MIX-ENABLE

STRATEGIES FOR SUSTAINABLE AND ROBUST ORGANIC MIXED LIVESTOCK FARMING

EDUCATIONAL TOOLKIT

MIX-ENABLE

EDUCATIONAL TOOLKIT:

To inform and consolidate the sometimes incomplete knowledge of multi-species livestock farming.

To transform the sometimes negative learners' representations of multi-species livestock farming.

For mobilizing knowledge in action and acquiring skills in order to understand the sustainability and viability of farm diversification.

3 INDEPENDENT AND COMPLEMENTARY TOOLS:

The proposed order of use of the different tools is the **quiz,** then the **Q-sort** and finally the **implementation,** but this order can be different and adapted to the convenience of each teacher.

N°1 QUIZ

OBJECTIVE: Informing

To build a first knowledge base on multi-species livestock farming among the students.

N°2 Q - SORT

OBJECTIVE:

Transforming representations

Identify learners' initial representations of multi-species livestock farming;

Set up the construction of an argumentation.

N°3 IMPLEMENTATION

OBJECTIVE:

Mobilizing knowledge in action (fictitious or real)

To apply the new knowledge to farm cases and place the learners in a reflection on the most relevant solution of multi-species livestock farming.

INRAE AgroParisTech ENSFEA Ecole Nationale Supérieure de Formation de l'Enseignement Agricole
Institut de l'élevage idele
itab l'Institut de l'agriculture et de l'alimentation biologiques
Wallonie recherche CRA-W
FiBL
THÜNEN
FORSCHUNGSRING e.V.
BOKU
Università degli Studi della Tuscia
SLU
CORE organic
Avec la contribution financière du compte d'affectation spéciale développement agricole et rural CASDAR
Ministère de l'Agriculture et de l'Alimentation

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SUMMARY:

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STRATEGIES FOR SUSTAINABLE AND ROBUST ORGANIC MIXED LIVESTOCK FARMING WITH THE MIX-ENABLE PROJECT

Aim of the project:

Explore the conditions of sustainability and robustness of European organic mixed livestock farms, integrating two or more animal species.

Especially the influence of integration between farm components.

MIX-ENABLE

Main project activities:

- Survey farms to assess the level of integration.
- Propose an indicator system for integrated assessment of organic mixed livestock farms.
- Characterize the conditions for the sustainability and robustness of organic mixed livestock farms in Europe.
- Conduct farm-level experiments comparing specialized and mixed livestock production (e.g. pasture use or animal health).
- Integrate obtained knowledge into models that can simulate organic mixed livestock farm performances.
- Design educational toolkit on organic multi-species livestock systems.

Lien internet: https://projects.au.dk/coreorganiccofund/core-organic-cofund-projects/mix-enable/

This transnational project is funded via the ERA-net CORE Organic Cofund based on funds from participating countries and funding from the European Union.

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MIX-ENABLE Partners:

INRAE, BOKU, Wallonie recherche CRA-W, FiBL, FORSCHUNGSRING e.V., Institut de l'Élevage idele, itab l'Institut de l'agriculture et de l'alimentation biologiques, SLU, THÜNEN, Università degli Studi della Tuscia

Financers:

CORE organic, Avec la contribution financière du compte d'affectation spéciale développement agricole et rural CASDAR, Ministère de l'Agriculture et de l'Alimentation

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STRATEGIES FOR SUSTAINABLE AND ROBUST ORGANIC MIXED LIVESTOCK FARMING

QUIZ

STUDENTS

MIX-ENABLE

STUDENTS

A QUIZ MULTI-SPECIES LIVESTOCK FARMING TO TEST YOURSELF

Multi-species livestock farming is defined here by the association of at least two different animal species within the same farm, regardless of the interactions among the different farm enterprises.

Multi-species livestock farming is generally less represented and less studied than single species livestock farming in Europe. Furthermore, there is a lack of official data on the number of multi-species livestock farms in Europe. Yet, a growing scientific literature has demonstrated some strengths (and weaknesses) of such systems.
This tool is an educational quiz on the theme of multi-species livestock systems. You will try to answer each question based on your knowledge and/or intuition.

First name: ....

Last name: ....

Date: ....

PART 1: ENVIRONMENT

1. Multi-species livestock systems involve thinking about the **FEEDING NICHE** principle, which is defined as the physical and chemical properties of a species' diet*. Two species have the same feeding niche if their diet is strictly identical in a given environmental setting. While this situation is impossible according to evolution principles, feeding niches between two species can **overlap** if they share a more or less important part of their diets.

FILL IN THE BLANKS IN THE SENTENCES BELOW WITH THE RIGHT WORDS FROM THE FOLLOWING LIST:
- decreases
- dietary preferences
- morphological characteristics
- increases

1 - The feeding niche of a species is defined, in particular, by its ....

2 - A smaller dietary overlap between two species .... the risk of interspecific competition.

3 - Cattle and sheep have partly different feeding niches because the sheep's .... allow them to graze closer to the ground and select plant species they eat.

4 - In a pasture grazed by cattle and goats, the overlap of feeding niches between the two species .... when the feed resource becomes scarce.

** According to Elton's definition of an ecological niche.*

2. LINK THE CONCEPTS TO THEIR DEFINITION APPLIED TO MULTI-SPECIES LIVESTOCK FARMING.

Feeding niche complementarity between species ☐

Economies of scope ☐

Interspecific competition ☐

Economies of scale ☐

1. Running two different productions within the same farm is potentially more economical and efficient than each production being run in two separate farms for the same production level.
2. The unit cost of production in a farm decreases when the total output quantity increases.
3. Two livestock species co-grazing within a farm consume the same resources (grass, water, etc.).
4. Two livestock species within the same farm can enhance the use of different resources or different parts of the same resources. For instance, one species might access a resource that the other species cannot.

PART 1: ENVIRONMENT (following)

3. AGRICULTURAL ORGANIC EFFLUENTS mostly come from animal feces. However, their composition may vary strongly depending on the species, on the type of housing, on the type of storage and on husbandry practices. Nitrogen contained in husbandry effluents is found under two major forms: ammoniacal nitrogen (NH4) and organic nitrogen. Ammoniacal nitrogen is quickly transformed into nitrates and becomes available for plant. Organic nitrogen is mineralized slowly and becomes available for plants on the medium to long-term. The speed at which they become available will depend on the carbon to nitrogen ratio (C/N) of the soil.

Thus, nitrogen availability to plants varies depending on the effluent. This information should be considered by the multi-species livestock farmer in the management of crop and grasslands fertilization.

RANK LIVESTOCK EFFLUENTS WITH RESPECT TO THEIR % CONTENT OF AMMONIACAL NITROGEN, FROM GREATEST TO LOWEST:

	Answer:
A. Cattle manure	....
B. Pig slurry	....
C. Poultry manure and droppings	....
D. Composted cattle manure	....
E. Cattle slurry	....

4. A CATTLE-SHEEP CO-GRAZING EXPERIMENT WAS CONDUCTED IN 2019 IN ORDER TO MEASURE THE EFFECT OF CO-GRAZING ON ABOVEGROUND FLORISTIC AND FAUNISTIC (INSECTS) BIODIVERSITY IN PASTURES.

According to you, the result was that cattle-sheep co-grazing:
Circle the correct answer(s).

A. Significantly improved floristic and faunistic biodiversity.
B. Significantly improved floristic biodiversity but not faunistic biodiversity.
C. Significantly degraded all aboveground biodiversity in pastures.
D. Did not have an impact on aboveground biodiversity in pastures.

PART 2: ANIMAL HEALTH AND BEHAVIOR

5. In organic multi-species livestock farming, the closeness of two livestock species in a farm can sometimes have an impact on animal health. **LINK EACH SPECIES COMBINATION BELOW TO THE RIGHT LEVEL OF SANITARY RISK**:
Link each box on the left to the right box on the right.

Sheep x Goats ☐	
Poultry x Pigs ☐	☐ Existing risk
Sheep x Cattle ☐	☐ Non existing risk
Pigs x Cattle ☐	

IN THE CONTEXT OF PARASITIC DISEASES (E.G. NEMATODE), LINK EACH SPECIES COMBINATION TO THE TYPE OF IMPACT IT HAS ON ANIMAL HEALTH:
Link each box on the left to the right box on the right. Careful: each box on the right does not necessarily correspond to a single box on the left.

Sheep x Goats ☐	☐ Positive impact
Poultry x Pigs ☐	☐ Negative impact
Sheep x Cattle ☐	☐ Positive and negative impacts
Pigs x Cattle ☐	☐ No impact

6. Imagine a farm in southwestern France with a fattening duck enterprise (for foie gras production) and a beef cattle enterprise. The farmer wants to grow maize on the ducks' open-air run. **ACCORDING TO YOU, WHAT WOULD BE THE CONSEQUENCES OF THIS PROJECT?**
Circle the correct answer(s) for the following questions

A. No impact on animal enterprises.
B. Maize silage production is less dependent on fertilizer inputs.
C. Maize brings shade to ducks during summer.
D. Ducks eat part of the maize dedicated to cattle.
E. Cattle gets parasitic diseases from ducks.
F. Farmer's work hours decrease compared to the initial situation (without maize on ducks' run).

7. ACCORDING TO FRENCH REGULATIONS, RUMINANTS CAN USE POULTRY AREAS:

A. While poultry is also present.
B. Only when poultry is not present.
C. Other.

8. IN A HEIFER-SOW CO-GRAZING SYSTEM, SOWS TEND TO DIG THE SOIL MORE THAN WHEN THEY ARE ALONE.

A. True, they dig the soil more when they are with heifers than when they are alone.
B. False, they dig the soil less when they are with heifers than when they are alone.
C. No consequences expected.

ACCORDING TO YOU, HOW COULD THIS EFFECT OF HEIFER-SOW CO-GRAZING BE EXPLAINED?

D. Sows are more stressed when they are with heifers.
E. The two species have complementary diets.
F. Sows are distracted by cattle dung.
G. Heifers trample the soil, which makes it easier to dig.
H. The two species compete for access to grass (interspecific competition).
I. Co-grazing leads to parasitic dilution.

PART 3: RESOURCES AND BY-PRODUCTS

9. WITHIN THIS LIST OF HERBIVORES, WHICH ONES CAN GRAZE THE CLOSEST TO THE GROUND REGARDLESS OF THEIR DIETARY PREFERENCES? Rank them from the species which can graze the closest to the ground to the species which can graze the least close to the ground.

	Answer:
A. Sheep and goats	....
B. Horses	....
C. Cattle	....

10. WHAT IS/ARE THE CONSEQUENCE(S) OF THE DIFFERENT LIVESTOCK SPECIES GRAZING BEHAVIOR FOR THE FARMER?

Circle the correct answer(s) for the following questions

A. Decrease the number of non-grazed grass patches.
B. Increase the soil carrying capacity.
C. Improve herbage use efficiency.
D. Decrease overall fuel consumption on the farm.
E. Increase plant species heterogeneity on the pastures.
F. Decrease herbage nutritional value.
G. No consequences expected.

11. A DAIRY CATTLE FARM PROCESSING ITS MILK WANTS TO DIVERSIFY ITS PRODUCTION. WHICH SPECIES SHOULD BE ADDED TO THE FARM TO UTILIZE WHEY?

A. Sheep
B. Pigs
C. Goats
D. Broilers

12. IN A CO-GRAZING SITUATION, SHEEP EAT HERBAGE NEAR CATTLE DUNG. THIS IS HERBAGE THAT IS NOT EATEN BY COWS THEMSELVES.

A. True
B. False

PART 4: PRODUCTIVITY AND PROFITABILITY

13. In a controlled experiment from 1999, Danish researchers compared the average daily growth rate of 8 heifers co-grazing with pregnant sows to heifers grazing among themselves. **ACCORDING TO YOU, WHICH GROUP OF HEIFERS HAD A HIGHER DAILY WEIGHT GAIN?**

Circle the correct answer(s) for the following questions

A. Heifers co-grazing with sows
B. Heifers grazing without sows

HOW MUCH WAS THE DIFFERENCE IN AVERAGE DAILY WEIGHT GAIN BETWEEN THE TWO HEIFER GROUPS?

C. +20g/animal/day
D. +150g/animal/day
E. +250g/animal/day

14. HOW WOULD YOU EXPLAIN THE EFFECT OF HEIFER-SOW CO-GRAZING SHOWN IN THE ABOVE QUESTION?

A. Parasitic dilution
B. Dietary complementarity between the two species
C. Decrease in production costs due to economies of scope
D. Parasitic, viral or bacterial disease transmission from one species to another
E. Improved economic output from animals
F. Increase in grass availability for one species due to low grass consumption by the other

15. IN 2014, A META-ANALYSIS OF LITERATURE SHOWED THAT THE AVERAGE DAILY WEIGHT GAIN OF SHEEP WAS DIFFERENT WHEN THEY CO-GRAZE WITH CATTLE THAN WHEN THEY GRAZE AMONG THEMSELVES. ACCORDING TO YOU, WHICH GROUP OF SHEEP HAD A HIGHER DAILY WEIGHT GAIN?

A. Sheep co-grazing with cattle
B. Sheep grazing without cattle

HOW MUCH WAS THE DIFFERENCE IN AVERAGE DAILY WEIGHT GAIN BETWEEN THE TWO SHEEP GROUPS?

C. +15 g/animal/day
D. +105 g/animal/day
E. +245 g/animal/day

16. HOW WOULD YOU EXPLAIN THE EFFECT OF CATTLE-SHEEP CO-GRAZING SHOWN IN THE ABOVE QUESTION?

A. Parasitic dilution
B. Dietary complementarity between the two species
C. Decrease in production costs due to economies of scope
D. Parasitic, viral or bacterial disease transmission from one species to another
E. Improved economic output from animals
F. Increase in grass availability for one species due to low grass consumption by the other

17. In a study conducted by INRAE researchers on the production of grass-fed meat, a co-grazing system with beef cattle and meat sheep was compared to a beef cattle only system on one hand and a meat sheep only system on the other hand. In 2018, cattle were fattened without concentrates (grains) for the first time. Data show a significant difference in feed cost margins* between the co-grazing system and the two separate cattle and sheep systems. **ACCORDING TO YOU, WHAT ARE THE RESULTS OF THE EXPERIMENT?**

**The feed cost margin is what is left of the gross product once the cost of feed is subtracted.*

For lamb production:

A. Feed cost margins are higher in the co-grazing system than in the sheep only system.
B. Feed cost margins are lower in the co-grazing system than in the sheep only system.
C. The difference in feed cost margins is more than 150 euros/livestock unit.
D. The difference in feed cost margins is less than 50 euros/livestock unit.

For cattle meat production:

E. Feed cost margins are higher in the co-grazing system than in the cattle only system.

F. Feed cost margins are lower in the co-grazing system than in the cattle only system.

G. The difference in feed cost margins is more than 150 euros/livestock unit.

H. The difference in feed cost margins is less than 50 euros/livestock unit.

18. HOW WOULD YOU EXPLAIN THE EFFECT OF CATTLE-SHEEP CO-GRAZING SHOWN IN THE QUESTION ABOVE?

A. Parasitic dilution

B. Dietary complementarity between the two species

C. Decrease in production costs due to economies of scope

D. Parasitic, viral or bacterial disease transmission from one species to another

E. Improved economic output from animals

F. Increase in grass availability for one species due to low grass consumption by the other

PART 5: WORK ORGANIZATION

19. A French organic dairy cattle farmer wants to diversify her farm by adding a meat sheep enterprise. Not knowing how to implement and manage a multi-species livestock farm, she looks up official training programs on the website of technical institutes, Chambers of Agriculture and rural development associations. **HOW MANY TRAININGS RELATED TO MULTI-SPECIES LIVESTOCK FARMING CAN SHE FIND IN FRANCE (APPROXIMATELY)?**

Circle the correct answer(s)

A. 0

B. 10

C. 20

D. 50

E. 100

20. In a French organic free-range multi-species livestock farm, the farmer wants to have all animals grazing on the same paddock. But to effectively do so, she needs to consider the fencing system. **LINK EACH SPECIES TO THE SUITABLE TYPE OF GRAZING FENCES.**

A. Sheep

B. Cattle

C. Goats

D. Poultry

E. Pigs

1. Barbed wire fence (2 or 3 rows)
2. Non electrified netted fence
3. Electrified wire fence
4. Double enclosure fences (a combination of an external netted fence and an internal netted of electrified fence at least 25 cm away from the external fence)
5. Electrified netted fence

21. A multi-species livestock farmer needs to make decisions considering tradeoffs among different risks (economic, health). Those risks vary across farm structures and animal species combinations. **SELECT THE RIGHT POSITIVE AND NEGATIVE IMPACTS AND PLACE THEM IN THE CORRESPONDING BOX FOR EACH SITUATION.**

A. Increase in the number of working hours per year

B. Risk of parasitic, viral or bacterial disease transmission from one species to another

C. Risk of homogenization of the grassland, which can reduce biodiversity in the paddock

D. Decrease in soil erosion and underground water pollution by nitrates

E. Optimization of resource use

F. Decrease in fertilization costs

• In simultaneous or rotational co-grazing of two species, one species can eat the post-grazing residuals of the other species.

Positive impact	Negative impact
....	....

• To reduce digging by sows at grass, a farmer chooses to put the sows in the same paddock as cows.

Positive impact	Negative impact
....	....

• By adding a poultry enterprise to a dairy cattle farm, the farmer utilizes poultry droppings by spreading them on maize fields for cattle feeding.

Positive impact	Negative impact
....	....

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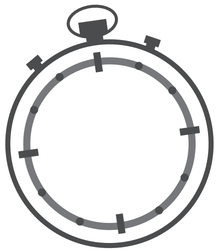
STRATEGIES FOR SUSTAINABLE AND ROBUST ORGANIC MIXED LIVESTOCK FARMING

QUIZ

WITH ANSWERS AND ARGUMENTS FOR TEACHERS

TEACHERS

TIME GRID PROPOSAL FOR THE USE OF THE QUIZ AND Q-SORT



Steps	Estimated time	Real time
Introduction and presentation of the topic	2	
Explanations on the Q-sort	2	
Individual reading of the Q-sort and positioning	10	
Review of positions by the instructor and discussion on statements for which there is less consensus	15	
Transition to another tool – Explanations on the quiz	3	
Quiz: individual thinking part 1: Environment	8	
Correction part 1	8	
Quiz: individual thinking part 2: Animal health and behavior	8	
Correction part 2	10	
Quiz: individual thinking part 3: Resources and byproducts	6	
Correction part 3	10	
Quiz: individual thinking part 4: Productivity and profitability	10	
Correction part 4	10	
Quiz: individual thinking part 5: Work organization	6	
Correction part 5	10	
Conclusion and thanks	3	
Evaluation form (optional)	7	
Total	**125 (2h 5min)**	

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TEACHERS

A QUIZ MULTI-SPECIES LIVESTOCK FARMING TO TEST YOURSELF

Multi-species livestock farming is defined here by the association of at least two different animal species within the same farm, regardless of the interactions among the different farm enterprises.

Multi-species livestock farming is generally less represented and less studied than single species livestock farming in Europe. Furthermore, there is a lack of official data on the number of multi-species livestock farms in Europe. Yet, a growing scientific literature has demonstrated some strengths (and weaknesses) of such systems.

This tool is an educational quiz on the theme of multi-species livestock systems. The format of the quiz is the traditional Question-Answer format, with answers being True/False or multiple-choice questions (MCQ) with one or more right answer(s). The rules for answering are detailed in each question. Within the time given by the instructor, participants will try to answer each question based on their knowledge and/or intuition. Once all participants have answered, a collective correction process will highlight the right answers for each question and the explanations behind the answers.

The educational goal of this tool is to understand and learn about the impacts of multi-species livestock systems on multiple areas (environmental, economic, social, technical). Impacts can be positive or negative. The mechanisms behind those impacts and the conditions within which those impacts exist are discussed in the answers to the questions. The quiz is not graded.

PART 1: ENVIRONMENT

1. Multi-species livestock systems involve thinking about the feeding niche principle, which is defined as the physical and chemical properties of a species' diet*. Two species have the same feeding niche if their diet is strictly identical in a given environmental setting. While this situation is impossible according to evolution principles, feeding niches between two species can overlap if they share a more or less important part of their diets.

FILL IN THE BLANKS IN THE SENTENCES BELOW WITH THE RIGHT WORDS FROM THE FOLLOWING LIST:

- decreases
- dietary preferences
- morphological characteristics
- increases

1 - The feeding niche of a species is defined, in particular, by its ....

2 - A smaller dietary overlap between two species .... the risk of interspecific competition.

3 - Cattle and sheep have partly different feeding niches because the sheep's .... allow them to graze closer to the ground and select plant species they eat.

4 - In a pasture grazed by cattle and goats, the overlap of feeding niches between the two species .... when the feed resource becomes scarce.

** According to Elton's definition of an ecological niche.*

2. IN A PASTURE GRAZED BY CATTLE AND GOATS, THE OVERLAP OF FEEDING NICHES BETWEEN THE TWO SPECIES WHEN THE FEED RESOURCE BECOMES SCARCE.

Feeding niche complementarity between species ☐	1. Running two different productions within the same farm is potentially more economical and efficient than each production being run in two separate farms for the same production level.
Economies of scope ☐	2. The unit cost of production in a farm decreases when the total output quantity increases.
Interspecific competition ☐	3. Two livestock species co-grazing within a farm consume the same resources (grass, water, etc.).
Economies of scale ☐	4. Two livestock species within the same farm can enhance the use of different resources or different parts of the same resources. For instance, one species might access a resource that the other species cannot.

▶Q1 (Feeding niches): **1. Dietary preferences. 2. Decreases. 3. Morphological characteristics. 4. Increases.**

Source: Lisa A. Shipley, Jennifer S. Forbey and Ben D. Moore, Walker "Revisiting the dietary niche: When is a mammalian herbivore a specialist?"

▶Q2 (Definitions): **1. Economies of scope. 2. Economies of scale. 3. Interspecific competition. 4. Feeding niche complementarity between species.**

Source: Juste et al. "Les processus de complémentarité de niche et de facilitation déterminent le fonctionnement des associations végétales et leur efficacité pour l'acquisition des ressources abiotiques"

PART 1: ENVIRONMENT (following)

3. AGRICULTURAL ORGANIC EFFLUENTS mostly come from animal feces. However, their composition may vary strongly depending on the species, on the type of housing, on the type of storage and on husbandry practices. Nitrogen contained in husbandry effluents is found under two major forms: ammoniacal nitrogen (NH4) and organic nitrogen. Ammoniacal nitrogen is quickly transformed into nitrates and becomes available for plant. Organic nitrogen is mineralized slowly and becomes available for plants on the medium to long-term. The speed at which they become available will depend on the carbon to nitrogen ratio (C/N) of the soil.

Thus, nitrogen availability to plants varies depending on the effluent. This information should be considered by the multi-species livestock farmer in the management of crop and grasslands fertilization.

RANK LIVESTOCK EFFLUENTS WITH RESPECT TO THEIR % CONTENT OF AMMONIACAL NITROGEN, FROM GREATEST TO LOWEST:

Answer:

A. Cattle manure ....
B. Pig slurry ....
C. Poultry manure and droppings ....
D. Composted cattle manure ....
E. Cattle slurry ....

4. A CATTLE-SHEEP CO-GRAZING EXPERIMENT WAS CONDUCTED IN 2019 IN ORDER TO MEASURE THE EFFECT OF CO-GRAZING ON ABOVEGROUND FLORISTIC AND FAUNISTIC (INSECTS) BIODIVERSITY IN PASTURES.

According to you, the result was that cattle-sheep co-grazing:
Circle the correct answer(s).

A. Significantly improved floristic and faunistic biodiversity.
B. Significantly improved floristic biodiversity but not faunistic biodiversity.
C. Significantly degraded all aboveground biodiversity in pastures.
D. Did not have an impact on aboveground biodiversity in pastures.

▶Q3 (Organic effluents): **C (70% mineral nitrogen available instantly) > B (60%) > E (40%) > A (10%) > D (0-10%)**
Multi-species livestock systems produce a diversity of effluents that can be utilized to match different crop production objective. For instance, by combining the use of cattle manure (organic matter inflow, long term fertility) with the use of pig slurry (rapid intake by the crop, ideal after winter), both short and long term crop fertilization requirements can be satisfied.

Source : C.A. Nord-Pas-de-Calais : https://nord-pas-de-calais.chambre-agriculture.fr/fileadmin/user_upload/Hauts-de-France/028_Inst-Nord-Pas-de-Calais/Telechargements/Recyclage/les-effluents-delevage.pdf

▶Q4 (Biodiversity): **A. Cattle-sheep co-grazing significantly improved floristic and faunistic biodiversity**.
In the experiment, the diversity of plant species, herbivorous insect species and predatory insect species was observed in three different situations: sheep grazing, cattle grazing and sheep-cattle co-grazing. A possible explanation to the improvement in floristic and faunistic biodiversity is that sheep and cattle have different ways of feeding and different dietary preferences (distinct feeding niches when the resource is available). This synergy may act on pasture composition in a way that allows for higher plant species diversity. Therefore, the fauna (here, insects) has access to more diverse resources. In this study, belowground faunistic diversity was not significantly impacted by the diversity of grazing animals.

Source: Wang and al. 2019 "Diversifying livestock promotes multidiversity and multifunctionality in managed grasslands"

PART 2: ANIMAL HEALTH AND BEHAVIOR

5. In organic multi-species livestock farming, the closeness of two livestock species in a farm can sometimes have an impact on animal health. **LINK EACH SPECIES COMBINATION BELOW TO THE RIGHT LEVEL OF SANITARY RISK**:
Link each box on the left to the right box on the right.

Sheep x Goats ☐	
Poultry x Pigs ☐	☐ Existing risk
Sheep x Cattle ☐	☐ Non existing risk
Pigs x Cattle ☐	

IN THE CONTEXT OF PARASITIC DISEASES (E.G. NEMATODE), LINK EACH SPECIES COMBINATION TO THE TYPE OF IMPACT IT HAS ON ANIMAL HEALTH:
Link each box on the left to the right box on the right. Careful: each box on the right does not necessarily correspond to a single box on the left.

Sheep x Goats ☐	☐ Positive impact
Poultry x Pigs ☐	☐ Negative impact
Sheep x Cattle ☐	☐ Positive and negative impacts
Pigs x Cattle ☐	☐ No impact

▶Q5 (Sanitary and parasitic diseases)
1. Sanitary risk: **Existing risk for all combinations**.
2. Parasitism: **Poultry x Pigs, Sheep x Goats: negative impact; Sheep x Cattle, Pigs x Cattle: positive and negative impacts**.

Multi-species livestock farming always bears sanitary risks because the same disease can affect multiple species: this mechanism is called interspecific transmission. However, co-grazing (simultaneous or sequential) can induce a positive health impact through parasitic dilution. The more there are both host and non-host animals in a pasture, the lower the prevalence of the parasite. The closer two species are biologically, the more likely it is for both of them to be affected by the same diseases. Sheep and goats are hosts for the same species of nematodes so the co-grazing of these species does not reduce nematode infections. In French and some other European regulations, poultry cannot live with other livestock species and has to be physically separated from them. Even so, in the case of a poultry-pigs livestock farm, the farmer represents a vehicle for the transmission of diseases between the two species (e.g. some avian flu strands can be transmitted to pigs).
Sheep-cattle combination experiments show lower prevalence of gastro-intestinal nematodes in lamb co-grazing with cattle. On the other hand, some nematodes and viral and bacterial diseases can be transmitted between sheep and cattle (e.g. sheep can asymptomatically carry the virus responsible for bluetongue and fatally infect cattle). Cattle and pigs have less diseases in common but can still transmit diseases to each other (e.g. brucellosis is a disease mostly seen in small ruminants but it can affect wild and domesticated pigs as well as cattle).

Sources: Seroepidemiological Evidence of Avian Influenza A Virus Transmission to Pigs in Southern China

6. Imagine a farm in southwestern France with a fattening duck enterprise (for foie gras production) and a beef cattle enterprise. The farmer wants to grow maize on the ducks' open-air run. **ACCORDING TO YOU, WHAT WOULD BE THE CONSEQUENCES OF THIS PROJECT?**

Circle the correct answer(s) for the following questions

A. No impact on animal enterprises.
B. Maize silage production is less dependent on fertilizer inputs.
C. Maize brings shade to ducks during summer.
D. Ducks eat part of the maize dedicated to cattle.
E. Cattle gets parasitic diseases from ducks.
F. Farmer's work hours decrease compared to the initial situation (without maize on ducks' run).

7. ACCORDING TO FRENCH REGULATIONS, RUMINANTS CAN USE POULTRY AREAS:

A. While poultry is also present.
B. Only when poultry is not present.
C. Other.

8. IN A HEIFER-SOW CO-GRAZING SYSTEM, SOWS TEND TO DIG THE SOIL MORE THAN WHEN THEY ARE ALONE.

A. True, they dig the soil more when they are with heifers than when they are alone.
B. False, they dig the soil less when they are with heifers than when they are alone.
C. No consequences expected.

ACCORDING TO YOU, HOW COULD THIS EFFECT OF HEIFER-SOW CO-GRAZING BE EXPLAINED?

D. Sows are more stressed when they are with heifers.
E. The two species have complementary diets.
F. Sows are distracted by cattle dung.
G. Heifers trample the soil, which makes it easier to dig.
H. The two species compete for access to grass (interspecific competition).
I. Co-grazing leads to parasitic dilution.

▶Q6 (Ducks and corn): **B, C, D.**
According to ITAVI (French technical poultry institute), farmers who started growing maize on duck areas have strongly decreased their fertilizer use and the soil became easier to till : (B). Additionally, maize brings shade to ducks, which improves animal wellbeing and could enhance duck production during summer : (C). One farmer observed that ducks eat the maize : (D) so they have set fences to protect the young corn plants. They remove the fences once maize has reached the 10 leaves growth phase. This adds to the work hours, even though some work hours might be saved through lower fertilization and easier soil preparation. Finally, there were no parasite transmissions from ducks to cattle.

Source: interview with Geoffrey Chiron, ITAVI
https://www.reussir.fr/volailles/des-parcours-de-canards-gras-avec-agroforesterie-et-culture-de-mais

▶Q7 (Regulations on poultry area): **C. Other : no other livestock can enter the poultry area**.
This regulation aims to fight against salmonella, a bacterial infection which can have important sanitary consequences. Other livestock species cannot share poultry area even if the poultry is absent at the time.

Source : Arrêté du 8 février 2016 relatif aux mesures de biosécurité applicables dans les exploitations de volailles et d'autres oiseaux captifs dans le cadre de la prévention contre l'influenza aviaire.

https://www.legifrance.gouv.fr/loda/id/JORFTEXT000032000273/

▶Q8 (Digging sows):
1. (Sows behavior) **B. False, they dig the soil less when they are with heifers than when they are alone**.
2. (Reasons) **E and F. The two species have complementary diets & sows are distracted by cattle dung**.
Sows have a selective behavior during grazing and often dig non-grazed grass patches. With heifers on the same land, sows are distracted by cattle dung. They eat the nutritious grass around the dung (higher nitrogen content in the grass fertilized by dung) and they dig in dried dung to eat insects. By focusing more on dung areas, they tend to dig less in the rest of the pasture.

Source: interview with Jakob Sehested

PART 3: RESOURCES AND BY-PRODUCTS

9. WITHIN THIS LIST OF HERBIVORES, WHICH ONES CAN GRAZE THE CLOSEST TO THE GROUND REGARDLESS OF THEIR DIETARY PREFERENCES? Rank them from the species which can graze the closest to the ground to the species which can graze the least close to the ground.

	Answer:
A. Sheep and goats	....
B. Horses	....
C. Cattle	....

▶Q9 (Ground level grazing): **B > A > C**.
With their two rows of incisors, horses can easily cut grass very close to the ground. Sheep have a cleft lip (an opening on the upper lip) and lower incisors which allow them to graze closer to the ground than cows. Cows use their tongues to rip grass and usually do not graze lower than 10 cm above ground. Goats use both their tongues and their lower incisors with the upper gum line to cut the grass and can theoretically graze as low as sheep. However, goat grazing requires a finer management to avoid digestive and metabolic issues.

Sources: Menard et al., Comparative foraging and nutrition of horses and cattle in European wetlands, 2002
Walker, J.W., 1994. Multispecies grazing: the ecological advantage. Sheep Res. J. 52–64.
Sehested, J., Søegaard, K., Danielsen, V., Roepstorff, A., Monrad, J., 2004. Grazing with heifers and sows alone or mixed: herbage quality, sward structure and animal weight gain. Livest. Prod. Sci
J.B. Hall, "Nutrition and Feeding of the Cow-Calf Herd: Digestive System of the Cow"
http://itab.asso.fr/downloads/cahiers-elevage/chevres.pdf

10. WHAT IS/ARE THE CONSEQUENCE(S) OF THE DIFFERENT LIVESTOCK SPECIES GRAZING BEHAVIOR FOR THE FARMER?

Circle the correct answer(s) for the following questions

A. Decrease the number of non-grazed grass patches.
B. Increase the soil carrying capacity.
C. Improve herbage use efficiency.
D. Decrease overall fuel consumption on the farm.
E. Increase plant species heterogeneity on the pastures.
F. Decrease herbage nutritional value.
G. No consequences expected.

▶Q10 (grazing consequences): **A, C, D**.
Multi-species livestock farming allows a better grass valorisation thanks to the anatomical characteristics and dietary preferences of different herbivores on the same pasture. One animal species can eat a plant species which is not eaten by another species; this way, post-grazing residuals in a paddock decreases and grass utilization improves over the years. In the case of a pasture with many non-grazed patches, utilizing a second livestock species for grazing can save fuel by replacing the need to mow the pasture.
On the other hand, the difference in grazing levels among herbivores does not have a known impact on soil carrying capacity. However, it is important to note that cattle trampling will have a stronger negative impact than goats on plant cover. Soil characteristics should be taken into account in the choice of simultaneous or sequential grazing and the period of the year for grazing.
By making the plant cover more homogenous, co-grazing could reduce plant biodiversity. This impact will depend on a number of conditions (animal species, stocking rates, initial ecosystem). The goal of the farmer should be to find an equilibrium between the use of plant resources and the biodiversity of pastures.
While co-grazing, plants' nutritional value can depend on the species considered. In a heifer-sow co-grazing experiment, grass quality (gross protein content and organic matter digestibility) was lower for heifers than with heifers only grazing but higher for sows than with sows only grazing. Sows can graze lower than cattle and access better quality grass, but they lose grass while chewing and might waste good quality grass. In a co-grazing situation, plants' nutritional value can increase for one livestock species but decrease for the other.

Sources: Legarto J., Leclerc M-C., Idele août 2007 « Guide pour la conduite du pâturage caprin-Synthèse réalisée dans le cadre du réseau national des techniciens caprins travaillant sur le thème du pâturage »
Sehested, J., Søegaard, K., Danielsen, V., Roepstorff, A., Monrad, J., 2004. Grazing with heifers and sows alone or mixed: herbage quality, sward structure and animal weight gain. Livest. Prod. Sci. https://orgprints.org/id/eprint/2971/1/2971.pdf

11. A DAIRY CATTLE FARM PROCESSING ITS MILK WANTS TO DIVERSIFY ITS PRODUCTION. WHICH SPECIES SHOULD BE ADDED TO THE FARM TO UTILIZE WHEY?

A. Sheep
B. Pigs
C. Goats
D. Broilers

12. IN A CO-GRAZING SITUATION, SHEEP EAT HERBAGE NEAR CATTLE DUNG. THIS IS HERBAGE THAT IS NOT EATEN BY COWS THEMSELVES.

A. True
B. False

▶Q11 (Whey): **B. Pigs.**
Whey's richness in lysine develops muscle and improves meat quality. In the French region of Franche-Comté, the use of whey as pig feed is a requirement for Morteau sausage and Franche-Comté pork production.
Sources : Cahier des charges de l'indication géographique protégée « Saucisse de Morteau » / « Jésus de Morteau » homologué par arrête du 28 juin 2017
Arrêté du 10 novembre 2008 portant homologation du cahier des charges de l'indication géographique protégée (IGP) Porc de Franche-Comté.
Jean-Jacques SNAPPE, Anne LEPOUDERE, Natacha SREDZINSKI, Protéines laitières, Edition T1, 2010.

Source: Article La France agricole, "Une alimentation à base de lactosérum", 15/05/03 - https://www.lafranceagricole.fr/article/une-alimentation-abase-de-lactoserum-1,0,72850058.html

▶Q12 (Sheep and cattle dung): **A. True**.
Sheep tend to graze grass close to cattle dung, which is not grazed by cattle themselves. Studies show this grass has a higher protein content and a better digestibility for ruminants.

Source: Nolan, T., & Connolly, J. (1989). Mixed v. mono grazing by steers and sheep. Animal Production, 48(3), 519-533. doi:10.1017/S0003356100004049

PART 4: PRODUCTIVITY AND PROFITABILITY

13. In a controlled experiment from 1999, Danish researchers compared the average daily growth rate of 8 heifers co-grazing with pregnant sows to heifers grazing among themselves. **ACCORDING TO YOU, WHICH GROUP OF HEIFERS HAD A HIGHER DAILY WEIGHT GAIN?**
Circle the correct answer(s) for the following questions

A. Heifers co-grazing with sows
B. Heifers grazing without sows

HOW MUCH WAS THE DIFFERENCE IN AVERAGE DAILY WEIGHT GAIN BETWEEN THE TWO HEIFER GROUPS?

C. +20g/animal/day
D. +150g/animal/day
E. +250g/animal/day

14. HOW WOULD YOU EXPLAIN THE EFFECT OF HEIFER-SOW CO-GRAZING SHOWN IN THE ABOVE QUESTION?

A. Parasitic dilution
B. Dietary complementarity between the two species
C. Decrease in production costs due to economies of scope
D. Parasitic, viral or bacterial disease transmission from one species to another
E. Improved economic output from animals
F. Increase in grass availability for one species due to low grass consumption by the other

15. IN 2014, A META-ANALYSIS OF LITERATURE SHOWED THAT THE AVERAGE DAILY WEIGHT GAIN OF SHEEP WAS DIFFERENT WHEN THEY CO-GRAZE WITH CATTLE THAN WHEN THEY GRAZE AMONG THEMSELVES. ACCORDING TO YOU, WHICH GROUP OF SHEEP HAD A HIGHER DAILY WEIGHT GAIN?

A. Sheep co-grazing with cattle
B. Sheep grazing without cattle

HOW MUCH WAS THE DIFFERENCE IN AVERAGE DAILY WEIGHT GAIN BETWEEN THE TWO SHEEP GROUPS?

C. +15 g/animal/day
D. +105 g/animal/day
E. +245 g/animal/day

16. HOW WOULD YOU EXPLAIN THE EFFECT OF CATTLE-SHEEP CO-GRAZING SHOWN IN THE ABOVE QUESTION?

A. Parasitic dilution
B. Dietary complementarity between the two species
C. Decrease in production costs due to economies of scope
D. Parasitic, viral or bacterial disease transmission from one species to another
E. Improved economic output from animals
F. Increase in grass availability for one species due to low grass consumption by the other

▶Q13 (Daily weight gain for sows and heifers): **A. Heifers with sows. E. +250 g/animal/day**.
Average daily weight gain of heifers increases by 29% when heifers graze with sows.

Source: Sehested, J., Søegaard, K., Danielsen, V., Roepstorff, A., Monrad, J., 2004. Grazing with heifers and sows alone or mixed: herbage quality, sward structure and animal weight gain. Livest. Prod. Sci

▶Q14 (Daily weight gain for sows and heifers): **A. Parasitic dilution**.
Increased productivity is due to parasitic dilution. On the same pasture, heifer stocking rate is lower, which lowers the prevalence of gastro-intestinal nematodes.

▶Q15 (Daily weight gain for sheep and cattle): **A. Sheep co-grazing with cattle. C. +15 g/animal/day.**
The daily gain weight for sheep depends on the physiological stage. For instance, lactating ewes tend to fatten twice as fast when they are co-grazing with cattle than when they co-graze alone. Results also depend on the sheep-to-cattle ratio. Over 5 sheep per one cattle, performance decreases overall.

Sources: D'Alexis S. and al., 2014, Mixed grazing systems of sheep and cattle to improve liveweight gain: a quantitative review., Journal of Agricultural Science
D'Alexis S. and al., 2014, Mixed grazing systems of goats with cattle in tropical conditions: an alternative to improving animal production in the pasture, Animal, Volume 8, 1282-1289

▶Q16 (Daily weight gain for sheep and cattle): **A and B**.
Mixing small and big ruminants is an interesting pathway to improve individual productivity as well as land productivity by utilizing their feeding complementarity and by reducing gastro-intestinal parasitism among small ruminants.

17. In a study conducted by INRAE researchers on the production of grass-fed meat, a co-grazing system with beef cattle and meat sheep was compared to a beef cattle only system on one hand and a meat sheep only system on the other hand. In 2018, cattle were fattened without concentrates (grains) for the first time. Data show a significant difference in feed cost margins* between the multi-species system and the two separate cattle and sheep systems. **ACCORDING TO YOU, WHAT ARE THE RESULTS OF THE EXPERIMENT?**

**The feed cost margin is what is left of the gross product once the cost of feed is subtracted.*

For lamb production:

A. Feed cost margins are higher in the co-grazing system than in the sheep only system.
B. Feed cost margins are lower in the co-grazing system than in the sheep only system.
C. The difference in feed cost margins is more than 150 euros/livestock unit.
D. The difference in feed cost margins is less than 50 euros/livestock unit.

For cattle meat production:

E. Feed cost margins are higher in the co-grazing system than in the cattle only system.
F. Feed cost margins are lower in the co-grazing system than in the cattle only system.
G. The difference in feed cost margins is more than 150 euros/livestock unit.
H. The difference in feed cost margins is less than 50 euros/livestock unit.

18. HOW WOULD YOU EXPLAIN THE EFFECT OF CATTLE-SHEEP CO-GRAZING SHOWN IN THE QUESTION ABOVE?

A. Parasitic dilution
B. Dietary complementarity between the two species
C. Decrease in production costs due to economies of scope
D. Parasitic, viral or bacterial disease transmission from one species to another
E. Improved economic output from animals
F. Increase in grass availability for one species due to low grass consumption by the other

▶Q17 (Feed cost margins):
1. Lamb production: **A and C**
2. Cattle meat production: **E and H**.
In 2018, the study showed a feed cost margin of 770 euros/livestock unit in the multi-species system against 589 euros/livestock unit in a sheep only system. This is a difference of 181 euros/livestock unit in favor of the multi-species system. Cattle production also had better margins with co-grazing but the difference was much smaller (9 euros/livestock unit). This difference is partly due to selling prices.

Source: SALAMIX – Patrick Veysset and al. « Technico-economic results 2017-2018 », Results of Salamix presented during the Mix-Enable annual meeting of 03/04/2020.

▶Q18 (Feed cost margins): **A, B, E**.
Grass-fed lambs are sold earlier and heavier, in a growing market demanding of such products, while multi-species system cattle is sold younger and lighter, which is why income from cattle in the multi-species system is lower than in a cattle only system. A solution to improve cattle income in this case is to sell through very short supply chains. In sheep production, live weight was 341 kg/livestock unit in the multi-species system against 272 kg/livestock unit in the sheep only system. The use of mixed breeds in this experiment also had an influence on these results.

PART 5: WORK ORGANIZATION

19. A French organic dairy cattle farmer wants to diversify her farm by adding a meat sheep enterprise. Not knowing how to implement and manage a multi-species livestock farm, she looks up official training programs on the website of technical institutes, Chambers of Agriculture and rural development associations. **HOW MANY TRAININGS RELATED TO MULTI-SPECIES LIVESTOCK FARMING CAN SHE FIND IN FRANCE (APPROXIMATELY)?**

Circle the correct answer(s)

A. 0
B. 10
C. 20
D. 50
E. 100

20. In a French organic free-range multi-species livestock farm, the farmer wants to have all animals grazing on the same paddock. But to effectively do so, she needs to consider the fencing system. **LINK EACH SPECIES TO THE SUITABLE TYPE OF GRAZING FENCES.**

A. Sheep
B. Cattle
C. Goats
D. Poultry
E. Pigs

1. Barbed wire fence (2 or 3 rows)
2. Non electrified netted fence
3. Electrified wire fence
4. Simple fence at cattle height
4. Double enclosure fences (a combination of an external netted fence and an internal netted of electrified fence at least 25 cm away from the external fence)
5. Electrified netted fence

21. A multi-species livestock farmer needs to make decisions considering tradeoffs among different risks (economic, health). Those risks vary across farm structures and animal species combinations. **SELECT THE RIGHT POSITIVE AND NEGATIVE IMPACTS AND PLACE THEM IN THE CORRESPONDING BOX FOR EACH SITUATION.**

A. Increase in the number of working hours per year
B. Risk of parasitic, viral or bacterial disease transmission from one species to another
C. Risk of homogenization of the grassland, which can reduce biodiversity in the paddock
D. Decrease in soil erosion and underground water pollution by nitrates
E. Optimization of resource use
F. Decrease in fertilization costs

- In simultaneous or rotational co-grazing of two species, one species can eat the post-grazing residuals of the other species.

Positive impact	Negative impact
....	....

- To reduce digging by sows at grass, a farmer chooses to put the sows in the same paddock as cows.

Positive impact	Negative impact
....	....

- By adding a poultry enterprise to a dairy cattle farm, the farmer utilizes poultry droppings by spreading them on maize fields for cattle feeding.

Positive impact	Negative impact
....	....

▶Q19 (Trainings): **A. 0**.
To this day, there are no specific trainings for the management of several livestock enterprises within the same farm. Farmers need to get training for each specific livestock species separately. Some multi-species livestock farmers inherit their parents' farm which is already a multi-species livestock farm, other farmers have to learn on the go when they decide to diversify their farm.

▶Q20 (Fences):
Sheep **A: 2, 3, 4, 5**.
Cattle **B: 1, 2, 3, 4, 5**.
Goats **C: 2, 3, 4, 5**.
Poultry **D: 2, 5**.
Pigs **E: 4**.
The type of pasture fence depends on the regulations in each country. Sheep and goats can easily jump over or go under fences, so fences need to be suited to the animal's height or be netted. Double enclosure fencing is possible but less used.
Cattle can be contained by fences suitable for small ruminants. Sharing the same material for both species creates economies of scope.
Poultry need to be protected by netted fences to protect them from predators. Electrified fences are a good defense mechanism against foxes and other terrestrial predators.
Pigs' fences have specific regulations because they need to keep contact with wild pigs from happening in order to avoid the spread of diseases such as African swine fever.
Source: http://www.loire.gouv.fr/protection-par-des-clotures-des-elevages-de-porcs-a7136.html

▶Q21 (Trade-offs):
1. Post-grazing residuals. **E (Positive) and B + C (Negative)**.
2. Paddock with sows and cows. **D (Positive) and B (Negative)**.
3. Adding a poultry enterprise. **F (Positive) and A (Negative)**.

MIX-ENABLE

STRATEGIES FOR SUSTAINABLE AND ROBUST ORGANIC MIXED LIVESTOCK FARMING

Q-SORT

STUDENTS

Q-SORT

Multi-species livestock systems are defined here by the association of at least two different animal species within the same farm, regardless of the interactions among the different farm enterprises. Multi-species livestock farming is generally less represented and less studied than single species livestock farming in Europe. Furthermore, there is a lack of official data on the number of multi-species livestock farms in some countries. Yet, a growing scientific literature has demonstrated some strengths (and weaknesses) of such systems.

This tool is inspired by the Q-methodology, a research method used by social scientists and psychologists to study subjectivity and viewpoints. Here, in the following table, statements are provided and you are asked to indicate your stand on each statement individually on a scale from “strongly disagree” to “strongly agree”. There are 18 statements about multi-species livestock systems. You must respond within the time allotted by the instructor. You will then be asked to provide arguments to support your positions.

First name: ....

Last name: ....

Date: ....

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1.Being a multi-species livestock farmer means working more than a farmer specialized in a single livestock species (in terms of hours per day).				
2. A multi-species livestock farm is necessarily more complex to manage than a single species livestock farm.				
3. Doubling the number of animal enterprises in a farm means doubling the number of value chain stakeholders the farmer has to interact with (cooperatives, slaughterhouses, etc.).				
4. Combining multiple animal species in a farm increases byproduct and waste amounts which needs to be managed.				
5. Adding another animal enterprise to the farm requires high investment costs.				
6. Multi-species livestock farms perform worse economically than single species livestock farms.				
7. A multi-species livestock farmer is less exposed to market hazards and volatility (than a single species livestock farmer).				
8. Being a multi-species livestock farmer always involves direct selling of products.				
9. To optimize the benefits of multi-species livestock systems, one has to minimize the interactions among animal enterprises.				
10. Co-grazing allows a better use of standing biomass at grazing.				
11. Self sufficiency for feed is more difficult to achieve in a multi-species livestock farm than in a single species livestock farm.				
12. Co-grazing always increases stocking rates on pastures (Livestock Unit/ha)				
13. Multi-species livestock farms are more exposed to parasitic issues than single species livestock farms.				
14. All livestock species can share the same paddock without any risk for their health.				
15. Preventive parasitic treatments such as deworming are useless in multi-species livestock farming with a co-grazing situation.				
16. In a multi-species livestock farm, it is more difficult to manage fertilization than in a single species livestock farm.				
17. All ruminant species eat the same grass species.				
18. A single species livestock farm will improve its environmental performances by switching to a multi-species livestock system.				
Total:				

MIX-ENABLE

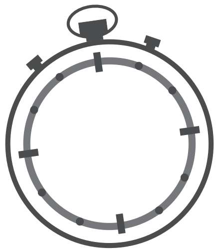
STRATEGIES FOR SUSTAINABLE AND ROBUST ORGANIC MIXED LIVESTOCK FARMING

Q-SORT

WITH ANSWERS AND ARGUMENTS FOR TEACHERS

TEACHERS

TIME GRID PROPOSAL FOR THE USE OF THE QUIZ AND Q-SORT



Steps	Estimated time	Real time
Introduction and presentation of the topic	2	
Explanations on the Q-sort	2	
Individual reading of the Q-sort and positioning	10	
Review of positions by the instructor and discussion on statements for which there is less consensus	15	
Transition to another tool – Explanations on the quiz	3	
Quiz: individual thinking part 1: Environment	8	
Correction part 1	8	
Quiz: individual thinking part 2: Animal health and behavior	8	
Correction part 2	10	
Quiz: individual thinking part 3: Resources and byproducts	6	
Correction part 3	10	
Quiz: individual thinking part 4: Productivity and profitability	10	
Correction part 4	10	
Quiz: individual thinking part 5: Work organization	6	
Correction part 5	10	
Conclusion and thanks	3	
Evaluation form (optional)	7	
Total	**125 (2h 5min)**	

ELEMENTS OF ANSWERS AND ARGUMENTATION FOR TEACHERS

This tool is inspired by the Q-methodology, a research method used by social scientists and psychologists to study subjectivity and viewpoints. Here, participants are presented with statements and asked to assess their stand on each statement individually on a scale from “strongly disagree” to “strongly agree”. There are 18 statements about multi-species livestock systems. Within the timeframe given by the instructor (e.g. 10 to 15 minutes), the participant will read each statement and position themselves on the scale. Once all participants have filled in their table, the instructor will review the positions on each statement and discuss them with participants. Participants will be asked to provide arguments to support their stand.

This tool can be used to achieve two separate educational goals. For participants who are introduced to the theme of multi-species livestock systems for the first time, this tool enables the instructor and the participants themselves to reveal their representations and preconceived opinions on the theme. It can also initiate participants’ thinking on the issues and challenges faced by multi-species livestock systems. For participants who have already studied multi-species livestock systems, the tool will enable them to mobilize the knowledge they just gained by building an argumentation for each statement.

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1. Being a multi-species livestock farmer means working more than a farmer specialized in a single livestock species (in terms of hours per day). **Arguments**: See Q21 of the quiz: For a multi-species livestock farmer, a decision regarding the farm organization sometimes requires addressing trade-offs between different risks (economic, health...), which vary according to farm structures and animal species combinations (e.g. increase in annual workload for a dairy farmer who adds a poultry enterprise to his farm and spreads poultry manure on the corn intended for cattle). The disadvantage of multi-species livestock farms is that they can generate more intense workloads for farmers (Martin et al., 2020). For example, managing sequential grazing by both species is more labor intensive than co-grazing or grazing by a single species, as illustrated by heifer-sow co-grazing, which requires weekly movement of animals and leveling of the ground (Sehested et al., 2004). However, work management adapted to the diversity of productions can avoid an increase in overall workload (Darnhofer et al., 2010; Hostiou, 2013). For example, sharing tasks between farmers (if more than one) can allow them to free up a considerable amount of free time (equal to or greater than that of a specialized farmer).		X	X	
2. A multi-species livestock farm is necessarily more complex to manage than a single species livestock farm. **Arguments:** The diversity of productions increases the number of activities and tasks to be performed on a farm. This can lead to greater management complexity for the farmer (Kingwell, 2011).			X	
3. Doubling the number of animal enterprises in a farm means doubling the number of value chain stakeholders the farmer has to interact with (cooperatives, slaughterhouses, etc.). **Arguments:** Farms in multi-species livestock settings tend to also practice on-farm processing and/or direct selling, because a diversity of production allows a diversity of products offered on the farm and thus a better attractiveness for consumers. However, the rules for "on-farm" slaughtering are not the same for all species. On-farm processing and direct selling can allow for a diversified product offer for customers on the one hand, and on the other hand, several such products can be sold to the same buyer in a long channel. Slaughtering can be carried out by a single actor thanks to multi-species slaughterhouses.		X		
4. Combining multiple animal species in a farm increases byproduct and waste amounts which needs to be managed. **Arguments:** See Q11 of the quiz: In a dairy farm that processes milk and wishes to diversify its production, which species can be used on the farm to add value to the whey? The co-products of one enterprise can be a resource for another enterprise. For example, in the case of a combination of dairy cattle and pigs, whey, a by-product of dairy processing on the farm, can be fed to pigs.		X		
5. Adding another animal enterprise to the farm requires high investment costs. **Arguments:** See quiz Q20: In an organic, free-range mixed farming system, a farmer decides to graze all of her animals on all of her pastures. But to know how to organize the grazing (simultaneous or rotational, for example), she must consider the management of the fences. A new production enterprise may involve investments in buildings, fences or machinery. However, depending on the type of enterprise, this might not always be true. For example, a sheep fence is also suitable for cattle grazing. And a new species can be housed in existing but unoccupied buildings.		X		

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
6. Multi-species livestock farms perform worse economically than single species livestock farms. **Arguments:** See Q17, Q18 of the quiz: In an INRAE study, the combination of suckler cattle and suckler sheep on pasture was tested and compared with specialized suckler cattle on the one hand and suckler sheep on the other. During the 2018 campaign, cattle were fed without feed concentrates for the first time, and the data obtained highlighted a significant difference in feed cost margin (FCM) between multi-species and specialized suckler cattle/suckler sheep systems. Studies show that in the case of a suckling cattle - suckling sheep combination, the feed cost margin increases, resulting in a better economic performance of the mixed system compared to the specialized systems.	X			
7. A multi-species livestock farmer is less exposed to market hazards and volatility (than a single species livestock farmer). **Arguments**: A diversity of products can secure the farmer's income in case of hazards (volatility of market prices, disease on a species, climatic hazards...).			X	
8. Being a multi-species livestock farmer always involves direct selling of products. **Arguments:** Multi-species livestock farms tend to also practice on-farm processing and/or direct selling, as a diversity of production allows for a diversity of products offered on the farm and thus a better attractiveness for consumers. However, the rules for "on-farm" slaughtering are not the same for all species A large number of multi-species livestock farmers seem to prefer direct selling to market their products. However, this is not the case for all farmers and it is not a prerequisite for the practice of multi-species livestock farming.	X			
9. To optimize the benefits of multi-species livestock systems, one has to minimize the interactions among animal enterprises. **Arguments:** See quiz Q2: Definitions of terms applied to multi-species livestock. See Q7 of the quiz: In France, regulations indicate that ruminants can use poultry runs only when poultry are not present. See Q11 of the quiz: In a dairy farm doing processing and wishing to diversify its production, which species can be used on the farm to valorize the whey? There are health risks depending on the combination of species involved. However, interactions can also be indirect yet beneficial. They can allow economies of scope, thus optimizing the efficiency of the farm in terms of resource use.	X			
10. Co-grazing allows a better use of standing biomass at grazing. **Arguments:** See Q1, Q2, Q9, Q10, Q12, Q21 of the quiz. Studies show that co-grazing can optimize herbage use efficiency by taking advantage of niche complementarities between herbivores (e.g. Shipley et al. 2009, Menard et al. 2002, Sehested et al. 2004).			X	
11. Self-sufficiency for feed is more difficult to achieve in a multi-species livestock farm than in a single species livestock farm. **Arguments:** The use of co-products of plant and animal enterprises in the diet of a species can increase food self-sufficiency for feed at the farm level.		X		
12. Co-grazing always increases stocking rates on pastures (Livestock Unit/ha). **Arguments:** See Q10 of the quiz. Co-grazing and stocking rate are not directly related; it depends on the practices implemented by the farmers. Stocking rate is an important factor to consider in objectively measuring the effects and impacts of co-grazing compared to mono grazing. In the trials studied by Sehested et al. 2004, the stocking rate was lower for co-grazing than for mono grazing. The stocking rate also changed according to the year, the grazing season and the plants present in the different paddocks, all of wich should be taken into account.	X			

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
13. Multi-species livestock farms are more exposed to parasitic issues than single species livestock farms. **Arguments:** See Q5 of the quiz: In an organic multi-species livestock system, the presence of two animal species can lead to interspecific transmission of parasites and diseases, depending the species combination and the nature and level of interactions among species.			X	
14. All livestock species can share the same paddock without any risk for their health. **Arguments:** See Q5 of the quiz: In an organic multi-species livestock system, the presence of two animal species can lead to interspecific transmission of parasites and diseases, depending the species combination and the nature and level of interactions among species. See quiz Q7: In France, regulations indicate that poultry should never share their living environment with other species.	X			
15. Preventive parasitic treatments such as deworming are useless in multi-species livestock farming with a co-grazing situation. **Arguments**: See Q5 of the quiz: In an organic multi-species livestock system, the presence of two animal species can lead to interspecific transmission of parasites and diseases, depending the species combination and the nature and level of interactions among species.	X			
16. In a multi-species livestock farm, it is more difficult to manage fertilization than in a single species livestock farm. **Arguments:** See Q3 of the quiz: Effluents in organic agriculture are mostly composed of animal manure. Their composition varies greatly depending on the species, housing conditions, breeding practices and manure storage equipment. The nitrogen contained in livestock manure is mainly found in 2 forms: ammoniacal nitrogen (NH4) which is rapidly transformed into nitrate and can then be used by plants, and organic nitrogen, contained in organic matter and which is slowly mineralized to be available for plants in the medium to long term (the speed depending on the carbon/nitrogen ratio in the soil). Availability of nitrogen for plants is therefore variable depending on the effluents used. This is an element to be taken into account by the multi-species-livestock farmer when allocating the different effluents to his fields in his fertilization plan. A cattle-pig farm can better meet the nitrogen fertilization needs of grasslands by better meeting nitrogen requirements than a specialized cattle farm. However, it is likely to have a slight surplus of phosphorus and due to that, may need to export part of the effluent (Levasseur, 2020). Cattle-pig farmers in the Massif Central use pig manure in spring for its short-term fertilizing effect and follow up with the application of cattle manure in fall before sowing cereals for its amending effect (von Kerssenbrock et al., 2020). The main advantage of this practice is the savings on fertilizer purchases. The main disadvantages are the development of certain weeds, the time and cost of application.	X			
17. All ruminant species eat the same grass species. **Arguments:** See Q1 of the quiz: Multi-species farming mobilizes the principle of feed niche, defined as the physico-chemical properties of a species' diet. Two species are said to have the same food niche when they have a perfectly identical diet in the same environment. If this situation is almost impossible according to evolutionary principles, it is possible to have what is called a food niche overlap, when two species have a part (more or less important) of their diet in common. See Q21 of the quiz: For a multi-species livestock farmer, a decision taken in the organization of his farm sometimes leads to trade-offs between different risks (economic, health...), which vary according to farm structures and animal species associations (Optimization of resource use).	X			
18. A single species livestock farm will improve its environmental performances by switching to a multi-species livestock system. **Arguments:** See quiz Q4: A 2019 experiment measured the effects of cattle/sheep co-grazing on aboveground floristic and faunal (insect) biodiversity in grasslands. The conclusion was that cattle/sheep co-grazing significantly improves floristic and faunal diversity. See Q21 of the quiz: For a multi-species livestock farmer, a decision taken in the organization of his farm sometimes leads to compromises between different risks (economic, health, etc.), which vary according to the farm structure and the animal species combinations (Risk of homogenizing the plant cover, which can potentially decrease the biodiversity of the grassland, Decrease in soil erosion and infiltration of nitrates that can pollute the groundwater).			X	

MIX-ENABLE

STRATEGIES FOR SUSTAINABLE AND ROBUST
ORGANIC MIXED LIVESTOCK FARMING

IMPLEMENTATION

MIX-ENABLE

SIMULATION TOOL

TO DESIGN LIVESTOCK FARMS BASED ON A MIX OF ANIMAL SPECIES

GOALS

- Use the acquired knowledge from tool 1 and 2 of the Mix-Enable toolkit to redesign a specialised livestock farm into a multi-species farm.
- Encourage students to consider mixing animal species as a lever for action in the design of livestock systems and in the improvement of their sustainability
- Grow their knowledge on sustainable multi-species farms.
- Formalise and teach students a critical thinking approach to rethink livestock systems based on inter-specific diversity.

PRINCIPLES

The simulation exercise is based on a case-study of a livestock farm, which is initially specialised in dairy cows, and whose functioning and performances do not meet farmer's expectations.
Students stand as a neighbour or as a farm advisor, who will help him to rethink his production system. Therefore, they will have to (1) take considerations of the challenges faced by the farmer, (2) propose associations of one or more animal species to overcome these and think about the technical consequences for this new production enterprise and for the whole farm too.
The proposed case study is inspired from a real-life example, that of the settling of the French experimental farm of INRAE in Mirecourt.

STRUCTURE

The simulation is structured into three steps, which consists in different learning activities for the students. The formalisation of this cognitive approach allows the students to differentiate the different steps, to materialise them and assimilate them.

3 STEPS CHARACTERIZES THE PROCESS OF SIMULATION

Red: Diagnostic steps
Blue: Conception step

DIAGNOSTIC

STEP 1

Understanding the initial farm situation (context, farmer's expectations, farm's structure and performances)

"Case study"

STEP 2

Identify and formalise challenges (by confronting farmer's will and the farm performances)

"Formalization of problems and challenges"

CONCEPTION

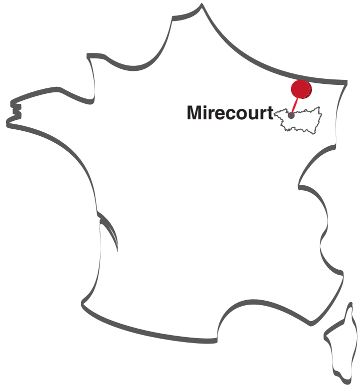
STEP 3

Design animal species combination to meet the challenges

"Designing relevant animal species combinations"

CASE STUDY
FARM DESCRIPTION

THE FARM BETWEEN 2004 AND 2015



Mister Mixall is the director of SPYCE agricultural school's farm in the Vosges region in France. The soil and climate conditions of the farm are described in Box 1.
The farm is a crop and dairy cattle farm that produces under an **organic label since 2004**. The **farmers' goals** are: reaching autonomy by reducing farm inputs (especially fodder for the herd), reducing worktime, and valorising the territory's resources.

In terms of land, the farm's total utilised agricultural area (UAA) amounts to 240ha and is split between 135 hectares of permanent grassland and 105 hectares of rotating field crops, which include 35ha of temporary grassland (Box 2, Fig. 2.1). In 2015, the farmer owns 90 dairy cows with half of the herd being Holstein Friesians and the other half being Montbéliarde. Finally, beside Mister Mixall, two workers are full-time employed on the farm.

The farm functions with two interacting sub-systems:

- A grass-based fodder system (GBFS) based on 80 ha of permanent grasslands, where grazing is maximised up to 250 days per year, with hay production, and zero concentrates for cows. There are 40 dairy cows in this system with replacement heifers. The calving period is set at the start of spring (between Jan. 15th to Apr. 15th) to fit with the grass production cycle.
- A crop-based fodder system (CBFS) based on arable land that are more favourable for annual crop (105ha), including crops for human consumption, rotating on a 6 to 8 year-cycle, plus 50 ha of permanent crops. A herd of 60 dairy cows and some replacement heifers are using the forage crop of this system, with 220 days of grazing per year. The calving period is set in autumn (between Oct. 15th and Dec. 15th) in order to produce milk in autumn and winter to compensate the dry period of the other herd.

Both systems are strictly autonomous in terms of forages. The CBFS ensures autonomy in straw for both systems. A small quantity of grains are exchanged from the CBFS to the GBFS for the heifers (2.5t per year) in exchange of manure. This exchanges are necessary in order to complete the elements cycle, and in limiting transfer of fertility between the two systems.

2016 REORIENTATION

SOME DIFFICULTIES AND DISSATISFACTIONS…

Although the farm is autonomous in fodder and straw while being organic, Mr Mixall is not fully satisfied about four different points:

- **On work conditions:**

Firstly, the repetition of certain tasks with poorly designed workstations makes work difficult (e.g. manual distribution of hay, grain sorting station at harvest time, animal restraint, etc.). Secondly, there is a lot of on-call work, particularly in connection with milking the cows, due to the fact that calving is staggered between the two herds.

- **On technical aspects:**

In terms of milk production, the dairy cows produce an average of 5150 kg of milk per cow per year in the GBFS, compared to 5777 kg in the CBFS (the regional average being 6000 kg per cow per year in organic farming). With approximately 600 kg of distributed concentrates per cow per year in the CBFS (compared to zero in the GBFS), Mr Mixall wonders about the efficiency (particularly energy efficiency) of the farm concentrates used by the CBFS dairy cows and therefore of this method of valorising the produced cereals.

Moreover, reproduction performance of the cows has deteriorated in both systems (see Box 3). This deterioration is greater in the GBFS: there is a higher decline in fertility rate and calving rate between 2004 and 2015, as well as a higher variability between years. That can be explained by the imposed constraints on fodder autonomy of the two systems, in a context of non-favourable climatic conditions (Box 2, Fig. 2.2). To improve the herds' reproduction performance, Mr Mixall implemented long lactation for 60% of the dairy cows in the GBFS and 50% of the dairy cows in the CBFS. However, one third of the dairy cows of both systems were culled for non-pregnancy after prolonged lactation. This poor reproduction performance jeopardises the farm sustainability: lower profitability and more work.

- **On economic aspect:**

Both systems are efficient with operating costs representing an average of 15% of gross product (excluding depreciation costs) for the CBFS and 16% for the GBFS. This economic efficiency allows the creation of 95000 euros of added value for the CBFS and 59000 for the GBFS. Divided by the land area of both systems GBFS generates more added value than the CBFS (591 vs. 753€/ha). The depreciation costs of CBFS's farm equipment appear to weight a lot in the economic performance of this system.

Between 2009 and 2015, the total workload for the GBFS was between 4300 and 3300 hours per year, compared to 8300 and 8000 per year for the CBFS.

- **On farm's contribution to the local food project:**

Althoug Mr Mixall's farm is autonous in inputs, it does not contribute to the direct creation of humane food and jobs in the local area (milk is sold to a large cooperative). In fact, cultivated land are producing fodder for animals instead of directly producing food for humans. Some visitors have pointed out to Mr Mixall this competition between feed and food on his farm.

… THAT HAVE LED TO TECHNICAL CHANGES IN 2016

To overcome these difficulties and dissatisfactions, Mr Mixall decides in 2016 to take technical changes both on the dairy herds and on the land use by stopping this dual fodder systems GBFS and CBFS. He decides to simplify the system by keeping one singe herd that will be fed with grazed grass, hay and no concentrates.

- **On the cropping system:**

Mr Mixall decides to allocate all of his arable land (110 ha) in to crop production for human consumption except for the first years of the rotation and cover crops (alfalfa and temporary grasslands) (Box 4)

- **On the herd:**

Mr Mixall decides to:

- Shift to once-a-day-milking all year long. This shift aims at reducing on-call work and reducing milk production to lower the compromise between reproduction and production.
- Set the calving period over two mounts in spring for all dairy cows in order to reduce worktime.
- Aim an age of first calving at 24 months to reduce the number of unproductive animals.
- Use ten suckler cows to raise the replacement heifers. This will reduce on-call work (in caring and feeding) and improve heifers' growth for an early calving (24 months).
- Adopt a cross-breeding strategy to improve animals' fertility, grazing efficiency and rusticity.

All together, these decisions aim at improving the work productivity of this system to gain economic efficiency and autonomy.

More globally, Mr Mixall is ready to diversify his production system both the animal side and crop side.

FORMALIZATION OF PROBLEMS AND CHALLENGES

STEP 1 STEP 2 STEP 3

ANALYSIS OF THE CONSEQUENCES OF 2016 CHANGES

The implementation of the technical changes in 2016 has led to a number of impacts on the system (Box 5, Table 5.1, year 2015, 2016 and 2017).

To help him analyse these impacts, Mr Mixall invites a group of local farmers with whom he and his employees are used to talk with. You are one of these farmers. He gives them the table in Box 5 showing the impacts on some of the farm's performances following the changes made to the crop rotation and the herd.

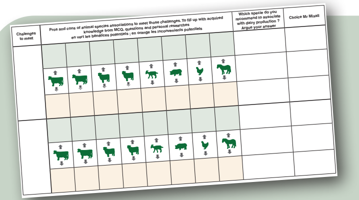
QUESTION

Looking at this table (Box 5), formulate the different impacts of the technical changes made on the farm. Based on this analysis, you should formulate the challenges that Mr Mixall has to meet in order to achieve his goals.

DESIGNING RELEVANT ANIMAL SPECIES COMBINATIONS

STEP 1 STEP 2 STEP 3

After identifying the challenges to be met by the SPYCE farm, the group of farmers helped Mr. Mixall to identify the levers of action to meet them, taking into account his goals. The group came up with various strategies, some of which involved the association of one or more animal species, in line with Mr Mixall's goal of reconnecting agricultural production with local consumption. **In order to identify the animal species to be associated with dairy cattle production, you discuss in turn the types of possible species associations and argue their respective interests.**



TO HELP YOU, use the Excel® file called "Tool 3_Challenges species associations.xls"

Look at the form on the next page from the Excel file

DESIGNING RELEVANT ANIMAL SPECIES COMBINATIONS

EXCEL® TABLE "TOOL 3_CHALLENGES SPECIES ASSOCIATIONS.XLS"

Chalenges to meet	Pros and cons of animal species associations to meet those challenges. To fill up with acquired knowledge, using by the Quiz and Q-Sort, questions and personal researches *In green the potential benefits; in orange the potential disadvantages*								Which specie do you recommend to associate with dairy production ? Argue your answer
	DAIRY	MEAT	DAIRY	MEAT					
	DAIRY	MEAT	DAIRY	MEAT					

IMPLEMENTATION
PEDAGOGICAL AID AND ANSWERS FOR TEACHERS

STEP 2: FORMALIZATION OF PROBLEMS AND CHALLENGES

STEP 1 ▸ **STEP 2** ▸ STEP 3

FOR TEACHERS: to help students to formulate the problems, make them decompose the thinking according to the three following steps:

❶ What are the goals and expectations of Mr Mixall.

❷ Analyse the positive and negative impacts resulting from the changes made in 2016. You can use the following table:

Positive impact		Negative impact	
Aspect	Arguments	Aspect	Arguments

❸ Finally formulate the challenges to meet by the farmer by putting together the farmer's goals and the observed negative impacts.

AID FOR STUDENTS: indicators in bold in the Table 5.1 - Box 5 (Annexes) are those that needs to be analysed deeply for the question.

▸ MR MIXALL'S GOALS ARE:

- enhance the farm's autonomy in farm inputs and the resource-use efficiency
- use the agronomic potential of the farm, that constantly changing over time and depending on the non-changing peco-climatic conditions
- improve work conditions
- contribute to food production
- create jobs in the local area

POSITIVE AND NEGATIVE IMPACTS

The changes in 2016 in the system have led to several "negative" impacts:
The shift to once-a-day-milking has generated a loss of milk production which, in addition to a decrease in the number of dairy cows, will result in a decrease in the farm's income. However, this decrease in production per cow must be considered in the light of (i) the decrease in the number of unproductive cows and (ii) the increase in the protein and fat content of the milk.
In addition, the introduction of suckler cows has made it possible to improve the growth of replacement heifers, to reduce the age at first calving and to improve partly their reproductive performance. On the other hand, this practice reduces the value of the unmarketable milk from milking cows.
Moreover, the cultivation of crops for human consumption leads to the production of non-marketable products such as stained potatoes or sorted grain (broken or small-sized grains). This raises the question of how to use these co-products.
Climatic variability is exacerbated, which results in lower fodder stocks for winter and during dry summer. Also, high precipitations in spring and autumn do not allow the grazing maximisation, given the poor bearing capacity of the soils. The number of days when grazing is not possible goes up on average. Summers are characterised by a deepening water deficit (June-September), which requires considerable supplementation of forage.
To adapt his autonomous system to the available resources, Mr Mixall adjusts the size of his herds to the available fodder resources.
Finally, although the contribution to the local supply of vegetable products has increased slightly (the potatoes are marketed via a wholesaler), this contribution remains low in relation to Mr Mixall's goals. The milk is delivered to a cooperative, so in a long value chain. This way of commercialisation is not satisfying Mr Mixall's will to commercialise his products locally.

▸ THE CHALLENGES FACING MR MIXALL

The farmer therefore faces several questions:

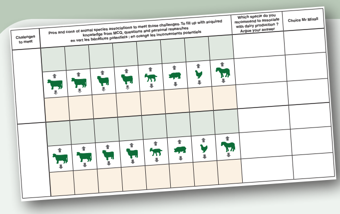
- How can the co-products of the dairy enterprise and the crops be used for human consumption?
- How can grazing (grassland and intercropping if necessary) be developed, given the poor soil conditions that make it difficult to grazing in wet conditions?
- How can he contribute more to the development of short food supply chain in the Mirecourt sector for both plant and animal products?

IMPLEMENTATION
PEDAGOGICAL AID AND ANSWERS FOR TEACHERS

STEP 3: DESIGNING RELEVANT ANIMAL SPECIES COMBINATIONS

STEP 1 STEP 2 **STEP 3**

Question for student: After identifying the challenges to be met by the SPYCE farm, the group of farmers helped Mr. Mixall to identify the levers of action to meet them, taking into account his goals. The group came up with various strategies, some of which involved the association of one or more animal species, in line with Mr Mixall's goal of reconnecting agricultural production with local consumption. **In order to identify the animal species to be associated with dairy cattle production, you discuss in turn the types of possible species associations and argue their respective interests.**



TO HELP YOU, use the Excel® file called "Tool 3_Challenges species associations.xls"

Look at the form on page 29 from the Excel file

FOR TEACHERS: have the groups of students present and discuss their choices of animal species associations. A summary is then produced across the groups. On the basis of the selected associations, students discuss the possibilities of implementation, the possible obstacles and/or support.

CHOICE OF MR MIXALL:

Mr Mixall decides to combine dairy production with two new enterprises : pork production to valorise crop co-products and sheep to valorise better grasslands.

FIGURE 1.1 - GEOGRAPHICAL CONTEXT

SOCIOECONOMIC ENVIRONMENT OF THE FARM

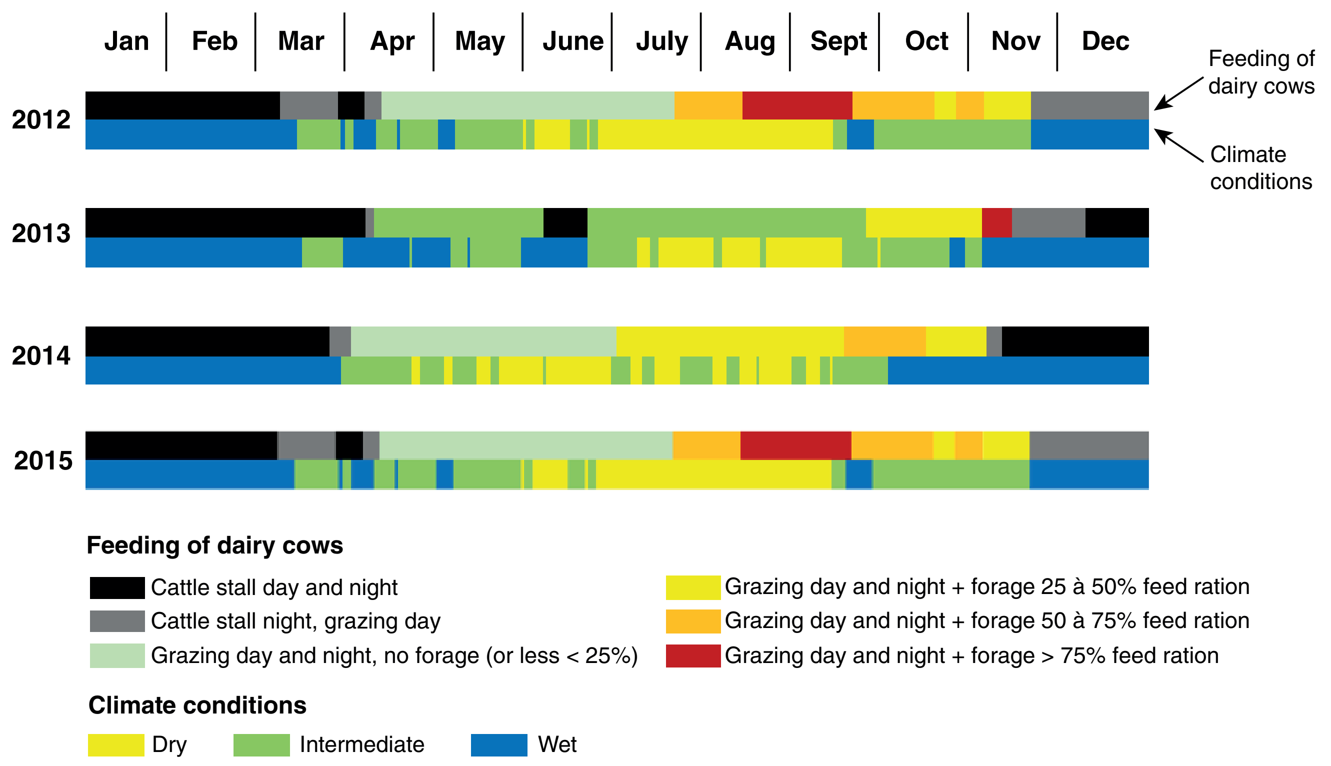
Plains of the Vosges region are characterised by a growing specialisation of farms and by an increasing average farm size. The region produces milk (mainly based on maize silage), cereals on arable land, and beef from suckler cows on permanent grasslands where land are non-arable. The dairy farms are part of a long supply chains that does not generate much value added locally. Organic farms follow the same economic model by delivering to agro-businesses of the region.

However, the region benefits from primary processing tools, and the gradual integration into local value chains offers favorable conditions for diversification activities. One can note too that the Mirecourt sector has a pig slaughterhouse at 45km and a ruminant slaughterhouse at 5km.

SOIL AND CLIMATE CONDITIONS OF THE FARM

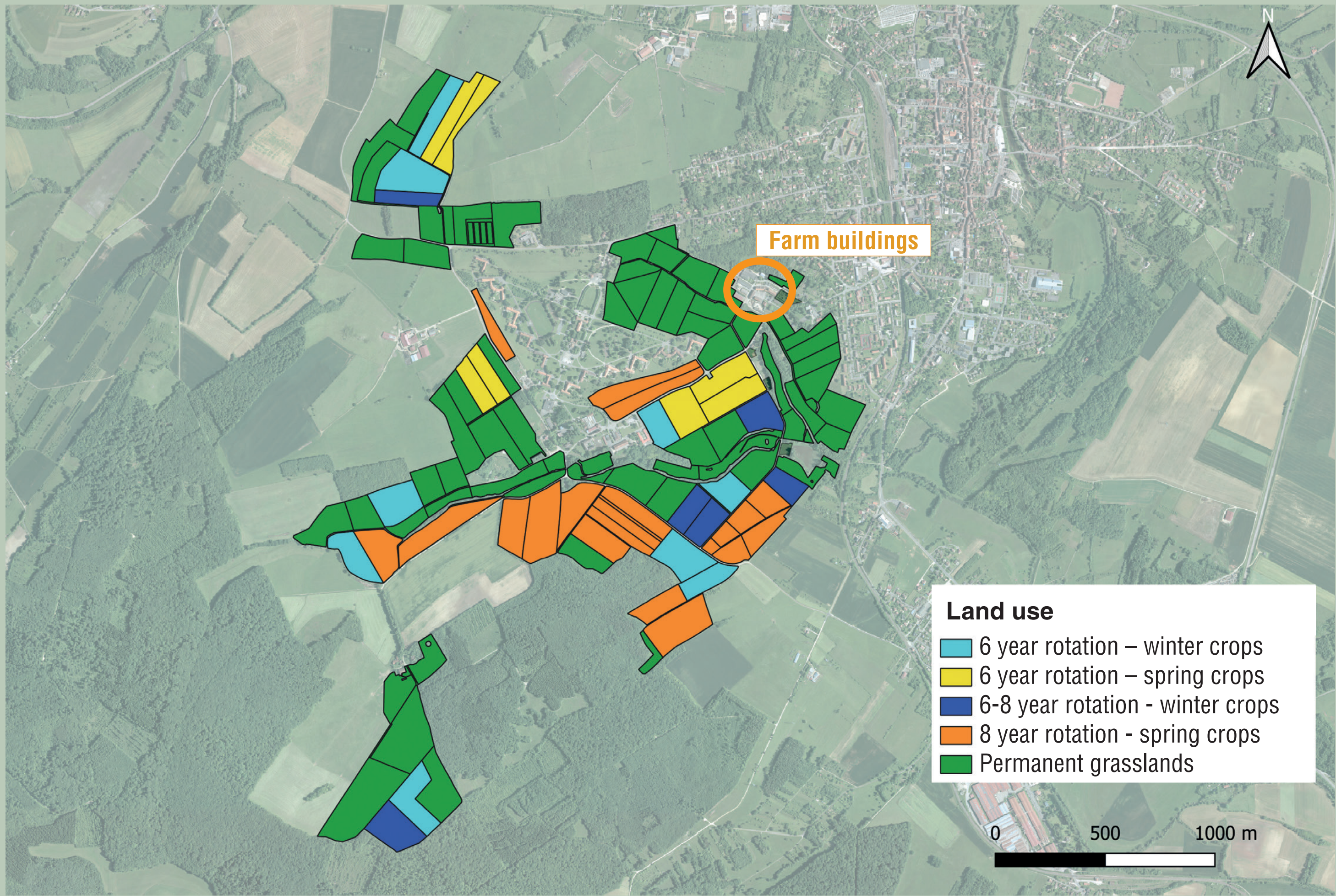
The farm has very heterogeneous soils with a dominant clay over dolomite, which poses bearing capacity problems for large ruminants (cattle) during rainy periods and throughout the winter. The climate is semi-continental (average annual rainfall of 869 mm, cold winters and hot summers). The climatic changes and adjustments in the feeding of dairy cows from 2012 to 2015 are described in Figure 1.2.

FIGURE 1.2 - SOIL AND CLIMATE CONDITIONS AND FODDER STRATEGIES CALENDAR FROM 2012 TO 2015



BOX 2 - LAND USE AND FARM DESIGN OF THE TWO FODDER SYSTEMS 2004 À 2015

FIGURE 2.1 - CONFIGURATION OF THE FARM AND LAND USE. THE BUILDINGS ARE NOT IN THE CENTER OF THE LANDS



BOX 2 - LAND USE AND FARM DESIGN OF THE TWO FODDER SYSTEMS 2004 À 2015

FIGURE 2.2 - FARM FUNCTIONNING

GRASS-BASED FODDER SYSTEM (GBFS)

« A very economical use of permanent grasslands »

Hay + regrowth

40 dairy cows Holstein and Montbéliardes
Calving : **15/01 – 15/04**

Grazing

80 ha permanent grasslands

Slurry, Manurer, green and white water milking parlor

Annual sales
- Spring and summer milk
- Beef meat

Manure →

← Straw / Grains

CROP-BASED FODDER SYSTEM (CBFS)

« Benefit from the complementarity of crops and livestock »

Harvested fodder, Straw/Grains

60 dairy cows Holstein and Montbéliardes
Calving : **15/08 – 15/11**

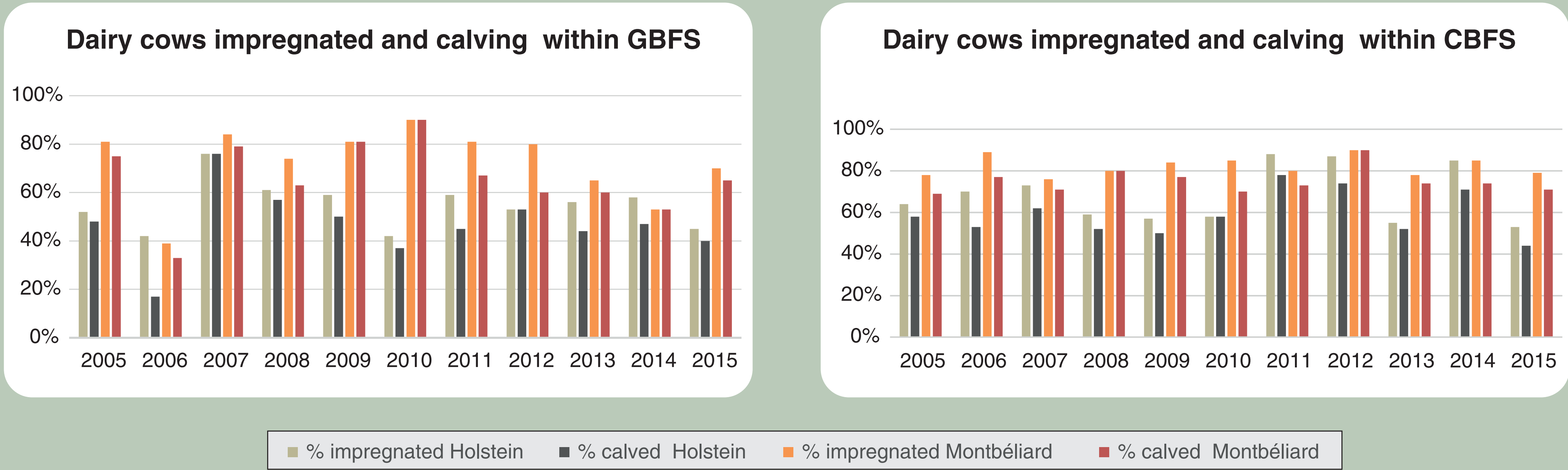
Grazing

55 ha permanent grasslands
+
105 ha crop rotations

Manure, Slurry, green and white water milking parlor

Annual sales
- Autumn – winter milk
- Beef meat
- Milling wheat
- Rye

FIGURE 3.1 - MAIN REPRODUCTION PERFORMANCES OF THE TWO HERDS (GBFS AND CBFS)



SALE OF PREGNANT COWS GBFS

Prim'Holstein : 1 in 2009 et 1 in 2011
Montbéliarde : 1 in 2011 et 4 in 2012

SALE OF PREGNANTCOWS CBFS

Prim'Holstein : 2 en 2004-2005, 3 en 2005-2006, 1 en 2006-2007, 2 en 2013-2014
Montbéliarde : 1 in 2004-2005, 1 in 2005-2006, 2 in 2006-2007, 2 in 2008-2009, 3 in 2009-2010, 2 in 2010-2011, 3 in 2013-2014

FIGURE 4.1 - CROP ROTATION AND HERD MANAGEMENT

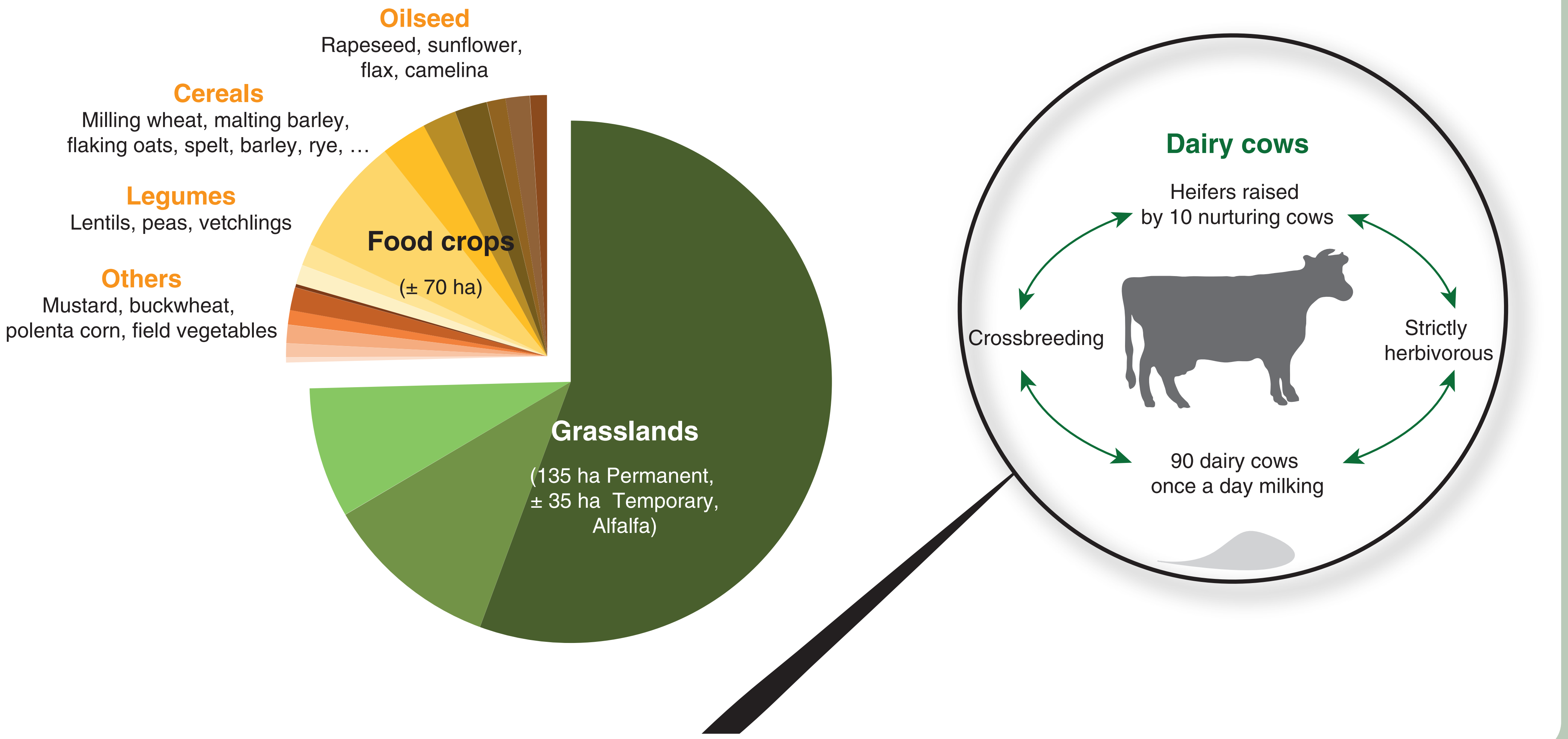


TABLE 5.1 - EVOLUTION OF SOME PERFORMANCES AFTER THE TECHNICAL CHANGES OF 2016

Variables	2015	2016	2017	2018	2019	2020
Permanent grasslands (ha)	135	135	135	135	135	135
Temporary grasslands (ha)	50.4	46.6	34.1	38.8	41.7	43.4
Crops (ha)	56.1	60.1	72.7	67.8	64.8	63.2
Crops for human consumption (ha)	25.1	42.4	72.7	67.8	64.8	63.2
Number of milking cows	100	90	90	90	90	90
Number of suckler cows (A cow feeds 3 calves)	0	3	10	10	10	10
Number of cross-bred milking cows					2	10
Number of replacement heifers	60	55	54	33	23	21
Average age at first calving (in months)	53.5	54.9	47.6	43.2	36	30
Sold milk per dairy cow per year (kg)	5335	3455	3501	3233	3268	3371
Total volume of unmarketable milk (kg per year)	19350	11278	11428	10553	10668	11004
Total volume of unmarketable milk and non-valorised by the calves (kg per year)	7187	4898	6639	6131	6197	6393
Share of non-valorised milk in total volume of unmarketable milk (en kg/an)	**37%**	**43%**	**58%**	**58%**	**58%**	**58%**
Fat content (g/kg)	42.1	45.2	45	44.7	46.9	47.4
Protein content (g/kg)	32.9	35.4	34.9	34	37.2	36.8
Average somatic cell (.103 cell/ml)	204	304	140	223	201	237
% of cows that have calved	60	65	70	68	70	72
Daily weight gain 0-270d replacement heifers fed with milk distributor (in g/d/heifer)	613	683				
Daily weight gain 0-270d replacement heifers fed by suckler cows (in g/d/heifer)		822	910	715	838	965
Number of sold calves	51	43	68	60	34	46
Weight of sold calves (kg)	58	56	53	57	45	49
Number of sold culled cows	48	48	30	57	38	16
Life weight of sold culled cows (kg/cow)	645	644	587	615	668	712
Forage stock at start of winter (tons of DM)	**590**	**810**	**700**	**590**	**540**	**420**

BOX 5 - CROP ROTATION AND FARM STRUCTURE FROM 2016

Variables	2015	2016	2017	2018	2019	2020
Forage stock at end of winter (tons of DM)	235	235	537	347	260	247
Winter consomption of forage	453	342	287	361	305	292
Summer consomption of forage	54.5	46.4	87.7	117.6	89.1	110.8
Number of days where cows cannot graze cause of poor soil conditions (j)	45	75	85	45	65	100
Unmarketable potatoes (tons)	0	0	2,8	2,8	2	1,5
Unmarketable oats (tons)	0	0	5,6	5,5	4	3
Unmarketable barley and wheat (tons)	0	0	12	13	10	7
Contribution to local supply of animal products	Null	Null	Null	Null	Null	Null
Contribution to local supply of vegetable products	Null	Null	field products including potatoes			

BOX 6 - REFERENCES TO GO FURTHER

REFERENCE LIST ON ORGANIC PORK PRODUCTION

- ITAB 2014 – Cahier technique Alimentation des porcins en agriculture biologique.
- IFIP 2016 - Références technico-économiques en élevages Bio.
- IFIP 2008 - Elevages transformant et commercialisant leurs porcs.
- ITAB-IFIP 2016 - Résultats techniques des élevages porcins bio en France en 2014.
- Florence MAUPERTUIS Chambre régionale d'agriculture des Pays de la Loire - Résultats technico-économiques 2015 de l'atelier de naissage plein-air biologique de la ferme porcine des Trinottières.
- Antoine ROINSARD ITAB 2014 - Valorisation des ressources fourragères par les porcins.

REFERENCE LIST ON ORGANIC SHEEP PRODUCTION

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MIX-ENABLE

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