over a given reference period, generally 3 months. Egg production covers all eggs produced during the reference period regardless of egg use (for laying, for consumption, for sale).

Since it is necessary to take into account the great variability in productivity between different breeds (traditional chickens and broody hens), this indicator must be produced for the same breeds of poultry as those for which the indicator on the number of poultry is estimated.

DATA COLLECTION PERIOD AND FREQUENCY

- **Before-project collection (Baseline):** Necessary for baseline data.
- **Collection during the project:** If the production cycle is shorter than the project cycle, the collection is organized at the end of each production cycle.
- **End-of-project collection (Endline):** Necessary to make comparisons and assess project performance.

More frequent data collection (quarterly or even monthly) is needed to measure changes in poultry and egg production.

DATA COLLECTION MANAGERS

- Programme managers
- Zootechnicians
- Project surveyors
- Monitoring and evaluation officer
- Farmers
- Professional organizations

COLLECTION METHODS

In the context of **small livestock farms**, data on total egg production during the reference period or on eggs per hen are **not readily available**, or are **not reliably estimated** by the farmer because most of these farms **do not keep records** of their breeding activities.

Data collection can be done in **two ways**:

1. Collection of data available in the **farm management record books** or in **veterinary or administrative registers** if such documents exist.

2. **Direct interview** with the farmer on egg production.

ESTIMATED EGG PRODUCTION

Egg production on a small farm is estimated based on the **total egg production over the year** (P^{total}) and is calculated as follows:

(P^{total}) = Average number of eggs produced per lay X Number of layings per year

The following **auxiliary variables** should be collected if available: **number of laying hens, average number of layings per hen per year, average number of eggs per laying**.

*For example, if there are **10 hens** on the farm, and if there are an average of **3-egg layings/year** and an average of **10 eggs / laying**, the total number of eggs produced on the farm out of 12 month can be calculated as follows:*

***Total eggs** = 10 x 3 x 10 = 300 eggs / year*

In the event that these data are not available from the producer, the egg production can be estimated from a **nominal baseline** to assess changes in egg production (increase or decrease in production).

EXAMPLE

Producers are asked to estimate the production of eggs on the farm over a given reference period.

*Each farmer is given **10 tokens**, which the farmer places in a basket (**the 10 tokens representing the nominal baseline for egg production before the project**).*

*Then, **10 additional tokens** are distributed to each farmer asking them to estimate any relative change in egg production, either by adding tokens to the initial basket, or by removing tokens.*

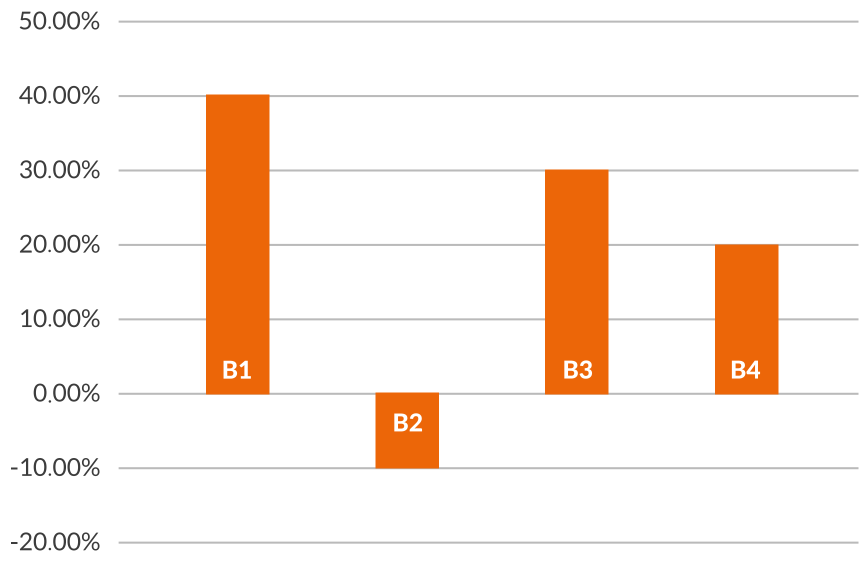
For example, adding 4 tokens means a 40 % increase in egg production; conversely, the withdrawal of 4 tokens represents a 40 % drop in egg production.

EXAMPLE

The table below gives the egg production from **4 breeders** noting a total of 20 tokens against a baseline of 10 tokens.

Breeders (B)	Egg production before project	Egg production after project	Increase in egg production
B1	10	14	**40.00 %**
B2	10	9	**-10.00 %**
B3	10	13	**30.00 %**
B4	10	12	**20.00 %**

Egg production



REFERENCES

- FAO, 2018. *Guidelines on methods for estimating livestock production and productivity* http://www.fao.org/3/ca6400fr/ca6400fr.pdf

INCOME FROM LIVESTOCK PRODUCTION

The income from livestock consists of the sale of one or more animals and the sale of livestock by-products. It concerns the use of livestock (sale, consumption, donation). Births and deaths of animals are not taken into account.

The income estimate is based on surveys of producers who have benefited from the project, using semi-structured interviews.

Survey questions:

- Which is the number of **livestock sold**: Income from the sale of cattle (Answer **A1**) and poultry (Answer **A2**)?
- What are the revenues from the sale of **livestock by-products**: Income from the sale of milk (Answer **B1**), income from the sale of eggs (Answer **B2**)?
- What are the **expenses** (Answer **C1**) and **known production costs** (animal feed, veterinary care) (Answer **C2**)?
- How much do you estimate was the **quantity of milk consumed** by the household or **given as a donation** (Answer **D1**)?
- How much do you estimate was the **quantity of eggs consumed** by the household or **donated** (Answer **D2**)?

The responses are recorded according to the type of breeding.

Types of breeding	*Income from livestock sales*	*Income from the sale of livestock by-products*	*Expenses and production costs*	*Self-consumption and donation of products (estimated in cash)*	*Income by type of livestock*	*Total income*
Small ruminant	A1	B1	C1	D1	**R1** = (A1+B1+D1) - C1	**R1 + R2**
Poultry	A2	B2	C2	D2	**R2** = (A2+B2+D2) - C2	

EXAMPLE OF LIVESTOCK INCOME CALCULATION (PROJECT RESILAC)

The interviewee (Breeder) considers breeding as his/her primary source of income. **The interviewer** identifies with him/her **the most representative period** of the year (last annual livestock market, last harvest, lean period, etc.).

1. The interviewer calculates with the breeder the **revenues** of this activity, by listing:

- Income obtained from **sale / donation of livestock** (ask for number of heads of livestock sold and their price to ensure income is correct).
- Income obtained from the **sale of by-products**: milk, manure, hides, etc.

The Breeder confirms that the income obtained was 100.000 CFA.

2. Then, the interviewer collects information about the **expenses** incurred by the breeder within the framework of his activity, including:

- **Livestock feed** expenditure
- **Animal health** expenditure
- **Consumption** (meat or milk consumed by him / his household and not sold)

The breeder confirms that the expenses incurred were 50.000 CFA.

3. The enumerator carries out the operation **revenues - expenditures = "real" annual income**.

In the case of this example, the annual income equals 50.000 CFA.

ESTIMATION OF INCOME FROM LIVESTOCK PRODUCTION BASED ON PRODUCER'S STATEMENTS

In the absence of available data, the income estimate can be made on the basis of the **producer's perception** of the **income differential** measured as the difference between the income situation resulting from the **implementation of the project** and that which would have prevailed **without project** (differential with - without project). In this case, we will therefore be satisfied with the income differential as perceived by the producer before and after the implementation of the project or the adoption of certain agroecological practices.

The basic income can be the average over the three years before the start of the project and as received by the producer.

All methods of estimating income based on the producer's declarations and understanding involve the use of **semi-structured interviews** and **scoring methods** or **hierarchical classification**.

It can be done by asking a **simple question** on the change of income by the type of livestock activity, before and after the project.

1. Examples of classification of income change by type of livestock activity, before and after the project, according to the following ranking:

- **(1)** Decrease in income
- **(2)** No change in income
- **(3)** Increase in income

2. If **changes in income** are observed between the "before" and "after" period of the project, ask the farmer to explain the **reasons** for these income differences and record their response.

Type of livestock farming	*Year 1*	*Year 2*	*Year 3*
Livestock farming 1	(2)	(2)	(3)
Livestock farming 2	(2)	(2)	(3)

INTERPRETATION

The average yield from livestock production help measuring the effect of livestock management practices (feeding system, alternative animal health practices, etc.) on animal production and zootechnical performance.

Its calculation can help explaining the **yiel difference** following the adoption of a given breeding practice or innovation. For example, to assess the effect of adopting an agroecological practice on livestock production (e.g. production of fodder legumes), we can compare yields of a livestock farm that uses agroecology with a farm that uses conventional farming practices, or a yield before and after the implementation of a project with crop and livestock integration.

INDICATORS OF SOCIAL EFFECTS

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EMPLOYMENT AND WORKLOAD (HARDSHIP)

In addition to its scientific and technical dimension, agroecology has a strong social component; one of the social aspects of agroecology is highlighted by the ability of the agricultural production system to ensure the necessary appeal of rural work.

The objective of agroecology is to make agriculture an **attractive sector** for young people living in rural areas. Indeed, agroecology practices represent potential **employment opportunities** for rural and urban areas of countries that have both strong demographic growth and a high rate of unemployment within the working population (including young people in rural areas in particular). Thus, employment linked to agroecology makes it possible to **curb the rural exodus** and **initiate the economic development of rural areas**. Agroecology is also a major lever for developing the dynamics of rural areas and **strengthening social cohesion** by reducing social inequalities (such as those regarding women and poor families). Employment in the agroecology sector also involves the mobilisation of community members to carry out common agricultural activities, thus contributing to better social cohesion.

Successful and fulfilling agricultural employment can be a determining factor in the **adoption of agroecological practices**. It is therefore necessary to assess these dimensions in the context of monitoring and evaluating an agroecology project. In this module, we are more specifically interested in the employment generated and the hardship of the work as a result of the adoption of agroecology.

DATA NEEDED TO MEASURE EMPLOYMENT AND WORKLOAD

Employment and workload are assessed through **job creation**, use of **community work** and also through the farmer's perception of the **harshness of the work** (increase, reduction), following the various tasks induced by the adoption of agroecology and compared to the agricultural activities before the adoption of agroecology.

The harshness of tasks is defined here as **exposure to one or more risk factors** linked to **significant physical constraints**, **intensive physical environment** or to certain **work rhythms** likely to harm the health of an individual, members of a family or a community.

COLLECTION PERIODS AND METHODS

The data is to be collected **before and after** an agroecological transition project or **before and after** the adoption of an agroecological practice promoted by **the project**.

As small producers do not often keep record of their working time, the data collection is primarily based on a **interview questionnaire direct** toward the producer. It is necessary to conduct **separate interviews with men and women**.

We ask the producer to mention the **different agricultural tasks** induced by the **adoption of agroecological practices** and to assess, according to their perception, the arduousness of these tasks according to a **perceived or experienced level of difficulty**.

For **surveys at the end of the project** cycle, it is necessary to collect information that can provide information on whether or not there has been a **change in agricultural practices** following the project.

DATA COLLECTION

The people responsible for data collection are **AAH's programme managers**, **agricultural team leaders and enumerators**, as well as **AAH's technical partners**, who have been previously trained.

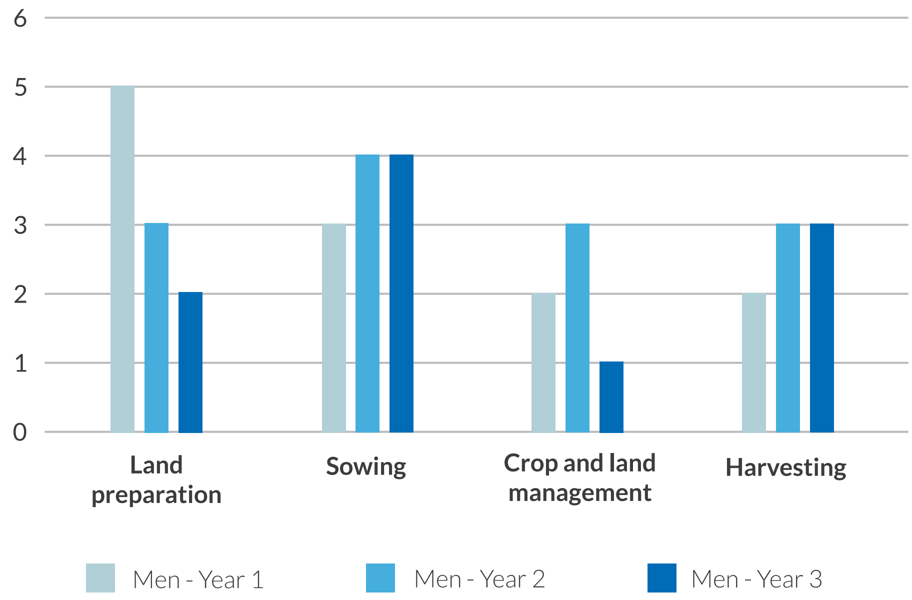
Data collection is done using *the table below*. This table is to be completed by the respondent, thereby distinguishing between agricultural activities carried out by **men** and by **women**. It is also important to question women about the work they do in the fields so as to take **gender dimensions** into account. This tool for collecting individual data should preferably be carried out, if possible, **several times** during the **agricultural calendar**, asking, for example, questions related to land preparation during land preparation time or harvesting at the time of the main harvest.

Agricultural calendar	*How are the tasks related to ____?**		*What are the particularly difficult tasks? (Man / Woman)***	*Change in the use of daily workers? (+, =, -)*	*Change in the use of community assistance? (+, =, -)*	*Change in practices after the project Yes / No*
Land preparation (clearing, ploughing, fertilisation)	Painful	5				
	Exhausting	4				
	Tiring	3				
	A little difficult	2				
	Somewhat enjoyable	1				
Sowing	Painful	5				
	Exhausting	4				
	Tiring	3				
	A little difficult	2				
	Somewhat enjoyable	1				
Crop management (weeding, fertilisation maintenance, disease, and pest management)	Painful	5				
	Exhausting	4				
	Tiring	3				
	A little difficult	2				
	Somewhat enjoyable	1				
Harvesting	Painful	5				
	Exhausting	4				
	Tiring	3				
	A little difficult	2				
	Somewhat enjoyable	1				

***Circle response**
****Delete as inappropriate**

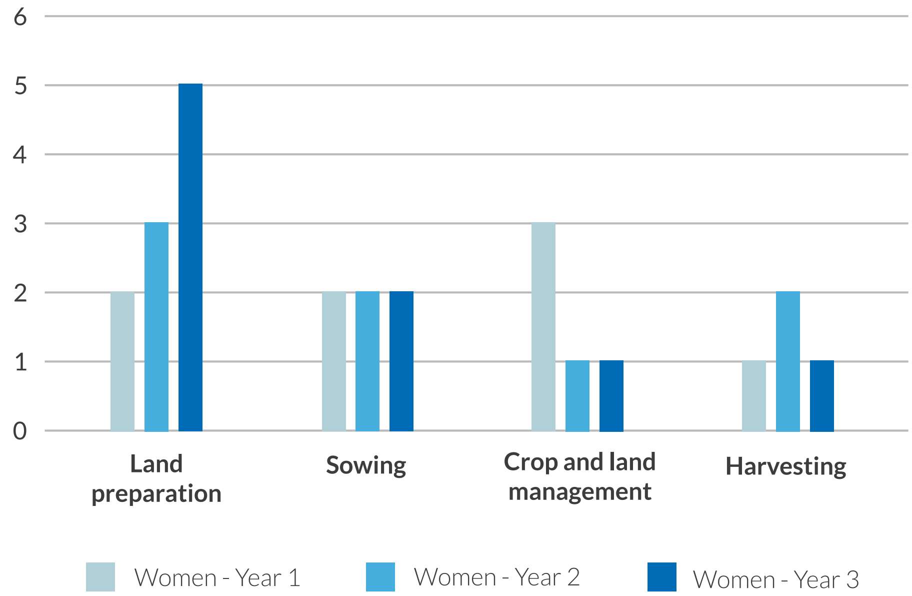
Analysis of the results must therefore **distinguish** between **women** and **men** answers, and follow the progression of the **hardship** of agricultural tasks, and the use of **external labour**, paid or not. *The graph below* shows an example of the possible scenarios. These analyses can also be done in more details, by distinguishing between the results obtained **per zones** where the programme were implemented.

Progression of the hardship for the men



We note that the arduous nature of the work in the fields carried out by **men** has changed during the three years of the programme. Respondents report that on average, the work related to the **preparation of plots** is less arduous in **year 3** than in **year 1** and even in **year 2**. This is a very positive sign, given that this same work was considered painful in year 1. The work related to **sowing and harvesting** is, on the other hand more difficult: exhausting for sowing and tiring for harvesting in **year 3**. Activities related to the **maintenance of plots** became enjoyable after being reported as tiring in **year 2**.

Progression of the hardship for the women



The arduous nature of field-related work carried out by **women** has evolved differently from that carried out by men. The work carried out for the **preparation of plots** by women became painful during the programme, whereas it was considered not very difficult at the start of the programme. On the other hand, we do not note any changes in **sowing-related work**. Activities linked to the **maintenance of the plot**, initially tiring, have become somewhat enjoyable over time. Finally, the **harvest** situation has not changed much, and remains on average somewhat enjoyable.

The data collection tool also mentions the evolution over time of the **use of external labour**, in the form of **mutual assistance** or **daily remuneration**. This information therefore makes it possible to provide additional analysis on the capacity of local agriculture to offer moments of social exchange and thus **strengthen social cohesion**, as well as offer **employment and income opportunities** to vulnerable farmers, whose means of income partly depend on access to daily work in the fields. We positively consider actions whose effects would provide **additional opportunities for mutual assistance and daily work**.

These findings must be linked to the **local context** and the **main events** that may have had an influence on the levels of arduousness of tasks. This may include climate change, greater mechanisation, actions of NGOs and technical authorities, etc. Without control groups, it is **not possible to confirm the effects** of Action Against Hunger's interventions; however, we can **put forward theories and assumptions** to be tested at a later date. It is useful to make these observations **intelligible** by linking them with practices in the field, observing all precautions.

WOMEN EMPOWERMENT[3]

Promoting social values (individual rights, respect for diversity, equity, social justice, sharing of experiences) as well as reducing inequalities through social cohesion are part of the scope of agroecology[4]. Social equity, especially with regard to women, is a central element. For Action Against Hunger, although not sufficient in itself to guarantee greater autonomy for women, agroecology programmes must contribute to the empowerment of women in agriculture, criteria that is increasingly highlighted in agricultural development projects[5].

Women's empowerment can be defined as **women's ability to make strategic life choices, to organise themselves to increase their independence and to take charge of resources** to ensure a degree of autonomy that enables them to l**imit their dependence**. It is a multidimensional concept, encompassing **social, economic, psychological, and political aspects** that relate to the status and autonomy of women[6].

In relation to agroecology, women's empowerment is defined as:

- **1. the ability and willingness of female farmers to influence decisions** that affect them and the closest members of their household,
- **2. the ability to control economic resources linked to agricultural activity**, and
- **3. the ability to move around freely, manage their time and workload**, as well as
- **4. participation in social activities** (membership in women's groups).[7]

The empowerment of women in agroecology implies **recognition** (by the woman herself and by society) of the roles that women choose to assume in society, access to the resources necessary to ensure their livelihood, and access to the possibilities and opportunities needed to make decisions for themselves. In this sense, within the framework of the agroecological transition, this empowerment contributes to the **process of change** towards **greater equity, both individual and collective** between men and women in agricultural production. The consideration of gender equality and the empowerment of women in agroecology is **relevant in several respects**[8]:

[3] This indicator is to be used only if the technical intervention is accompanied by social action, such as family dialogue
[4] CIDSE, 2018. *The principles of agroecology: towards just, resilient and sustainable food systems*
[5] Technical interventions are not sufficient in themselves to significantly improve women's autonomy. These technical interventions must be accompanied by social actions, such as family and community dialogue, that address gender issues
[6] HLPE. 2019. *Agroecological and other innovative approaches for sustainable agriculture and food systems that improve food security and nutrition.* www.fao.org/cfs/cfs-hlpe/fr/.
[7] Ristiana, R. and Handayani, D., 2018. *Does work influence women's autonomy or does autonomy deliberate women to work?*
[8] Levard, L, Bertrand, M., Masse, P. (2019). *Handbook for the evaluation of agroecology, Methods to evaluate its effects and the conditions of its development*, GTAE-AgroParisTech-CIRAD-IRD

1. In **family farms**, which constitute the majority of farms that implement agroecological practices, the **involvement of women** in production, marketing and/or management activities is acknowledged and often **very intense**; yet the crucial role of female farmers in agricultural production is **rarely recognised**.

2. Even though **the majority of smallholder farmers are female**, and even though much of the agricultural work is carried out by women, **decisions** about agricultural land, agricultural production, expenditure, yields and associated income controls often (if not always) rest with **men**.

3. At the **community and territorial level**, the participation of women and their empowerment strengthens the **dissemination of practices between families**. It has also been shown that **income managed** by women is more likely to be **reinvested** in improving children's education, food, nutrition, and health[9].

The development of production systems based on agroecological practices can have **negative effects** on the empowerment of women if **specific intervention activities** aimed at increasing decision-making and consideration of women within households and the community are not put in place. To be able to **measure the impact** of interventions, it is relevant to be able to assess the empowerment of women in agroecology by **setting up monitoring and measurement indicators**.

WHAT INDICATORS CONTRIBUTE TO WOMEN EMPOWERMENT?

Women empowerment in agroecology includes **social and economic aspects**. Based on the definition of empowerment as adopted in this document, within the framework of this module, the following **3 areas** are proposed to measure women empowerment, through a **composite indicator**.

- **1.** Contribution to decisions regarding agricultural production
- **2.** Group participation and leadership
- **3.** Leisure time/rest

DATA COLLECTION

Data collection is done using a **mixed method** comprised of an **individual questionnaire** with **female farmers** in beneficiary households of the agricultural project, **focus groups** with men and women (separate), and **observation of the management committees of associations / cooperatives** involved in the project (optional activity). If the aim of the study is to measure the effectiveness of an intervention[10] aiming to empower women, then data collection is to be done **at the beginning and at the end of the project**, to allow a comparison of the before / after results.

The individual interview with interviewees should take place in a **space that ensures confidentiality**. Nevertheless, it is necessary to take into account the **cultural dimension** that can be strong on gender equality in certain areas of intervention, and **adapt the interviews** according to how easy it is for women to speak out.

[9] World Bank, 2007. *From Agriculture to Nutrition Pathways, Synergies, and Outcomes*
[10] By intervention aimed at promoting women's empowerment, we mean a project that includes a specific activity that works on this aspect, for example, family dialogue, gender workshop, approach to strengthen women's leadership.

Focus groups with only women can also be offered to provide **qualitative information** on opinions, perceptions and practices related to women's empowerment, if this is more relevant. Likewise, **focus groups with men** conducted separately make it possible to **cross-reference information** and measure the **changes in men's attitudes** towards women and make it possible to understand how these changes in attitude contribute to women's empowerment, and to see what has changed or is changing.

Focus groups should take place only with **groups of women** (6-12 people), then only with **groups of men** (6-12 people), in order to get the opinions of both men and women. Participation is **voluntary** and the purpose of the discussion should be explained, and the **consent** of the participants sought before beginning. The aim is to compare the **results of the questionnaires** (verify the information) and provide **explanations** on local opinions/perceptions. **General information** includes the number of participants, location, gender, date, etc.

For each **area** (decision making, leadership, and breaktime), responses are scored on a **scale of 0 to 4**. An **average of the scores** for each area will establish a value for the composite indicator of the women's empowerment.

DATA COLLECTION

The people responsible for data collection are the **programme managers**, **facilitators**, and **agricultural surveyors of AAH** or its **partners**, who have been previously trained.

DATA COLLECTION TOOL

The questions on the empowerment of women presented below can be administered as an **individual questionnaire**, as part of a **KAP, Baseline, Endline survey** or can be the subject of a **specific survey**. As with any survey, it is necessary to refer to current **good practices** involving, among other things, applications to local authorities for **permission**, **training of interviewers**, **translators** and **testing of questionnaires**, a **presentation of the purpose of the survey** to potential participants, the **duration** of the interview and the **use of data** (confidentiality, etc.), as well as a request (oral or written) for **consent** from interviewees before proceeding with the interview.

The questionnaire should also collect the interviewee's **socio-demographic information** and **economic information** (relating to agricultural activity in particular), and involve the allocation of an **identifier** (ID) to make sure that the **data is anonymous**.

The socio-demographic data of interest include, among others: age, level of education, village/community, language/ethnicity or religion, number of children/household size, marital status, type of agricultural activity of the household, agricultural activities to which the woman takes part, ownership of the land and/or size of cultivated land, type of livestock and number of animals, processing activity/other production activity or other income-generating activity, significant household possession (tools, motorbike, etc.).

This information will be used during the analysis to **identify the profiles** of women with **high autonomy scores**, the profiles of women with a **low autonomy score**, and **factors associated** with degrees of autonomy (e.g. age, marital status, level of education, etc.). This will be important for analysing the results, understanding the factors that facilitate or prevent empowerment, identify groups with a lower level of autonomy and **make recommendations** for the project.

The following questions could be **adapted** according to the type of agricultural activity in which women participate in the area of intervention.

Questions	Answer	Score
1a. ***In your household, when an important decision on agricultural production is to be made (for example, the purchase or sale of land, purchase of equipment/major machinery, sale of crops, purchase / sale of livestock), do you participate in the decision making? Would you say that you participate never, rarely, sometimes, often / always in important decisions?***	Never	0
	Sometimes	1
	Often / Always	2
1b. ***If you wanted, could you decide to sell some livestock or part of the harvest?***	No	0
	Maybe	1
	Yes	2
	Don't know	0
2a. ***Are there any producer groups or associations / cooperatives in your community?***	Yes	If no, skip to question **2.e**
	No	
	Don't know	
2b. ***Do you belong to one of these groups?***	Yes / No	1 / 0
2c. ***Are the group (s) you participate in mixed (men and women in the same group)?***	Yes / No	
2d. ***In group meetings, do you ever stand up in front of others to give your opinion or ask questions? Would you say that you speak up often, rarely, or never?***	Never	0
	Rarely	1
	Often	2
2e. ***Do you ever speak in front of everyone in a meeting with men present?***	Yes / No	1 / 0
3. ***In your daily life, do you have time to take care of yourself, for leisure or to rest? Would you say that it happens never, it happens a few times a month, once a week, twice a week or almost every day?***	Never	0
	1-2 times a month	1
	Once a week	2
	Twice a week	3
	Almost every day	4

The questionnaire is sent to the women of the households participating in the project (**I=Interviewees**) and their responses are noted. Once the scores have been assigned for each interviewee, her **total score** is calculated, then her **average empowerment score** is given using the 3 indicators. The mean score is calculated by dividing the interviewee's total score by the maximum possible score (**12**).

	Indicators	*Score*
A	Important decisions related to agricultural production	n / 4
B	Active participation in the meetings of an association, group, mixed cooperative	n / 4
C	Availability to take care of yourself, your leisure, and/or rest time	n / 4
	Total	n / 12
	Average score = total score / maximum score (12)	

For each area of empowerment, a proposed list of detailed questions is provided in the **appendix 2**.

EXAMPLE OF ANALYSIS AND INTERPRETATION

The tables present the **averages obtained at the beginning** (74 interviewees) and **at the end of the programme** (69 interviewees), covering **3 villages (X, Y, Z)**.

Baseline Indicators	*Village X*	*Village Y*	*Village Z*	*Average Per Indicator*
Number of Respondents (= 74)	19	23	32	
Participation in high-level decision-making linked to resources (land, equipment, etc.) (average per domain)	3	4	2	**2.9**
Active participation in an association, professional organisation, mixed ownership cooperative (average per domain)	2	4	1	**2.2**
Rest and leisure time (average per domain)	1	2	0	**0.9**
Average score per village	**2.0**	**3.3**	**1.0**	**2.1**

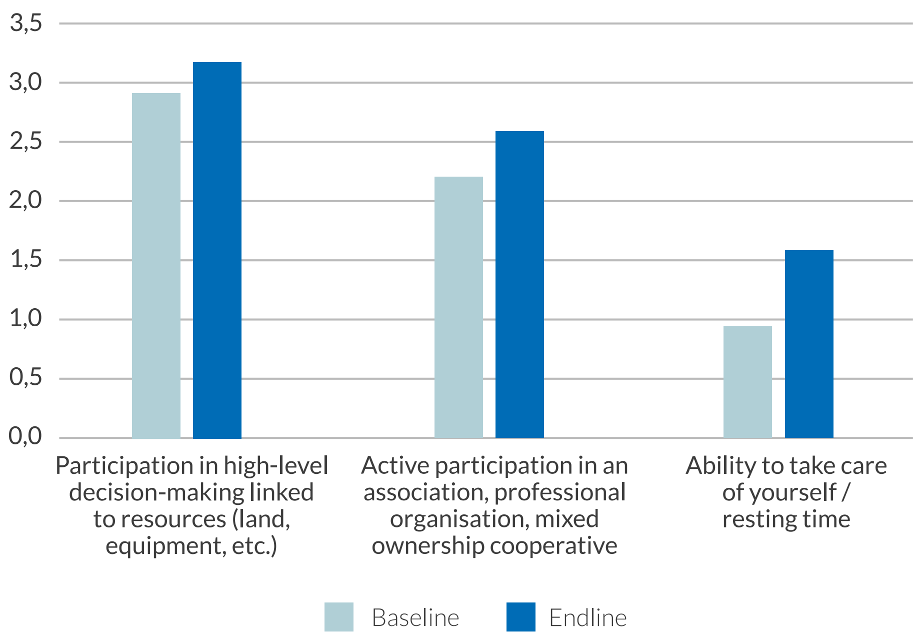
A quick glance at the *summary tables* highlights **significant differences** among the villages. Respondents in **village Z** report low autonomy relative to the other 2 villages, particularly **village Y**. There is also a big difference according to the autonomy indicators. Although, on average, the respondents "often" participate in high-level decision-making linked to agropastoral resources, they very rarely have time, only a few times per month, to take care of themselves and rest.

Endline Indicators	*Village X*	*Village Y*	*Village Z*	*Average Per Indicator*
Number of Respondents (= 69)	19	23	27	
Participation in high-level decision-making linked to resources (land, equipment, etc.)	4	4	2	**3.2**
Active participation in an association, professional organisation, mixed ownership cooperative	3	4	1	**2.6**
Ability to take care of yourself	2	3	0	**1.6**
Average per village	**3.0**	**3.7**	**1.0**	**2.6**

The situation has changed between the start and end of the programme. Respondents in **villages X and Y** report greater autonomy with a major increase for respondents in **village X**. On the other hand, the situation remains **unchanged** for respondents in **village Y**. The ability of respondents to take care of themselves increased significantly in **villages X and Y**.

More detailed analyses should be carried out given that this rapid analysis is only intended as a **guide for colleagues in the field**. It is important **not to conclude that these changes are attributable to AAH's activities**; they could very well be the result of **multiple interactions**. Nevertheless, we can formulate hypotheses that can subsequently be tested via **operational research programmes** including control groups. Depending on the sample, it is also important **not to generalise the results** if the respondent group is not representative of village women. The results therefore apply to the respondents and not to the women in Villages X, Y and Z.

Evolution of women empowerment during the programme



During the programme lifetime, women's autonomy, measured using the **3 indicators** chosen by AAH, seems to have, **on average, increased** during the course of the programme. This applies to **participation in major decisions** related to household production, **active participation** in mixed groups and the **newly-acquired ability** of respondents to take care of themselves and set aside rest and leisure time. This change is particularly noticeable for the final indicator.

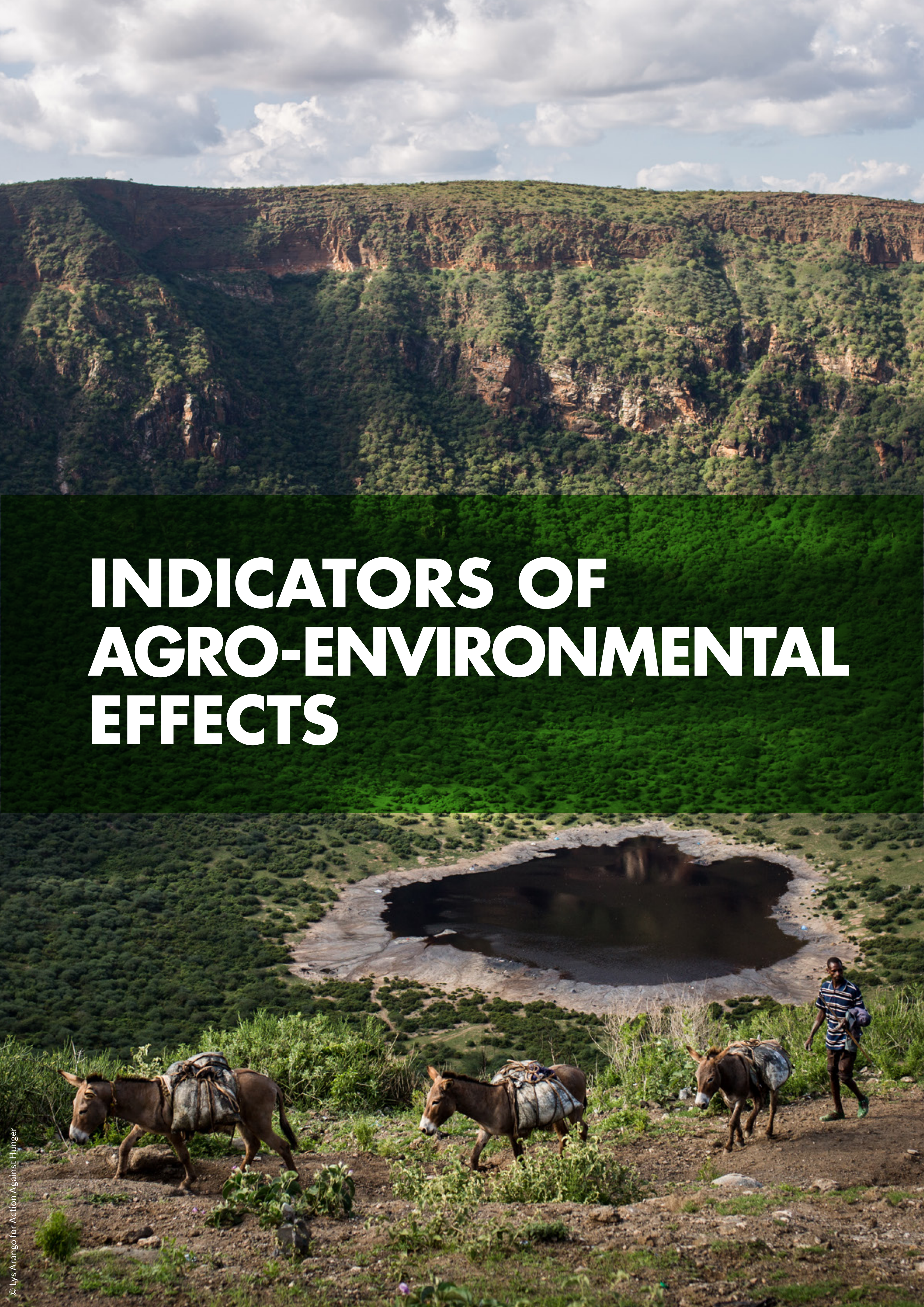
This analysis should also be **cross-referenced with demographic data** (age, marital status, language, etc.) in order to identify the group of women that has the **lowest level of empowerment** and formulate **recommendations** aimed at empowering this group of women according to the identified empowerment domains (decision-making, active participation in management committees, rest periods, etc.). It is also important to carry out a **mapping exercise** to see if the **information and support linked to existing groups should be improved**, for example, or if the **creation of groups** capable of strengthening women's social integration should be encouraged). If, for example, women's active participation in meetings is negligible despite the presence of village associations, this can be explained by the fact that they do not identify with these groups. If that is the case, the creation of groups promoting women's empowerment opportunities should be facilitated.

EXAMPLES OF POST-PROJECT RECOMMENDATIONS

Based on the survey results, the following **recommendation examples** should be proposed for the next stage of the project:

- Prioritise women with a **low level of empowerment** in **family dialogue** activities (provide the target group characteristic, for example, age group or community).
- Carry out **communication activities** to make visible **existing associations and cooperatives** and encourage women to participate.
- Develop an **action plan** with the management committees of cooperatives/associations to promote the participation of women in **leadership positions**.
- Engage in **multisectoral collaboration** (WASH, Nutrition, Mental Health and Care practices) to **reduce women's increased workload** within the project framework.

INDICATORS OF AGRO-ENVIRONMENTAL EFFECTS



SOIL HEALTH INDICATORS

Soil health, also known as soil quality, is defined as the soil's ability to perform its essential production functions of providing food and raw materials. Maintaining soil health is therefore a key agro-environmental indicator of agroecology as it is essential for both agricultural productivity and the resilience of production systems and the environment.

Assessing soil health is particularly important on the **scale of a plot of land** because agricultural practices are carried out on this scale. Nevertheless, **unsustainable agricultural practices** that have an impact on soil health can also be measured using other criteria (for example, signs of erosion and decline in the surrounding biodiversity). **Soil quality** is assessed on the basis of its **inherent and dynamic soil properties**.

Inherent soil properties, intrinsic characteristics associated with their pedogenesis are **invariant** and **change very little or not at all** according to the type of agricultural activity. The inherent properties are mainly related to the **factors of soil formation**: climate, topography, bedrock, biota, and weather. Examples of inherent properties are soil texture, type of clay, depth of bedrock, etc.

The dynamic properties are dependent on **human activities** and **natural disturbances**. **Significant changes** in the dynamic properties of soils can occur over a single year or agricultural season. In the context of this module, the focus will be on indicators relating to the dynamic properties of soils, including their **capacity to retain water and nutrients**, **organic matter**, soil **structure**, **infiltration rate**, **bulk density**, soil **biota**, etc.

The dynamic properties of the soil are **negatively impacted** by **conventional farming practices** and by certain **unsustainable traditional farming practices**, such as conventional ploughing operations, monoculture, the use of chemical inputs (fertilizers and plant protection products), slash-and-burn agriculture, grazing and over-grazing and the passage of heavy agricultural machinery etc.

Conversely, **all agroecological practices** concur to **the improvement and strengthening of the dynamic properties of the soil**; they include, for example, crop association and crop rotations (in particular with legumes), integrated pest management, the application of organic manure, mulching, the management of soil salinity, minimum tillage, etc.

In the case of tillage, for example, if soil disturbance is kept to a minimum, earthworm populations can recover fairly quickly within a few years. However, considering that soil quality management is **specific to a given site or region**, it is impossible to list here all the scenarios and solutions for managing soil health.

WHY EVALUATE SOIL QUALITY?

The main objective of the soil quality assessment is to provide information regarding **the trends in soil quality** (increase, decrease or maintenance) following the implementation of certain agricultural practices. The results obtained from the baseline assessment serve as a **benchmark** against which to **assess future changes**. Subsequent successive measurements provide information on the trends or action needed for improving soil properties, following the **recommended improvement measures**.

WHAT INDICATORS ARE USED TO ASSESS SOIL QUALITY?

Soil health is measured by its **physical, chemical, and biological properties**, processes, or soil characteristics.

- **Physical properties**: (soil structure, water retention capacity, infiltration rate),
- **Chemical properties**: (pH, electrical conductivity, reactive carbon, soil nitrate content, extractable phosphorus, and potassium)
- **Biological properties**: (presence of microorganisms, soil respiration, organic carbon, etc.)
- **Soil organic matter**: Organic matter, or more precisely soil carbon, transcends all **three categories of indicators**. Physically, organic matter influences the structure of the soil and all properties associated with it. Chemically, organic matter influences changes in soil pH. Biologically, organic matter acts as a nutrient and energy source for soil fauna. Soil quality is therefore determined by **a combination of the influence of organic matter on the physical, chemical, and biological properties of the soil**.

The indicators used to assess the quality of the soil may **vary** depending on whether we are dealing with **farmers or scientists**; for example, while a researcher may prefer to base the assessment of soil quality on indicators such as the organic matter in the soil, a farmer may prefer to assess soil quality on the basis of soil colour, smell or texture. Soil quality indicators as **perceived by farmers** can be classified into **three categories**[11]:

- **Physical indicators** of soil condition which include the colour, texture and structure of soils.
- **Bioecological indicators** which correspond to cultivated plant and weeds growing on this soil, their state of development, colour and size.
- **Productivity indicators** that compare the production of previous years on the same plot.

The indicators proposed in this guide are an adaptation of the indicators from the **Latin American Scientific Society of Agroecology** (SOCLA)[12] and the **FAO Tool for Agroecology Performance Assessment** (TAPE)[13]. These take into account indicators from scientific research as well as indicators of soil quality as perceived by farmers (see *Table 1*).

[11] Blanchard, M., 2010. *Management of soil fertility and the role of the herd in cotton-grain-livestock systems in southern Mali: local technical knowledge and practices of integration between agriculture and livestock livestock farming*

[12] Nicholls, CI and al., 2004. *A rapid, farmer-friendly agroecological method to estimate soil quality and crop health in vineyard systems*

[13] FAO, 2019. *Tool for Agroecology Performance Evaluation (TAPE)*

Table 1: *Soil quality indicators*

Indicator	*Link with soil quolity*
Physical	
Soil structure (organisational structure of the different particles of sand, silt, and clay)	Soil with well-formed aggregates that do not crumble easily, and which retain and transport water and nutrients, provide habitats formicroorganisms, limit soil erosion, ensure good air circulation and better soil respiration
Soil depth / Plant rooting depth	Estimation of crop productivity potential, degree of soil compaction
Infiltration and bulk density	Water movement, porosity, and ease of tillage
Water holding capacity	Storage and availability of water: aerated structural soil, which swells in the presence of water and which retains humidity after rain or watering.
Soil organic matter, soil colour	A dull or dark colour indicates decaying organic matter in the soil and is a good indicator of good OM content which improves soil fertility, structure, and the capacity to retain nutrients and water. This also limits soil erosion
Chemical	
pH	Soil acidity or alkalinity
Electrical conductivity	Plant growth, microbial activity, and salt tolerance
Extractable nitrogen, phosphorus, and potassium	Availability of plant nutrients
Biological	
Carbon and nitrogen from the microbial biomass	Microbial catalytic potential, carbon, and nitrogen reservoir
Potentially mineralizable nitrogen	Soil productivity and nitrogen potential
Presence of micro and macro-organisms	The measure of biological activity and its contribution to the circulation of water and air. Ability to rapidly absorb and «digest» organic matter to make it available to plants.
Plant cover	Ground cover plants, whether living or dead, contribute to the preservation of soil health, in particular its organic matter content and its capacity for water retention; in addition, plant cover plays a role in environmental functions such as wildlife habitats and in the fight against the impact of climate change, soil erosion, weed control, etc.

Since it would be difficult to measure each of these indicators in the context of an AAH field project, it is advisable to focus the monitoring on **a minimum number of indicators necessary** to obtain an **overall evalaution** of the quality of the soil assessed, the means and resources available locally to collect data, and the agricultural systems and land use in the area concerned. Also, factors such as ease of measurement and the data collection period all need to be taken into account **when choosing indicators** to monitor AAH project in the field.

The indicators are to be chosen according to their **relevance to a given agronomic context**: comparison of two cropping systems and soil management, the effects of agricultural techniques and their evolution over time, etc. When an indicator is **not measurable or functional** in a given situation, it is simply **not measured**; it should **be replaced, as far as possible, by another indicator** that is easier to measure in the intervention area and which is more relevant to that particular situation.

This module, which does not aim to be exhaustive, will focus on the following indicators of soil quality:

- **Invertebrate population**, an indicator of soil biological activity
- **Soil colour**, an indicator of the organic matter content of the soil
- **Plant cover** (mulch, crop residues)
- **Indicators of soil erosion**

The methods for collecting and measuring each of the proposed indicators are available in *separate documents*.

MEASUREMENT METHODS

Some of the indicators may be **quantitative** and others **qualitative**, they are measured either as a result of **observation** or through **analysis**. Qualitative monitoring are based on **visual observations** of the colour and external appearance of the soil, or even on its **smell and texture**. For example, farmers often use soil colour as an indicator of soil quality (the darker the soil, the richer it is in organic matter, and the more fertile it is; light red or yellow soils are generally considered to be poor soils). Another example of qualitative assessment is the **presence of gullies and ravines** that indicate that there are signs of soil erosion.

Qualitative evaluations have the advantage of being **simple and quick** to do, carried out by AAH's mission technicians or its technical partners, all of whom are trained in the various monitoring indicators.

Also, since some of these indicators (signs of erosion, soil colour, plant cover) are vision and observation based, the use of **photographs as a monitoring tool** is recommended in order to achieve a more objective assessment of them. *A protocol* for taking photographs, referencing the sites and the photos taken is provided in **appendix 4**.

However, due to the **subjective nature** of qualitative assessment, in many cases the qualitative assessment of soil should be supplemented by other **quantitative indicators** related to other soil characteristics (for example pH and soil structure). However, these measurements may call for more or less elaborated methods, requiring **technical and human resources** of quantitatively measuring certain indicators. For example, pH can be measured with simple methods (see **appendix 5**), while indicators such as soil structure or electrical conductivity may require more elaborated methods.

Soil quality can be monitored with:

- **Periodic measurements** over time to monitor **changes or trends** in soil quality following the implementation of certain agroecological practices.
- Changes are monitored by comparing soil condition to **a reference condition** of soil quality.
- Thus, **a scale of values** is proposed for each indicator.
- In some cases, the soil condition is measured from a **photograph** aiming at objectively depicting the relevant observed indicator.
- In some cases, soil condition is monitored using photographs so as to **objectively describe** the observed situation.

By using this method of monitoring, it is possible to:

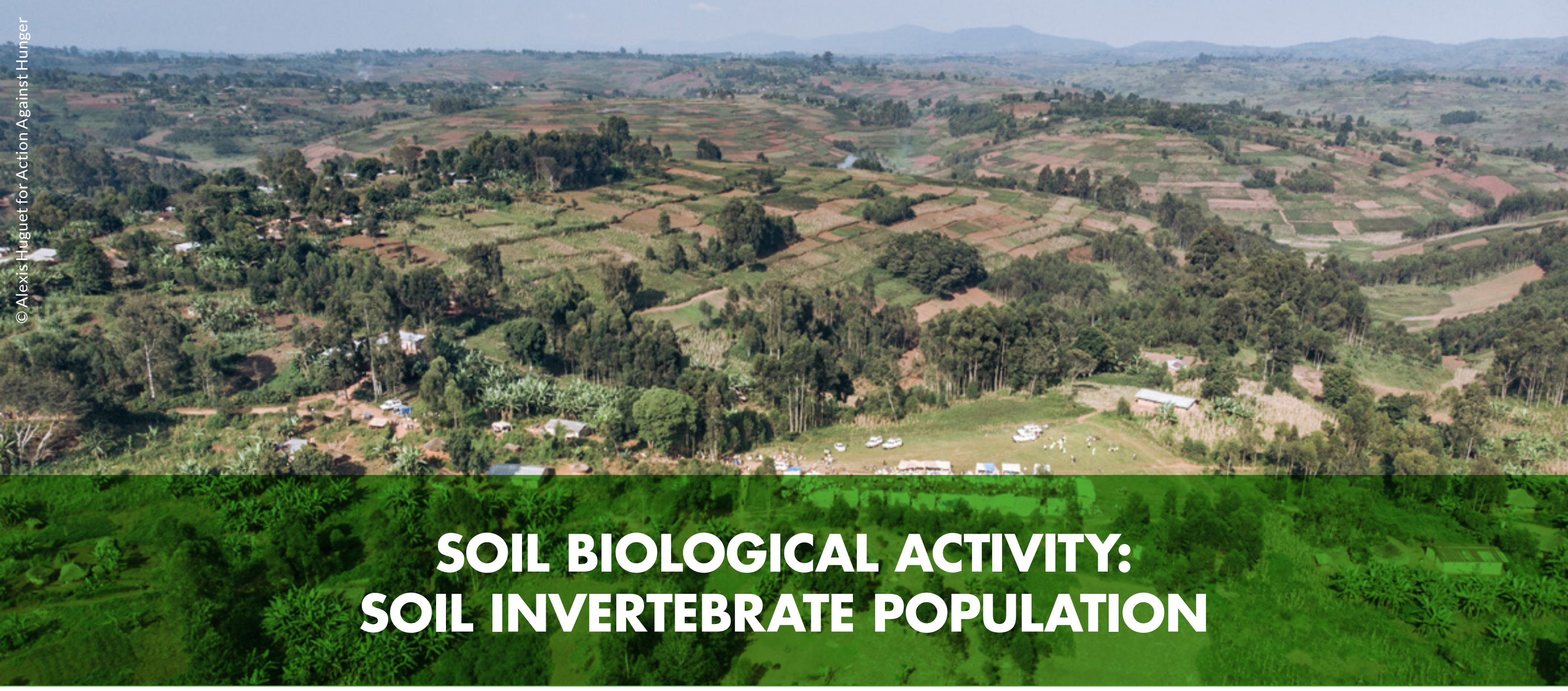
- Take measurements in the same field over time to **monitor the evolution of the relevant soil quality**, after having **implemented certain agroecological practices** of soil health management.
- Monitor the **evolution of soil health** over time at **a given site**.

CONDITIONS FOR MEASUREMENT AND SAMPLE COLLECTION

- Take samples and measures under **suitable conditions** (not too dry or too wet).

- Indicators such as the invertebrate population or soil organic matter are affected by tillage and should be assessed **prior to tilling**.

- Choose the best time to conduct the assessment and take the measurements and the samples **at the same time each year**.

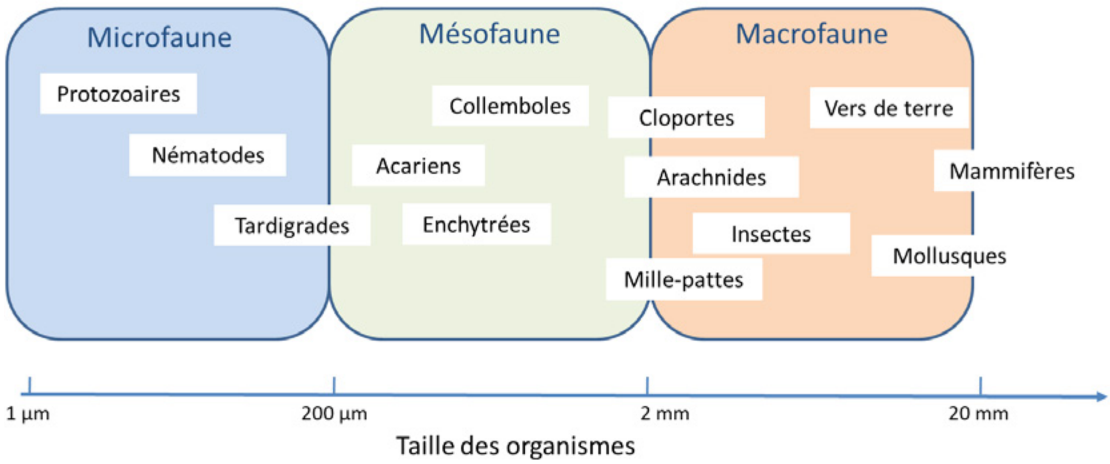


SOIL BIOLOGICAL ACTIVITY: SOIL INVERTEBRATE POPULATION

Soil biological activity refers to the abundance, diversity, and activity of living organisms (fauna or soil biota) that contribute to soil productivity and perform various ecological and agricultural functions. The abundance and diversity of invertebrates are very good indicators of soil quality.

Soil fauna can be classified into **three groups**, according to size :

- **Microfauna**: less than 0.2 mm
- **Mésofauna**: from 0.2 to 2 mm
- **Macrofauna**: more than 2 mm



In the context of this monitoring tool, soil **macrofauna** includes all groups of invertebrates, **90 % of which can be observed with the naked eye**, particularly earthworms and insect populations (beetles, termites, ants, etc.).

Source: Philippe LEBEAUX

Source: Afrique Agriculture

Source: Mathieu COULIS

The biological activity of the soil, and particularly its **invertebrate population**, is one of the **four indicators** selected to assess soil health in the context of AAH agroecology project monitoring tool (the other three indicators are **rate of organic matter**, **soil cover**, and indicators monitoring **signs of soil erosion**). This indicator changes according to the characteristics of the site (food availability and soil conditions), growing seasons, etc.

ROLE IN SOIL HEALTH

Like the physical and chemical properties, **biological properties** of soil contribute to its **essential functions**. Biological properties are part of the dynamic properties of soil that are **very sensitive to tillage and chemical contaminants**. Population of soil macrofauna generally increases the microbial activity of soil, improving its fertility as well as its physical properties. For example, **earthworms** play a key role in changing the physical structure of soil by producing new aggregates and pores, thus **improving soil aeration, infiltration, and drainage**. They improve soil **porosity** by digging and mixing the soil. By eating organic matter, soil invertebrates participe in the **decomposition of plant residues**, enhance **soil nutrient cycling** and **redistribute nutrients** in the soil profile. **Plant roots** often follow the burrows created by earthworms and insects to access soil nutrients. The absence of macrofauna or their low population can reduce nutrient cycling in the soil as well as nutrient availability and utake by plant.

In general, **soil macrofauna improves soil quality** by:

- Increasing the **availability of soil nutrients** for plants.
- Decomposition of organic matter by incorporating litter into the soil and activating both **mineralization** and **humification** processes.
- Improving soil physical properties, such as soil **aggregation** and **porosity**.
- Suppression of certain **harmful organisms or pathogens.**
- Improving the activity of certain **beneficial soil microorganisms**.

In addition, the soil macrofauna supports the **development of soil microorganisms**, which contain significant amounts of **nutrients in their biomass** that they return to the soil when they die. These microorganisms also produce **growth hormones** and compounds that stimulate plant growth and promote **good aeration, structure, infiltration and water retention** in the soil. Microorganisms also reduce **disease and pest pressure**. The benefits of microorganisms can i**ncrease crop production** and **reduce application of fertilizers**.

Invertebrate populations are **highly variable in space and time**. **Species diversity** plays the most important role:

- Invertebrates living on or near the **surface** decompose plant residues.
- Species living in the **topsoil** bury, ingest and mix soil 20-30 cm deep.
- Species that **deeply** mix plant litter and organic matter beyond 20-30 cm.

FACTORS AFFECTING SOIL MACROFAUNA POPULATION

Deep tillage disturbs soil macrofauna. Invertebrate populations depend on the intensity and frequency of soil disturbances. Additionally, the **indirect effects** of tillage must be considered. These indirect effects include increased **soil surface temperature**, increased **evapotranspiration**, reduced **litter input** and faster **oxidation** of crop residues. For example, earthworm populations are generally higher (2 to 3 times) in **undisturbed soil systems** (e.g. no-till) than in the tillage systems often used in conventional agriculture.

Chemical fertilisers and pesticides that are **very toxic** to earthworms and insects; they also modify many **chemical and physical properties** of the soil on which the invertebrate population depends. Excessive use of acidifying fertilizers as well as certain insecticides and fungicides can reduce the number of invertebrates in the soil.

Temperature plays a significant role in the **life cycle of invertebrates**. Many invertebrate species have the behavioural and/or physiological ability to adapt and survive adverse conditions (thermal regulation, slow metabolism or hibernation, migration towards a more favourable environment).

Soil moisture generally determines the **soil fauna** as well as the distribution of invertebrates and their activity in the soil. Both excess and insufficient moisture are detrimental to the invertebrate population.

AGRICULTURAL PRACTICES FAVOURABLE TO THE INVERTEBRATE'S POPULATION

The following agroecological practices **increase invertebrate populations**:

- **Regular organic returns** (crop residues, green manure) and soil rich in organic matter promote the development of invertebrate populations.
- The use of **organic fertilisers** derived from the urine and faeces of humans and animals.
- **Reduce tillage** (minimum disturbance, direct seeding, strip crops, ridge livestock farming).
- **Crop rotation** (with leguminous crops) and **cover crops**.
- **Irrigation water** management and better **drainage.**

DATA COLLECTION MANAGERS

- Programme managers
- Agricultural technicians
- Trained project surveyors

PERIODS AND METHODS OF MEASUREMENT

- Data collection should be done **before the start of the project** (baseline data) and **at the end of the agroecological project** in order to compare, if necessary, the impact of the project on the macro-fauna.
- Data collection should be done at a minimum and if possible **once a year** for multi-year programs.
- Samples can be taken **at any time of the year**, knowing that invertebrate populations vary in size and number depending on the species and the season.
- Sampling should be done on soils that are **not very wet or dry**, because when the soil is too dry or too wet, it is difficult to obtain a representative sample.
- **In arid regions**, it is advisable to take the sample at **the beginning of the rainy season** and when the humidity and temperature of the soil are good.
- In order to make comparisons from one year to the next, the number of invertebrates should be assessed **at the same time of the year**.
- Sampling should be done **once a year** and in **several sites on the farm** (macrofauna population being generally unevenly distributed in a field and varying according to the season).

MEASUREMENT PROTOCOL

- Identify **3 plots** that from AAH projects in the intervention area.
- Identify **3 sampling sites** on each of the plots. These sites must be **geo-referenced** to be easily located and allow precise sampling at the same places every year.
- Keep the **same geo-referenced plots over the years** in order to monitor the growth rate of macro-fauna population on the plots.
- Dig a shovelful of soil **15 cm wide** and **20-30 cm deep**.
- Take **3 shovelfuls** from each site.
- Separate and count the **number of invertebrates** for each shovelful.
- Note the **total number per shovelful**.
- Calculate the **average shovelfuls** per site.
- Calculate the **average number of invertebrates per year** to assess changes over time, from year to year and at each site.

INTERPRETATION

Each level of invertebrate population is assigned a **score between 1 and 5**:

Note	*Number of invertebrates per shovelful*	*Interpretation*
5	More than 4 individuals in a shovelful	Good presence
3	1-4 individuals in a shovelful	Average presence
1	No presence or sign of invertebrate activity	Absence of invertebrates

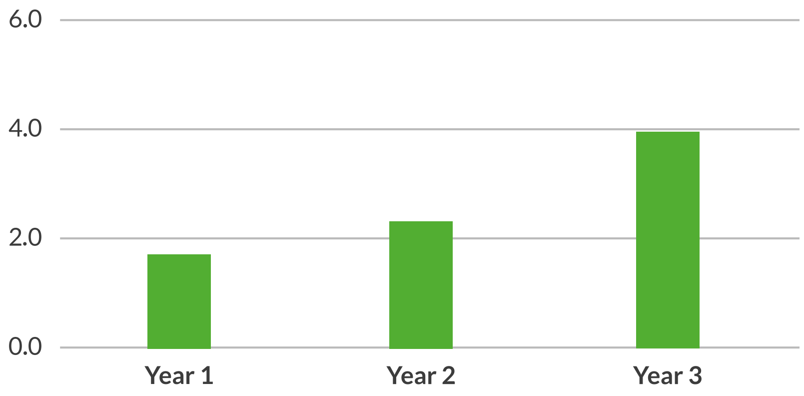
Once the invertebrate count has been done and the scores assigned, the **average** is calculated to assess the changes from one year to another according to the following scores:

- **Average score between 4 and up**: Satisfactory
- **Average score between 3 and < 4**: Acceptable
- **Average score between 2 and < 3**: Low
- **Average score between 1 and < 2**: Very insufficient
- **Average score between 0 & < 1**:Poor

EXAMPLES

FIELD									
Shovelful	*Year 1*			*Year 2*			*Year 3*		
	S1	**S2**	**S3**	**S1**	**S2**	**S3**	**S1**	**S2**	**S3**
Sh1	1	1	1	3	3	1	5	3	1
Sh2	1	3	3	1	3	3	5	5	5
Sh3	1	3	1	3	1	3	3	3	5
Medium site (S)	1.0	2.3	1.7	2.3	2.3	2.3	4.3	3.7	3.7
Average Field	**1.7**			**2.3**			**3.9**		

Population of invertebrates in the farm



The graph above indicates that in **year 1** this field records a very low level of invertebrate presence, a low level in **year 2** and an acceptable level in **year 3**. These data can be **cross-referenced with past or current agricultural practices** on this field in order to identify the practices that have negatively or positively influenced the invertebrate population.

LIMITATIONS

- The population of invertebrates is **highly dependent on climatic conditions** and their monitoring over several years are necessary to obtain significant results.
- Invertebrates are not "native" to all soils. Since invertebrate activity is less likely in **dry soils**, in **arid areas** it is recommended to use **other indicators** to monitor and assess soil quality.
- This method of monitoring invertebrate population cannot help in monitoring **certain species** of earthworms and insects that dig deep or move quickly.

NOTES

- The results of the monitoring will be all the more accurate when the **same teams** measure them over time and at the **same time of year**.
- Evaluation scores do not represent an absolute value, but an **approximate value for estimating the indicator**.

MONITORING SIGNS OF SOIL EROSION

Soil health is measured through several indicators and monitoring soil erosion is one of the four indicators used to monitor soil health in AAH's agroecology projects (the other three indicators are soil cover, soil organic matter, and the presence of invertebrate).

Observing the signs of erosion makes it possible to monitor **degree of soil erosion** due to the effects of **various degradation factors**: water, wind, agricultural practices (tillage, monocultures, application of chemicals, etc.); Erosion occurs when all or part of the soil is **moved away over a variable distance from the site** where it is located, by the action of water, wind, gravity or even agricultural practices or human activities.

Erosion is not due to human activity alone as **natural erosion** occurs even in the absence of human disturbance. However, it is the **accelerated erosion** caused by agricultural practices and other unsustainable land management practices that accentuate soil degradation. **Soil erosion is considered the most prevalent form of land degradation in arid zones**, with **wind and water erosion** accounting for 87 % of land degradation. Overgrazing, loss of vegetation cover and the absence of adequate soil conservation practices increase the susceptibility of these soils to erosion.

The continued appearance of signs of erosion in a cultivated area results in a **reduction of the agricultural area** and a **loss of fertile land**. The erosion of the topsoil leads to a loss of soil fertility, of its water retention capacity, of its organic carbon content; which affects its **productivity** and ultimately the **profitability** of the farm. Reduced soil productivity due to erosion can result from thinning of the soil topsoil, which reduces the volume available for **plant roots**. It is more common for crop yields to be reduced by the **loss of plant nutrients** and for the physical, chemical and biological properties of the soil to be **degraded**. For example, water erosion by runoff is accompanied by a loss of water that can reach 30 to 45 % of the annual rainfall on some plots. In areas that receive only 400 to 500 mm per year, these losses compromise crop yields.

Monitoring soil erosion provides very useful information on soil health, especially when it is considered with **other indicators of soil health**, such as organic matter content, on which many indicators of soil health depend. Knowing the state of soil degradation and **identifying the problem** is the first step in the **decision cycle**, essential for recommending soil **restoration and conservation** measures.

FACTORS RESPONSIBLE FOR SOIL EROSION

- **Actions of water** (water erosion) and **wind** (wind erosion).
- **Traditional agricultural techniques** that are generally based on cleaning fields and burning residues from the previous crop, weeds, and shrub regrowth. Sowing on bare ground exposes the soil to erosive rains during the crop development cycle (3-5 weeks depending on the type of crop).
- **Removal of crop residues** which strips the soil.
- **The state of the plant cover**: The main determinant of erosion because cover crops makes it possible to limit runoff and therefore water erosion.
- **Land topography**: Erosion increases with the slope; and the greater the slope of the land, the greater the runoff.
- **The soil surface condition** due to cultivation practices, the texture and depth and its organic matter content.
- **Permanent tillage** which weakens its structure.
- **Deforestation**, destruction of trees in the fields.
- **Overgrazing** and encroachment by livestock.

AGRICULTURAL PRACTICES TO REDUCE SOIL EROSION

The following agroecological practices **reduce soil erosion**:

- **Permanent soil cover** (maintenance of crop residues, mulching, cover crops)
- **Reduced tillage** or zero tillage (conservation agriculture)
- **Rotation / association** of crops
- **Strip crops**
- Installation of **anti-erosion structures** (windbreaks, zai, stone bunds, half-moons)
- Maintaining **shrub cover** (reforestation and assisted natural regeneration)

This farmer has kept **shrubs** in his field which grow back after weeding and somewhat protect the soil in the dry season. Before the first rains, the farmer cleans his field by cutting the stems of the shrubs and leaving them on the ground without burning them. **Stone bunds** were made to reduce the speed of runoff.

(Yatenga, Burkina-Faso: Photo and text after Dugué, P., 2002)[14]

[14] Dugué, P., 2002. *Erosion and its mechanisms in dry tropical Africa. In: Handbook of the agronomist.* Montpellier

Erosion control techniques are implemented **at the plot level** (tillage, crop association) as well as **at the level of a group of plots** or a portion of a watershed.

OBSERVATION PERIOD FOR SIGNS OF EROSION

Generally, erosion signs can be **visible any time of the year**; but signs of water erosion are best seen after **heavy rains**. **At the beginning of the agricultural season**, observations consist of looking for the presence of **gullies** before the rains and **in the middle of the season**, they consist of looking for the materialization of **runoff gullies**.

RESPONSIBLE FOR OBSERVING EROSION SIGNS

The persons responsible for observing and evaluating signs of erosion are **programme managers**, and **agricultural enumerators from AAH** and its **partners**, who have been previously trained.

METHODS FOR MONITORING SIGNS OF EROSION

Due to the interaction of **many parameters** related to erosion, it is difficult to assess and quantitatively measure erosion in the field. In the context of this monitoring tool, the evaluation of erosin signs is limited to the **analysis of soil surface conditions**.

The degree of erosion is a **qualitative indicator** that shows the degree of **erosion severity** on a given soil. The activity of observationmonitoring activity consists of identifying **signs of soil erosion** that can have negative impact on agricultural yields and monitor them over time. These signs should as far as possible be **easy to observe, measure or estimate**, so that an observer can assess the degree of degradation as objectively as possible. The analysis of soil surface conditions makes it possible to **assess the risks of erosion** incurred by this soil. The evaluation is based on observations, which are more easily described than quantified. The **assessment and monitoring** consists of identifying and observing signs of erosion over time.

These signs are: decrease in the thickness of the topsoil, decrease of soil organic matter, the presence of gullies, ravines, deposits of fine elements and sand in low-lying areas in the field, exposed tree or plant roots, formation of small sand dunes, waterlogging of the soil, salt formation on the surface, soil compaction, etc.

Examples of erosion signs

WATER CHANNELS/RILLS

*In this field, the tillage left a **groove (or hollow)** which will **drain the rainwater** and thus form a **channel.***

(North Cameroon: Photo and text after Dugué, P., 2002)[15]

*Over the years, the **runoff water** creates a water passage that will turn into a **channel** and widen as rains fall.*

(Yatenga, Burkina-Faso: Photo and text after Dugué, P., 2002)

***Channels** appearing during a **heavy rain** just after crop emergence. The young plants were pulled up and washed away. The water flows through these same channels as rain increase. Over the years if the farmer does not intervene, the **channel** turns into a **ravine**.*

(North Cameroon: Photo and text after Dugué, P., 2002)

Channels** of erosion formed in a cornfield **after rain.

(Brabant, 2010)[16]

***Rill erosion** evolving into **channels** in a cassava field.*

If measures are not taken, the channels will reach the cassava plants and destroy the crop.

(Brabant, 2010)

[15] Dugué, P., 2002. *Erosion and its mechanisms in dry tropical Africa. In: Handbook of the agronomist.* Montpellier

[16] Brabant P., 2010. *A method for assessing and mapping land degradation. Proposal of standardized directives.* CSFD thematic files. N°8. August 2010. CSFD / Agropolis International, Montpellier,

RAVINES

***Gullying** can be significant when runoff is high and the **soil is loose and deep**. The gully increases with **each heavy rainfall**. Here the gully is located in the middle of a millet field on fertile soil and results in a loss of cultivated area.*

(Yatenga, Burkina-Faso: Photo and text after Dugué, P., 2002)[17]

DEPOSITS OF FINE ELEMENTS AND SAND IN LOW AREAS

*As the **velocity of runoff decreases**, both the **fine elements** (clay and silt, organic matter particles) and **the coarser elements** (sand) will settle. This is common when water flowing from a gully arrives in a relatively flat and wide bottom. If the sand deposits are important, they will **"silt up" the lowland**.*

(North Cameroon: Photo and text after Dugué, P., 2002)

INUNDATION OF THE LOWLANDS

***The network of gullies and ravines** channels large quantities of water that will not benefit to crops on the glacis. This **muddy water** loaded with fine elements and nutrients is lost to agriculture; the water can stagnate for several days, leading to the **destruction of traditional lowland farming**.*

(Yatenga, Burkina-Faso: Photo and text after Dugué, P., 2002)

[17] Dugué, P., 2002. *Erosion and its mechanisms in dry tropical Africa. In: Handbook of the agronomist.* Montpellier

METHODS FOR MONITORING SIGNS OF EROSION

Since it is difficult to define **classes of erosion** to be applied in the same way for all types of soils and to different types of erosion, a method is proposed here **to be applied globally** to all signs of soil erosion observed, independent of the type of soil and the type of erosion.

The degree of erosion is evaluated on a **scale of 1 to 5** corresponding to **three levels of soil condition**:

- **1** = poor condition (strong erosion)
- **3** = average condition (moderate erosion)
- **5** = good condition (little or no erosion)

The As the rating is **flexible**, if the degree of erosion does not correspond to any of the three ratings (1, 3, 5) but is between two, it can be assigned an **intermediate rating**.

Degree	*Degree of erosion*	*Signs of soil erosion*
1	Advanced	• Heavy and muddy runoff • Deeply eroded soils, giving way to a vast network of deep ravines and gullies • Very thin or absent topsoil • Heavily cleared crops • Roots of trees and shrubs exposed below the crown and visible over several cm. • Dust clouds are released when cultivating on windy days • A significant amount of topsoil removed from the plot and deposited elsewhere in the vicinity • Abundant sand deposits in the lower parts of the farm and in the drainage axes • Numerous crusts on the soil surface • Bare areas, without spontaneous vegetation, that can cover more than half of the land surface
3	Medium	• Minor signs of erosion are visible • Water erosion is moderately important with some gullies and medium depth gullies • Little runoff, minor loss of topsoil • Decrease in humus layer thickness to over 25 % • Sand deposits upstream of field obstacles • A considerable amount of soil is blown out of the field • Plants partially unleavened • Surface crusts covering less than 10 % of the land
5	Nul to weak	• No visible signs of erosion: No soil displacement, no ravines, no or little runoff observed • Little or no water erosion • No wind erosion: Most of the wind-blown soil remains on the plot • Thickness of the surface layer of humus is intact

Observing signs of erosion **over time on the same plots** provides a good **estimate of the degree of erosion**. It is advisable to make observations on several plots and over time in order to have a **global view** of the degree of erosion in the area concerned.

Since the monitoring of erosion signs is based on **observation**, **photos** taken over time should be used to allow an objective comparison of situations. This is why the choice of the site is essential for taking photos. The site must be oriented so that **the sun shines on the soil profile** where the signs of erosion are observed; this allows having **photographs that are representative** of the soil characteristics and of signs of erosion observed. This site must be **geo-referenced with GPS data** in order to allow sampling at the same locations or around the site. *A detailed protocol* for taking photographs and georeferencing the sites is provided in the **appendix 3 and 4**.

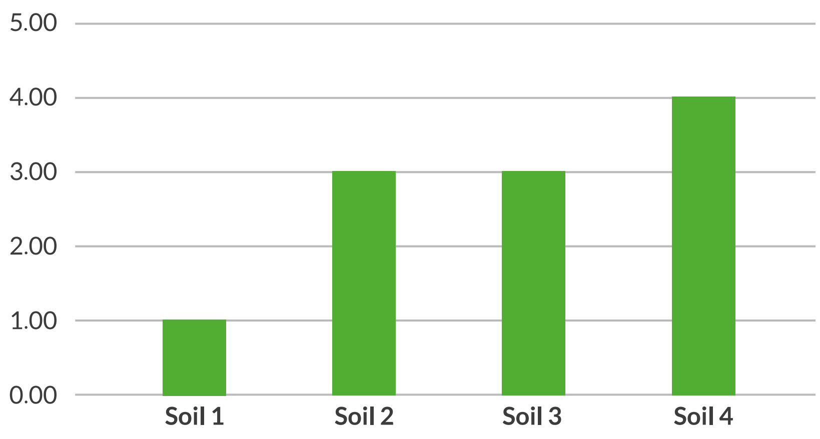
For example, in the context of a land restoration project, observations should be made **at the beginning and at the end of the project** in order to compare the condition of the soils before and at the end of the project and to see the impact of the project on reducing erosion reduction and restoring land. In this case, it is about **observing the erosive dynamics** based on the observation of **active or inactive erosion processes**.

EXAMPLES

The following table shows examples of erosion monitoring on **4 soils** from 4 different zones of a project, spread over **3 years**.

Year	*Y1*	*Y2*	*Y3*	*Average*
Soil 1	1	1	1	**1.00**
Soil 2	5	1	3	**3.00**
Soil 3	4	2	3	**3.00**
Soil 4	4	3	5	**4.00**

Average degree of erosion



Soil 1 has an advanced level of erosion; which requires the implementation of **anti-erosion measures** to **restore and preserve** the quality of this soil, by mobilizing a certain number of practices to reduce erosion such as plant cover, mulching, the addition of organic matter, reduction of tillage. Reduced erosion reduces sediment runoff and thus improves the soil's water holding capacity. In areas subject to wind erosion, conservation agriculture practices as well as the installation of windbreaks will help to slow down or reduce the progress of erosion on this soil.

Even if **soils 2, 3 and 4** show moderate signs of erosion, the same **soil conservation practices** are advocated in order to prevent subsequent soil degradation and therefore protect it against erosion.

LIMITATIONS OF THE METHOD FOR MONITORING SIGNS OF EROSION BASED ON THE DEGREE OF EROSION

- The observations are influenced by the **subjectivity of the observer**. For example, an evaluator's attention tends to be focused on clearly visible signs of erosion such as gullies for water erosion or dunes for wind erosion. On the other hand, the **degradation of soil physical properties** (a major constraint to land productivity) is **underestimated**, because it is not directly visible in the field, but assessed through l**aboratory tests**.

- In addition, the evaluation of the same degree of erosion can **vary from one country to another** because of the very different ecological contexts and, sometimes, the subjective assessments of the evaluators. In addition, this is why the use of a **database of descriptive photos** of the various signs of erosion is essential to achieve better monitoring of signs of erosion.

REFERENCES

- Brabant P., 2010. *A method for assessing and mapping land degradation. Proposal for standard guidelines.* Dossiers of the FSCD French Scientific Committee on Desertification. N°8. August 2010. CSFD / Agropolis International, Montpellier; https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers12-04/010050923.pdf

- Dugué, P., 2002. *Erosion and its mechanisms in dry tropical Africa.* http://www.laboress-afrique.org/ressources/assets/docP/Document_N0905.pdf

VEGETATION COVER

Vegetation cover is one of the four indicators selected to assess soil health as part of the monitoring of AAH's agroecology projects (the other three indicators are the level of organic matter, the invertebrate population in the soil and indicators of signs of soil erosion). Plant cover can be made with mulch (dead plants) or with cover crops (living plants).

Mulching (or mulch) consists of covering the soil with a layer of at least **2 cm of crop residues** (leaves, grass, twigs, crop residues, straw, etc.) in order to ensure that the crop is covered to protect it **against erosion** and to stimulate the **biological activity** of the soil and therefore its fertility.

Cover plant: Any plant that covers the soil and improves its fertility can be considered a cover plant. Cover crops can range from **legumes** (with the advantage of enriching the soil with nitrogen) to **fast growing grasses** with high biomass production. *A non-exhaustive list of cover plants* is given in the **appendix 6**.

The choice of cover plants is **not done randomly** but depends on the type of soil, agroecological conditions, species of cover plants, the producer's investment capacity, etc.

A cover crop is not always suitable for reducing evaporation from the soil as this crop can also use a lot of soil water for growth. **In arid or semi-arid regions**, it is preferable to use **mulching** with crop residues or remains of plant material. This will help retain **soil moisture**, which can then be used by crops. **In humid regions**, **mulching** can be used just like **cover plants**, in particular legumes that can be used at the same time as vegetative cover, fodder, and green manure (especially because of their capacity to fix the soil nitrogen).

ROLE OF MULCHING IN SOIL HEALTH

Mulching contributes to the preservation of soil health, especially **soil organic matter content**; In addition, mulching plays broader **environmental roles** such as habitat for wildlife and as combating the impacts of climate change. In general, cover crop plays the following roles[18]:

- **Protects the soil from wind and water erosion**: This prevents soil particles from being washed away, thus reducing the effects of drought as a climatic hazard.

- **Improves infiltration of rainwater and irrigation**: Thanks to the maintenance of a good soil structure. Which helps prevent the formation of impermeable crusts (sometimes called capping) observed on uncovered soils.

- **Keeps soil moist by reducing evaporation**: Mulch provides shade for the soil, protecting it from sunlight. This makes it possible to reduce evaporation. Plants can be irrigated less because they use the water available in the soil more efficiently.

- **Nourishes and protects soil organisms**: Vegetable mulch is an excellent source of carbon for soil organisms and provides favourable conditions for their growth.

- **Blocks weed growth**: The mulch layer prevents the development of weeds.

- **Provides nutrients for crops**: While decomposing, the organic matter in the mulch continuously releases its nutrients, thus fertilizing the soil.

- **Increases the organic matter content of the soil**: Part of the mulch is transformed into humus and then gradually decomposed.

[18] FAO, 2015. *Mulching (or mulching) in organic livestock farming* http://www.fao.org/3/ca4049fr/ca4049fr.pdf

FACTORS AFFECTING PLANT COVER

- **Traditional agricultural techniques**: for soil preparation: cleaning of fields of crop debris, slash-and-burn agriculture; This operation exposes the soil to erosion and therefore to the loss of its organic matter.[19]

- **Burial of crop residues** and organic matter available from deep ploughing makes the soil vulnerable to erosion, leading to the formation of capping.

- **Extensive breeding** as practised in some areas is based on the use of rare natural rangelands as grazing areas. Crop residues are thus heavily grazed so that very little is left to serve as ground cover.

- **Fodder harvesting**: To meet the feed needs of livestock, agro-pastoralists harvest large quantities of dry grass from the plots. The soil is left bare at the beginning of the dry season, which favors wind erosion and, in areas with a slight slope, water erosion.

AGRICULTURAL PRACTICES OF PLANT COVER MANAGEMENT

The following agroecological practices make it possible to **preserve or strengthen plant cover**:

- **Rotation / association of crops**
- **Crop sewing practices under plant cover**
- **Reduced tillage** combined with **mulching or cover crops**

All recommended agricultural practices aim to cover the soil **between two growing seasons** in such a way as to prevent the formation of capping, to preserve the structure of the soil, and to avoid soil degradation.

[19] Dugué Patrick. 2002. *Erosion and its mechanisms in dry tropical Africa*

PERSON IN CHARGE OF DATA COLLECTION

The people responsible for observation and data collection are the **programme managers**, **agricultural facilitators**, and **interviewers for AAH** or their **technical partners**, following training.

COLLECTE DE DONNÉES

- **Data collection** is to be done **at the start of the agricultural season** and **at the end of the agricultural season**, at harvest.
- **The monitoring of the plant cover** is also to be done at the beginning and at the end of each agricultural project promoting the plant cover, in order to compare the state of the soils before and at the end of the project, and to see the impact of the project on to the increase in plant cover.
- If the **production cycle** is shorter than the **project cycle**, we organize the collection during each end of production cycle.

METHODS OF MONITORING AND INTERPRETATIONS

- The vegetation cover is evaluated in terms of **presence / absence of coverage**.
- For a mulch or cover crop to be effective and give good protection, the soil must be covered by more than **30 %**[20] , because that is the threshold from which mulching can intercept rain energy, reduce runoff, facilitate water infiltration, and improve organic soil matter and therefore its water retention capacity.
- In addition, since the covered soils do not show crusting (sign of erosion), the visual observation will also take into account the **presence or lack of crusting**.
- A score is assigned to each observed situation as indicated in *the following table*.

[20] Eric Roose, *Potential of mulching to reduce erosion and restore the productivity of tropical soils*
https://books.openedition.org/irdeditions/24270

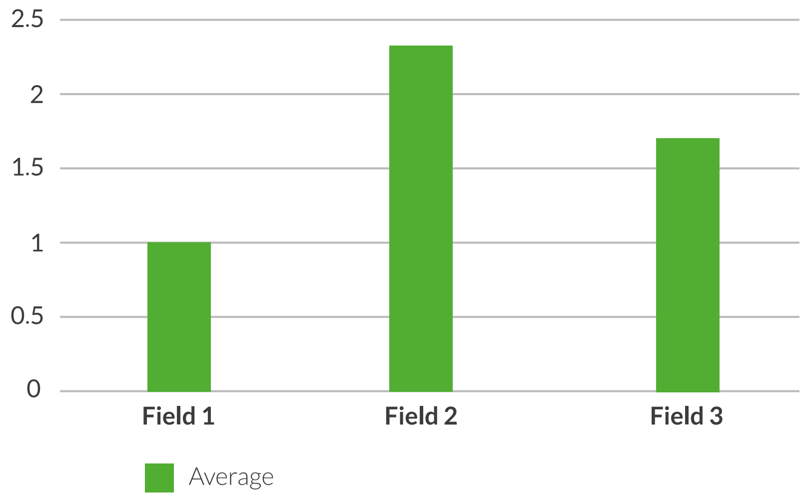
Note	*Observed signs*	*Interpretation*
0	Bare soil without any vegetation cover, without any residue of crops or dry grass - The crust > 5 mm and is continuous, without cracking **Soil restoration practices such as half-moons and zai are necessary to recover such soils**	**Bad condition**
1	Less than 30 % of soil covered with crop residues or dry grass - A crust that is 2 to 3 mm thick and very cracked	**Weak**
2	30-60 % of soil covered with crop residues or dry grass - Little or no crust	**Average condition**
3	More than 60 % of soil covered with crop residues, living plant cover No crust	**Good condition**

EXAMPLES

The table below presents the results of a monitoring of cover crop over time on **3 fields**.

Year	*Field 1*	*Field 2*	*Field 3*
Year 1	0	2	1
Year 2	1	2	1
Year 3	2	3	3
Average	**1.0**	**2.3**	**1.7**

Monitoring of soil cover



- As can be seen in *the above graph*, the state of the **vegetation cover has improved** over the years. This could be explained by the adoption of the practice of mulching by producers.

- **In the third year**, **farms 2 and 3** reached good condition with more than 60 % of their surface covered by plant cover.

- Monitoring the practice of mulching and plant cover on several sites / villages of AAH project makes it possible to make **spatial comparisons** between different project areas / villages.

- In the framework of an agro-ecological transition, rather than aiming for the maximum level of plant cover to be achieved, it is the **gradual adoption of the practice** of plant cover that should be the objective.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SOIL ORGANIC MATTER

Soil colour is a very good indicator of the quality of the soil and in particular of its composition in organic matter. Soil organic matter is one of the four indicators selected to assess soil health in the context of monitoring AAH agroecology projects (the other three indicators are soil cover, invertebrate population in soil and indicators monitoring signs of soil erosion).

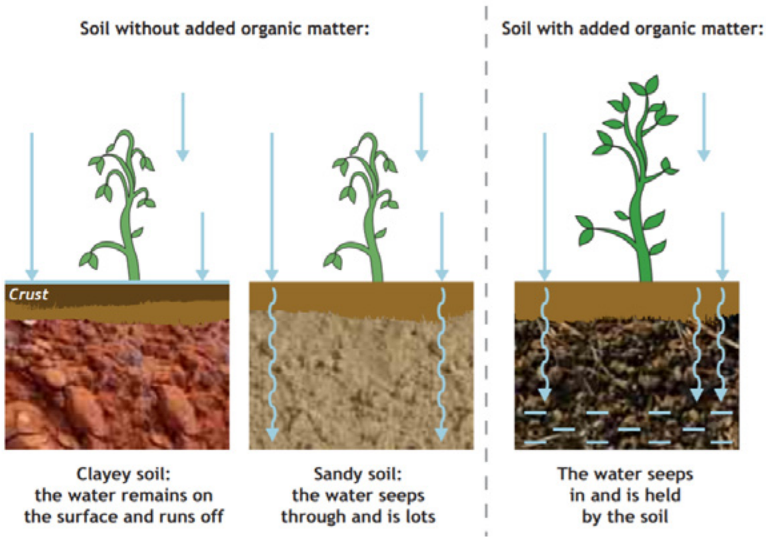
In general, the **darker** the colour of the soil, **the more organic matter** it contains. The colour of the soil is a variable put forward by farmers to assess the quality of their soil. The **colour-fertility** and soil quality relationship is found in many soil typologies around the world and corresponds to **the basis for determining the level of soil fertility**, long retained in agricultural sciences: **The organic matter rate relationship -Fertility level**[21]. A change in colour may thus indicate a change in organic matter due to particular agricultural practices. Soil colour is an **indirect measure** of other useful soil properties that cannot be easily and accurately measured.

THE ROLE OF ORGANIC MATTER IN SOIL HEALTH

Soil organic matter plays an important role in regulating most **biological, chemical, and physical soil processes**, which together determine the health of soils. So the organic matter composition of the soil can help **indirectly assess other useful soil properties** that cannot be easily measured.

Organic matter promotes **water infiltration and retention**, helps to develop and stabilise **soil structure**, **reduce erosion** and maintain **carbon "sinks"** in the soil, thus helping to combat climate change. Organic matter is also an important **food resource** for organisms living in the soil and is an important source and an important reservoir of **nutrients** for plants. Decline of soil organic matter reduces soil fertility and nutrient supply; this results in an increased dependence on **chemical fertilisers** to maintain soil nutritional status. Soil organic matter can also be a useful indicator of **soil drainage** and the degree of **soil aeration**.

[21] Blanchard, M., 2010. *Management of soil fertility and the role of the herd in cotton-grain-livestock systems in southern Mali: local technical knowledge and practices of integration between agriculture and livestock livestock farming*



Source (AgriSud, 2010)

FACTORS AFFECTING SOIL COLOUR AND SOIL ORGANIC MATTER

- **Traditional agricultural techniques**: Clearing crop residues from fields, slash-and-burn agriculture - which exposes the soil to erosion and therefore to the loss of its organic matter.

- **Tillage**: Regular tillage **deeper than the topsoil** (20-30 cm) increases the decomposition and respiration of organic matter; which leads to the **loss of soil carbon** and an increase in the amount of CO^2 released into the atmosphere.

- **Monoculture and over-exploitation of the soil** which decreases organic matter content and leads to the deterioration of soil structure, resulting in significant soil loss through wind erosion.

- **Chemical fertilisers and pesticides** that are very toxic for macro and microorganisms that decompose organic matter in the soil.

- **High humidity and poor soil drainage**: Poor aeration and prolonged saturation with water give rise to a series of biochemical reactions that produce **toxins**, which can damage the root system of plants.

AGRICULTURAL PRACTICES TO BETTER MANAGE SOIL ORGANIC MATTER

The following agroecological practices help to **preserve soil organic matter**:

- **Minimal tillage, direct seeding, strip cropping, ridge cropping**
- **Mulching** with crop residues, **cover crops**
- **Crop rotation** (with leguminous crops) and **cover crops**
- **Application of organic fertilisers** based on urine and human and animal excrement, crop residue
- **Better management of soil propertie**s (including pH) obtained through the application of organic fertilisers
- **Irrigation water** management and better **drainage**
- **Reforestation** and naturally-assisted **regeneration**

RESPONSIBILITY FOR OBSERVATION AND EVALUATION

Programme managers, **agricultural extension workers** and **enumerators, from AAH missions** or their **trained technical partners**, are responsible for observation and monitoring.

PERIODS AND METHODS OF MEASUREMENT

- Data collection is to be done **before the start** (baseline data) and **at the end of the agroecological project**.
- The best time for soil sampling is during **harvest**, and **before any tillage.**
- Observations and measures should be carried out on soils with l**ow humidity but not too dry**, because when the soil is too dry or too wet, it is difficult to get a representative sample with distinct colours.
- Sampling is to be done **once a year** and in **several sites** on the plot.
- To monitor the sampling sites **over time**, the sites must be **geo-referenced using GPS data** in order to allow accurate sampling every year at the **same places** or around the initial site.
- Since the monitoring is based on **observation**, the use of **photographs** is necessary to allow an **objective comparison** of the status of the sites. This is why the **choice of the site** is important for taking the photos. *A detailed protocol* for taking photographs and geo-referencing the sites is provided in the **appendix 3 and 4**.

MEASUREMENT PROTOCOL

- Choose the site for evaluation and **soil sampling** from an area of **1 square metre**.
- Collect the **geographic data** of the site and **reference it** so that it can be easily identified for the next sampling.
- On a **white surface**, separate the **topsoil** (upper horizon) from the **lower layers** of the soil (deeper than 20-30 cm).
- Take **pictures** at an angle that shows the **colour of the soil** and the differences.
- Carry out **one assessment per year** on the plot, taking **3 samples** for each assessment.
- Compare the **colour of the soil sample from the topsoil** with that from the **lower soil layers**. In general, the **topsoil** (the upper layer) is **darker** than the lower layers from the subsoil because this is where organic matter accumulates.

- Assess the **colour differences** between the sample from the surface layer and that from the lower layer. The following three levels should be used for comparison:

- **a.** The colour of the surface soil is **similar** to the colour of the subsoil.
- **b.** The surface soil is **a little darker** than the subsoil, but the colour **difference is small**.
- **c.** The colour of the surface soil is **significantly darker** than the subsoil and the topsoil is **clearly defined**.

- In order to monitor over time (if possible over **3-5 years**), the sampling sites must be **geo-referenced using GPS data** in order to allow accurate sampling every year **at the same places** or around the initial site

INTERPRETATIONS

1. Interpretation consists of **comparing the colour** of the sample from the top soil with that from the lower soil layer.

2. As the colour of the topsoil layer can **vary considerably** from one soil type to another, the comparison should be made on **how much the colour has changed** rather than the absolute colour of the soil (see *photos below*).

Soil layer rich in organic matter

Soil poor in organic matter

© P. Brabant, 2010[22]

3. To each level of colour, a **score between 1 and 5** is assigned (see *table below*).

Visual score	Comparative Description	Interpretation
5	The colour of the surface soil is significantly darker than the subsoil and the topsoil is clearly defined.	**Good level of organic matter**
3	The surface soil is a little darker than the subsoil, but the colour difference is less clear	**Average level of organic matter**
1	The colour of the surface soil is similar to the colour of the subsoil	**Low level of organic matter**

[22] Brabant P., 2010. *A method for assessing and mapping land degradation. Proposal of standardized directives.* CSFD thematic files. N°8. August 2010. CSFD / Agropolis International, Montpellier,

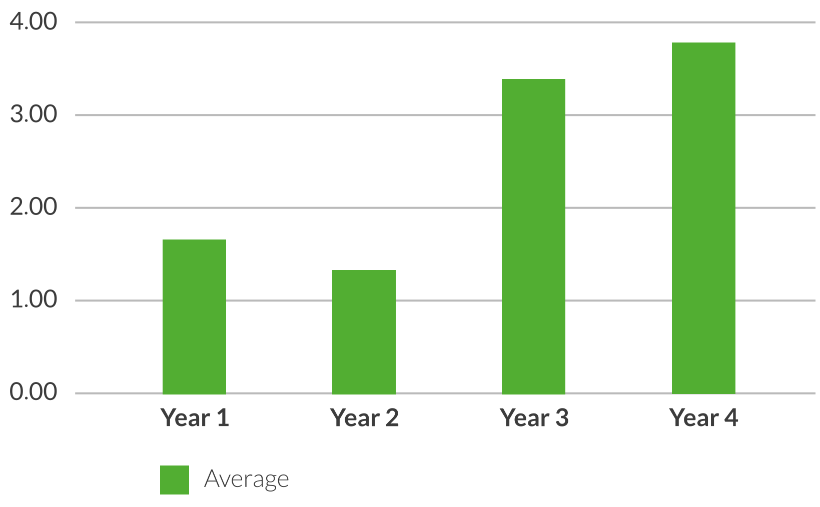
4. As the scoring is **flexible**, if the soil sample does not match any of the three scores (1, 3, 5) but falls in between two scores, an **intermediate score** is assigned.

5. Once the scores have been assigned, the **average** is calculated to evaluate the **changes** from one site to another or from one year to another according to the following **scores**:

- **Average score > 4** (good quality soil rich in organic matter)
- **Average score between 2 and 4** (medium quality soil with an acceptable level of organic matter)
- **Average score < 2** (poor quality soil, poor in organic matter)

	Years			
Samples from Farm 1	Y1	Y2	Y3	Y4
S1	1	1	5	3
S2	3	1	3	5
S3	1	2	2	3
Average	**1.67**	**1.33**	**3.33**	**3.67**

Soil organic matter



The graph above indicates that the soil organic matter in this farm has **changed over the years** (**Y1, Y2, Y3, Y4**) from a low level of organic matter content to an **acceptable level** of organic matter. It should be noted that organic matter takes **4 to 5 years** to respond to **changes in practice**, such as adding organic inputs.

These data can be **compared with past or current agricultural practices** on this field over several years in order to **monitor the changes in organic matter** on this soil.

NOTES

- Without the use of a **specific tool** like the **Munsell code**[23] for example, the assessment of soil organic matter based solely on its colour remains **subjective** because the colour definition depends on **the judgment of each evaluator**.
- In addition, the colour is the **visible result** of the amount of organic matter but also of **other elements** involved in the fertility level.
- The results of assessments will be all the more accurate when they are measured by **the same teams** each time, in **the same places** and at **the same time of year**.
- Evaluations in **several parts of the field** will be more likely to provide more convincing results.

[23] The Munsell code is a colour chart used internationally by soil scientists to describe the colour of the soil. The principle of this chart consists in comparing a sample of the soil studied with colour pellets distributed on the plates of a booklet according to three criteria: the base colour, the clarity and the saturation.

APPENDIXES

APPENDIX 1.
METHOD FOR SETTING-UP YIELD SQUARES
(According to Bediye et al., 2016)[24]

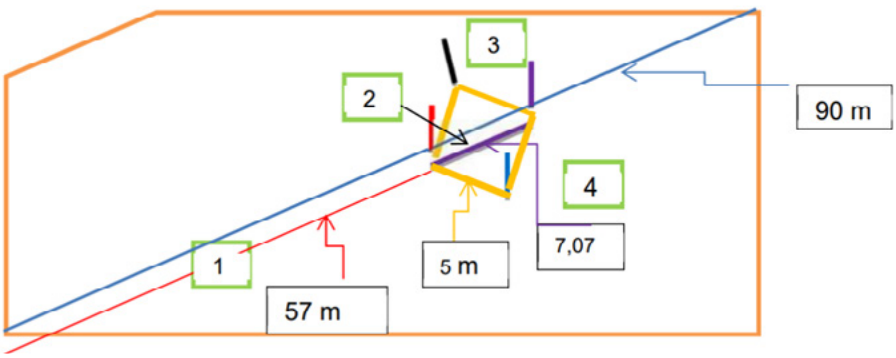
The approach proposed here is a method of setting-up yield squares using **GPS**.
It comprises the following steps:

- Determining the **perimeter** and the **plot area** from the **plot survey** (tracking) or **plot measurement** which consists of calculating the plot's perimeter.
- Identifying the **long diagonal** and measuring its length.
- Choosing a one, two or three **digit number that is smaller than the length of the diagonal** on *the random number table* (this depends on the number of digits that make up the length of the diagonal). For example, for a diagonal with a length of **70 m**, use a **two-digit random table**.
- **Marking out the length** corresponding to the number chosen on the long diagonal and placing at the end a **stake** which represents the first vertex of the square to be laid out.
- From this vertex, placing a **second stake** (second vertex) whose length will be that of the **diagonal of the square** to be laid out.
- From these two vertices, placing the t**hird and the fourth vertices** that will be equidistant from each of these first two vertices, i.e. the length of the side of the square.

Figure n°1 illustrates the process for setting up ***yield per square in a maize field****. Take for example a corn plot of 350 m and a long diagonal of* ***90 m****. The* ***random number*** *chosen is* ***57 m****. The square to be set up has a* ***5 m*** *a* ***side*** *and its* ***diagonal*** *is* ***7.07 m****.*

The square will be laid out as follows:

1. *Measure* ***57 m from the top of the diagonal*** *and put in the* ***first stake*** *(red).*
2. *Mark out the* ***diagonal*** *of the square to be set up (****7.07 m****) and put in the se****cond stake*** *(purple).*
3. *Put the* ***third stake*** *(black)* ***equidistant (5 m)*** *from the first two.*
4. *Put in the* ***fourth stake*** *(blue) similarly* ***equidistant (5 m)*** *from the first two.*



[24] BEDIYE et al., 2016. *Sample survey on yield squares for grains, rice and corn in the 17 municipalities of the ProSOL and ProCIVA projects*

NB :

- *7.07 m is equal to the s**quare root of 50**.*
- *For a square with **sides 2 m long**, the diagonal is equal to the **square root of 8**, i.e. 2.83 m.*
- *For a square with **sides 1 m long**, the diagonal is equal to the **square root of 2**, i.e. 1.41 m.*

Once the yield square is placed within the plot, the **ears or panicles are counted** and **the entire crop within the square is weighed**.

For example, the formulas used to calculate corn grain and rice grain yields are as follows:

Corn: for a yield square of **25 m²**:
R = Average weight of an ear of corn x total number of potential ears x 400 x 0.28
0.28 is a **reduction coefficient** that expresses **the proportion of corn grain contained in an ear.**

Rice: for a yield square of **1 m²**:
R = Average weight of a rice panicle x total number of potential panicles x 10,000 x 0.60
0.60 is a **reduction coefficient** that expresses **the proportion of rice grain contained in a panicle**.

Two-digit random number table

02	22	85	19	48	74	55	24	89	69	15	53	00	20	88	48	95	08
85	76	34	51	40	44	62	93	65	99	72	64	09	34	01	13	09	74
00	88	96	79	38	24	77	00	70	91	47	43	43	82	71	67	49	90
64	29	81	85	50	47	36	50	91	19	09	15	98	75	60	58	33	15
94	03	80	04	21	49	54	91	77	85	00	45	68	23	12	94	23	44
42	28	52	73	06	41	37	47	47	31	52	99	89	82	22	81	86	55
09	27	52	72	49	11	30	93	33	29	54	17	54	48	47	42	04	79
54	68	64	07	85	32	05	96	54	79	57	43	96	97	30	72	12	19
25	04	92	29	71	11	64	10	42	23	23	67	01	19	20	58	35	93
28	58	32	91	95	28	42	36	98	59	66	32	15	51	46	63	57	10
64	35	04	62	24	87	44	85	45	68	41	66	19	17	13	09	63	37
61	05	55	88	25	01	15	77	12	90	69	34	36	93	52	39	36	23
98	93	18	93	86	98	99	04	75	28	30	05	12	09	57	35	90	15
61	89	35	47	16	32	20	16	78	52	82	37	26	33	67	42	11	93
94	40	82	18	06	61	54	67	03	66	76	82	90	31	71	90	39	27

APPENDIX 2.
SAMPLE QUESTIONS FOR THE COLLECTION OF DATA ABOUT WOMEN'S EMPOWERMENT

Below is a list of proposed questions for each empowerment domain.

DECISION-MAKING

In general, how are **major decisions** made in households engaged in agricultural activities?

Types of decisions	*Who participates in the discussion?*	*Who makes the final decision?*
Buying / selling land		
Buying / selling small livestock		
Buying / selling large livestock		
Buying equipment / tools		
Choice of crop type		

Consider the example of a husband who **decides to sell a crop**, but his **wife does not agree**:

- *How is the final decision is made?*
- *Who owns the land?*
- *Can a woman own land? Is it common?*

WOMEN'S PARTICIPATION IN ASSOCIATIONS AND LEADERSHIP POSITIONS

- *Do women participate in the cooperatives or associations that you are familiar with?*
- *Are there women in the management committees? What is their role?*
- *In your opinion, is it possible for a woman to become the president or treasurer of an association?*
- *Is it easy/difficult for a woman to speak publicly in front of men?*
- *In general, how do men in your community view women who occupy important leadership roles? For example, women who lead associations?*

RESTING AND LEISURE TIME

- *When do men have time for leisure, rest, or social activities? What do they do during this time? How often do they have time for rest/leisure (time that is neither dedicated to productive work nor housework)? Every day, every week, etc.?*
- *When do women have time for leisure, rest, or social activities? What do they do during this time? How often do they have time for rest / leisure (time that is neither dedicated to productive work nor housework)?*
- *Do men and women have sufficient or insufficient time for rest and leisure?*
- *In your opinion, do you think that women should spend more time on rest and leisure activities?*
- *Could you explain why you think this?*

LEADERSHIP: WOMEN'S PARTICIPATION IN THE MANAGEMENT COMMITTEES OF ASSOCIATIONS/COOPERATIVES

In addition to **individual questionnaires**, it is possible to observe **how existing cooperatives, associations and groups operate** in order to determine whether their governing bodies promote the **representation and meaningful participation of women** in their leadership structures. This survey can be carried out by asking **questions about how the group operates** during an interview or discussion with committee members and by **directly observing the meetings**.

SAMPLE QUESTIONS TO ASK COMMITTEE MEMBERS

- *How big is the cooperative/group?*
- *How many men are members? How many women are members?*
- *Does the group / cooperative have women on its management committee?*
- *How many women are on the committee/included in the total number of committee members?*
- *If so, what are the positions assigned to women on the committee?*
- *Do women hold positions with important responsibilities? (for example, the treasurer, president, and secretary are senior leadership positions, while the head of housekeeping or office messenger are subordinate positions)*
- *Are women's opinions respected in the committee?*

DIRECT OBSERVATION FORM FOR MEETINGS

- During the meeting, what was the **speaking time** in minutes for women/men (during the meeting, the observer measures the speaking time for men and women).
- What did the **major discussions and decisions** revolve around during the meeting?
- Did the women **participate** in the discussion of important topics?
- Did their **opinion** count in the decision making?
- During the meeting, where any **questions or problems** raised specifically **related to women** (specific needs, challenges, etc.)? If so, were these challenges **discussed in order to resolve them**?
- Describe how men and women were **seated** during the meeting: Are they at the **same levels**? Is there an **order of importance**?
- Describe the **attitude** of women who **speak in public**: Are they confident / lacking in confidence, etc.?
- Describe how **men react** when a **woman speaks in public**: What is their **attitude**? (Example: Respect and listening, disinterest, laughter, mockery, etc.).

APPENDIX 3.
PROTOCOL FOR SITE SELECTION AND SAMPLE COLLECTION

This protocol indicates the procedure for the choice of sites, as well as the time, place and how to take soil samples for tracking soil quality indicators.

SITE SELECTION AND SAMPLE COLLECTION

- The choice of study sites must be **representative of the project area** and of the **different types of farms** implementing agroecological practices.
- The selection of sites is to be done **randomly** based on the **list of plots in the project**. For example, 4 plots selected on the basis of the implementation of agroecological practices on these sites.
- It must be ensured that the selected sites have the **same type of soil** and have the **same topographical characteristics** as the project area.
- Each site and each plot must be **geolocated with GPS data**.

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SAMPLE COLLECTION

When should samples and / or photographs be taken?

- It is important to take into account the **period of sampling** because the properties of the soil vary during a **season**, but also according to the **cultivation operations** put in place (mulching, tillage, etc.).
- In general, at least **one annual sample** is recommended. Annual sampling will detect changes in soil quality indicators over time.
- In general, depending on the soil quality indicators one wants to monitor, the best times for data collection and observations are the period **before crop planting** and the period **after harvest**.

Where on the plot to take a sample?

- The soil properties being **very variable** from one field to another and even within the same type of soil, it is advisable to take samples in **several places and sites on the field** in order to take into account the **variability of the area** which is an important consideration in determining where to sample in a field.
- In addition, samples should **not be taken at arbitrary depths**. In general, a depth of **20-30 cm** is necessary for reliable data.

- To monitor soil quality indicators over time, ensure that measurements and samples are taken each time on the **same plots** and in the **same locations**. Take care to **locate and mark** all the sites where samples are taken.

- Also try to take measurements or make observations under the **same weather conditions**. Intervention during periods of **drought or excessive humidity** should be avoided, not only because of the physical difficulty of taking quality samples, but also for reasons of accuracy of observation.

How many samples?

- The number of samples depends on the **type of indicators being monitored**. For more details on the number of samples taken to monitor the different indicators, refer to *the sheets corresponding to each indicator*.

APPENDIX 4.
PROTOCOL FOR PHOTO TAKING WHILE MONITORING AGROECOLOGY INDICATORS

As the qualitative assessment of certain indicators is based on visual observation, the use of good quality photographs is necessary to have more informed information and a more objective assessment of these indicators. Taking photographs makes it possible to follow more objectively the impact of an agricultural practice on the soil.

1. FOR WHICH INDICATORS SHOULD THE PHOTOS BE USED?

The indicators whose assessment requires the use of photos are those related to **soil health**, and in particular the indicators related to:

- **Monitoring soil erosion**
- **Monitoring soil organic matter**
- **Monitoring of plant cover**

2. HOW TO TAKE THE PHOTOGRAPHS?

- First of all, you have to **choose where to take the photos** describing the indicator being monitored.
- The photograph must be taken at the **same place**, if necessary every year, according to the indicator followed and at the **same time of year**.
- In order to facilitate **locating the site**, this site must be **georeferenced by GPS data**, now widely used on cameras; which will facilitate taking pictures in the same places, thus allowing an **objective comparison** with the initial situation or previous situations.
- The site must be oriented so that it is **well lit** so that the photo can clearly highlight the soil profile where the observed indicators are observed.
- Avoid taking photos with one part in the **shade** and another in the **sun**.
- It is necessary to avoid as much as possible the use of **flash** which alters the colours and prioritize shooting in **natural light**.
- Take **several pictures** while highlighting the **small details** (for example details on the colour of the soil, the size of an erosion ditch, the thickness of the surface crust, etc.).
- Use **JPEG format** (widely used format) for the photos.

3. IDENTIFICATION AND CLASSIFICATION OF PHOTOS

Once the photos have been taken, after returning to the office, the photos must be **classified** so they can be easily identified. The **references** of the photos must indicate the photo number, a site identification number, the indicator being monitored, details of the indicator, the date the photo was taken.

The photos are to be named according to the following **nomenclature**:

photo1_sitenumber_indicatortype_imagenumber_indicatordetail_date of the photo

4. COMPARISON OF PHOTOS BETWEEN MULTIPLE SHOTS

Visual observation and **comparison** with photos taken during the first data collection makes it possible to detect **possible changes** in the indicator, and to visually **attest to the improvement or deterioration of soil health**. When comparing photos, ask yourself the following questions and note the changes:

- What **change** do you observe compared to the first photo taken or data collection?
- Did **major events** affect the location where the photo was taken that could **bias the observation** or comparison?
- Is the **plot grazed between two growing seasons** or since the last photograph? (This question is important for monitoring plant cover, for example.)
- Overall, what **agricultural practices** have been implemented on the site since the last photograph?

APPENDIX 5.
SOIL PH MEASUREMENT PROTOCOL

- Take a **dry soil** sample.
- **Sieve** the sample, add **distilled water** and shake the mixture.
- Allow the mixture to **stand** until a sufficiently **marked layer** has formed.
- Use a **pH pen, pH meter or pH paper** to determine the pH of the sample.
- Repeat the process **three times** for each soil horizon.

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- Dry and sieved soil sample
- Distilled water
- 100 ml graduated cylinder
- 100 ml beaker
- pH meter, pH pen or pH paper
- Small weighing scale
- Soil pH data sheet

APPENDIX 6.
LIST (NON-EXHAUSTIVE) OF PLANTS USED AS COVER CROPS

GRASS

- Andropogon gayanus
- Avena sativa
- Brachiaria brizantha
- Brachiaria decumbens
- Brachiaria humidicola
- Brachiaria ruziziensis
- Cenchrus cilaris
- Cynodon dactylon
- Eleusine coracana
- Eleusine indica
- Panicum maximum
- Paspalum notatum
- Penissetum typhoides
- Pennisetum artropurpureum
- Pennisetum clandestinum

LEGUMES

- Arachis pintoi
- Arachis repens
- Cajanus cajan
- Canavalia ensiformis
- Cassia rotundifolia
- Centrosema sp
- Clitoria ternatea
- Crotalaria grahamiana
- Crotalaria sp
- Desmodium uncinatum
- Dolichos lablab
- Glericidia sepium
- Lotus uliginosus
- Macroptilium atropurpureum
- Pueraria phaseolides

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