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AGRICULTURE & INNOVATION



EIP-AGRI Focus Group

Mixed farming systems: livestock/cash crops

STARTING PAPER

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1. Introduction

1a. EIP-AGRI Focus Groups

EIP-AGRI Focus Groups (FG) collect and summarise knowledge on best practices in a specific field, listing problems as well as opportunities. They take stock of the state of play in research and practice and highlight possible solutions to the problems identified. Based on this, the Focus Groups suggest and prioritise innovative actions. They identify ideas for applied research and for testing solutions in the field, involving farmers, advisers, the industry and other stakeholders, and propose ways to disseminate good practices. Focus Group results provide new and useful ideas to solve practical problems and start new Operational Groups or research projects.

Please see the [EIP-AGRI brochure on Focus Groups](#) for more information.

1b. The aim of the EIP-AGRI Focus Group on mixed farming systems

As stated in the call text, this Focus Group will address the following issue ‘How to develop livestock/cash crop interactions and promote their benefits as a sustainable alternative to farm or territorial specialisation?’ by carrying out the following activities:

- Identify, describe with adequate examples and compare different combinations of livestock/cash crop systems both at farm and/or territorial level. Provide examples of different mixed agricultural systems other than livestock/cash crops.
- Where relevant and possible, describe environmental, economic and social impacts produced by the (re)-introduction of mixed systems into specialised farms/territories.
- Analyse cases of re-introduction of mixed farming at farm and/or at local level: what made it possible? What stopped the process? Lessons learnt.

- Identify remaining research and innovation needs and provide ideas for Operational Groups and other innovative projects.

The purpose of this starting paper for the Focus Group on mixed farming systems is:

- To establish a common understanding about the scope of the Focus Group and its objectives.
- To identify key questions for discussion with the Focus Group including:
 - a) Identifying and describing relevant case studies of maintenance/reintroduction of mixed farming systems combining cash crops and livestock, on the farm and local levels.
 - b) Suggesting priorities for practical innovations and research needs to maintain or reintroduce mixed farming systems.
 - c) Where relevant and possible, outlining environmental, economic and social impacts produced by the (re)introduction of mixed systems into specialised farms/regions, based on the case studies.

This starting paper introduces different topics for discussion during the Focus Group meetings. The key questions listed above will be presented in more detail in the following sections. The starting paper provides a preliminary outline of existing knowledge to be shared with and complemented by the Focus Group experts.

1c. Background information for the EIP-AGRI Focus Group on mixed farming systems

i) A worldwide renewed interest for mixed farming systems, economic and environmental advantages

This Focus Group will take stock of the state of play concerning mixed farming systems integrating cash crops and livestock in Europe. The specialisation of farming systems has led to drastic consequences, including: pollution due to an excess of manure and slurries, dependence on external inputs and fodder/feed, loss of biodiversity, lower resilience to climate and market changes. These negative impacts are mainly linked to the separation of livestock rearing and crop cultivation both on the farm and the local level.

Integrating crops and livestock may be one way to limit these negative impacts while maintaining agricultural production. In mixed farming systems, different agricultural practices are combined to optimise resource efficiency, reduce and re-use waste, reduce dependency on external inputs and increase farm productivity and resilience by diversifying the sources of income. A real integration between cash crops and livestock would also include the use of cereals and grasslands for animal feeding and in return the use of organic manure for fertilisation. Farmers need to develop specific skills and practices to achieve this coordination between crops and livestock.

Despite a renewed interest worldwide in mixed farming systems, these systems are still declining in Europe.

ii) A broad definition of mixed farming systems

A number of different mixed farming systems are currently used or have been used in the past. Mixed farming systems are commonly defined as *“the association of crops and livestock in a coordinated framework, more often at farm level, even if the association can be considered at regional level”*¹. This definition considers the whole scale of mixed farming systems, even those with a low integration of crops and livestock.

To come to a better understanding of mixed farming systems for this Focus Group, we have listed and analysed several current existing definitions. [Appendix A](#) compiles different definitions of mixed farming systems, from the farm to the local level. As Appendix A shows, there is no current precise definition of mixed farming. The definitions vary according to the context (research, policy, advisory). Policy tends to consider economic aspects; the European Commission for instance uses the percentage of Standard Gross Proceeds

¹ (Seré et al., 1996)

linked to livestock or crops to define mixed crop-livestock systems. The FAO also takes the agricultural criterion into account and states that for mixed systems a minimum quantity of the animal feed used should be produced on-farm. Research studies are more focused on agricultural practices to characterise mixed systems.

The definitions commonly used in Europe differ from American ones². Whereas American researchers consider “integrated crop-livestock systems” with an explicit focus on integration between crops and livestock, European research studies use the terms “mixed systems” or “mixed farming systems”³. They therefore include all farming systems involving both cash crops and livestock in their definition of mixed farming systems even when the agricultural practices do not directly connect crops and livestock.

At first, mixed farming systems were only considered at the farm level. The lack of skilled labour favoured on-farm specialisation whereas mixed farming systems required a large workforce to manage both crops and livestock. So, we began to think about mixed farming systems at the local level, i.e. through exchanges between existing specialised farms. The [EU FP7 CANTOGETHER project](#) introduced the concept of local mixed farming systems, which include exchanges between specialised crop and livestock farmers⁴. This option can provide local environmental benefits for soils and biodiversity without the need to reintroduce crops or livestock on already specialised farms.

For this Focus Group, the definition of mixed farming systems which was chosen is one which would cover all the potential types of integration between cash crops and livestock from an economic and an environmental point of view. For these reasons the starting paper outlines a **working definition of mixed farming systems for the FG** as follows:

The mixed farming systems considered by this FG are systems including at least one type of cash crop and one type of livestock production. They will be considered at farm and at local level, as a combination of specialised farms exchanging resources between them. We will neither consider systems based on agroforestry or sylvopastoralism nor autonomous livestock system using crops only for animal feeding.

The Focus Group will work on the combination of livestock and cash crops that can enable European agriculture to become more resilient and environmentally-friendly without neglecting farm competitiveness.

2. Examples of successful mixed farming systems combining crops and livestock

The basis for discussion at the first Focus Group meeting will be case studies of successful mixed farming systems where farmers’ practices are adapted to, and work well in the local context. These will be presented and discussed by the Focus Group experts. The examples presented below are intended to inspire and lead to further examples from all over Europe. The homework document explains how the experts are to present these examples.

The working definition of the Focus Group on mixed farming systems includes a large diversity of farming systems across Europe. Some have existed since the 1950s⁵; others have been recently reintroduced⁶. As stated above, the Focus Group will explore the integration between crops and livestock on both the farm and local level.

² (Hendrickson et al., 2008 ; Russelle et al., 2007)

³ (Ryschawy et al., 2013 ; Wilkins et al., 2008)

⁴ (Moraine et al., 2014)

⁵ (Ryschawy et al., 2013)

⁶ (Moraine et al., 2014)

Within the large diversity of mixed farming systems, different levels of integration can be observed, ranging from coexistence of separate farm units to clear synergies between crops and livestock, such as when animals feed on crop residues, and the manure is used to fertilise the crop fields. The simple coexistence of farm work units or specialised farms interacting through market mechanisms seems not to be a relevant level of integration to provide environmental benefits, for instance biodiversity maintenance, soil quality improvement, recoupling Nitrogen and Carbon cycles, ...). Specific agricultural practices that create synergies between crops and livestock management will allow farmers to really benefit from the agronomic potential of mixed farming systems. It will be important to describe how crops and livestock are integrated in the case studies

To help us describe successful options taking account of economic, environmental and social aspects, we will consider concrete case studies. These examples will be a practical basis to understanding which associations of specific local conditions and combinations of agricultural practices are currently successful across Europe. Two categories of mixed farming systems could be considered here: i) mixed farming systems which have been maintained over time and; ii) reintroduced mixed farming systems. The following examples provide an illustration of these two different types of mixed farming systems.

An example of maintaining mixed farming at the farm level

Maintaining autonomous cattle-cash crops farms in difficult soil and climatic conditions.

At the farm level, successful examples of mixed farming systems have been maintained since the 1950s in South-western France in the French Côteaux de Gascogne. In this area with natural constraints, due to the type of soils, steep slopes of up to 60% and the climatic conditions, agricultural specialisation has been limited. Half the existing farms in the area are still mixed crop-livestock farms. These farms integrate i) grazing beef cattle fed through grazing and crops produced on-farm and ii) cash crops. The farms may include complementary livestock production (i.e. ducks or pigs). Local farmers have maintained their farms through successful strategies to limit inputs, such as achieving autonomy in herd feeding and fertilising, through crops-livestock interactions. They are involved in a participatory research programme involving local advisers and researchers to help them define the successful practices to maintain their farms. As an output of this collaborative work, they have diversified their rotations to include legumes, other crops for animal feed and cash crops. In particular, sowing legume intercrops to achieve feed autonomy for the herd is a relevant agroecological option.



An example of the reintroduction of mixed farming at the local level

Reintroduction of mixed systems through exchanges between already specialised farmers.

At the regional level, specialised crop farmers from the Tarn-Aveyron Basin in South-western France have developed exchanges with local livestock breeders. To limit their dependence on the global market and their impact on the environment, they developed this collaboration to: i) diversify their rotations according to local livestock farmers' herd feeding needs and; ii) benefit from the manure produced by the herds to improve the quality of their soils in the long term. They are now organising participatory meetings with their advisers and local researchers to decide how to organise themselves collectively to make the integration between

specialised farms work. For instance, including legumes in their rotations would be a new option as they would be able to sell the forages to livestock breeders.



Discussion questions:

Which successful examples of cash crop-livestock associations exist both on the farm level and the local level?

3. Opportunities and barriers for maintaining or reintroducing mixed farming systems

The aim of this section of the starting paper is to provide the context for the Focus Group's discussions on: i) opportunities allowing farmers to maintain their mixed farming system and the limiting factors they may encounter; ii) strategies to benefit from opportunities and overcome limiting factors for the success of mixed farming systems; iii) potential innovative actions and gaps for further research. For this purpose, we will first propose a list of factors influencing farmers in their choice and then provide some examples of opportunities and barriers in the cases introduced in Chapter 2.

3a. Factors influencing the development of mixed farming systems

Several factors can influence the success of mixed farming systems: either creating barriers or generating opportunities. Three major types of factors are known to influence the maintenance of mixed farming systems, namely: i) the general economic and political environment, including global markets and CAP policy; ii) the farm structure, including land, livestock unit size, workforce available; and iii) the regional location, including local markets and advisory services⁷.

An example of factors influencing the maintaining of beef cattle-cash crops farms in Southern France.

In the French Côteaux de Gascogne, the trend of farm enlargement, modernisation and specialisation of livestock can be partly explained by large effects of the Common Agricultural Policy (CAP) and the globalisation of markets⁸:

*- The year 1970 marked the beginning of the general process of specialisation and modernisation of local agriculture **under the influence of markets and CAP policy**:*

⁷ (Veysset et al., 2005)

⁸ (Ryschawy et al., 2013)

- **Global markets** favoured cash crops, with high prices for cereals. **The first pillar of the CAP policy** helped investments to modernise agriculture such as irrigation and land management actions, even if the agro-environmental subsidies of **second pillar of CAP policy** encouraged farmers to maintain grasslands and therefore livestock on their farm.

- CAP aimed to support European farmers' incomes and rural development through direct subsidies. Farmers were financially encouraged to increase production and to choose a specific market sector to benefit from economies of scale through specialisation.

- **The farm structure**, including farm size, number of workers and buildings available, influences the choices of farmers. Among other factors, the land they have influences their land-use decisions and labour availability could limit the maintaining of mixed farming systems.

- **The local market context** largely influences production orientations, since it includes local options for selling agricultural products.

- The demand for weanlings from the Italian market or the high price for cash crops combined with the implementation of subsidies from the CAP encouraged some mixed farmers to specialise in one specific work unit (either in cash crop, or in a specific livestock production such as beef cattle production).

- Small livestock production declined, and specialised meat or dairy breeds largely replaced local breeds to produce more appropriate weanlings for the Italian market, or monogastrics or to increase milk or egg production.

3b. Opportunities and barriers for mixed farming systems

The factors mentioned above have an impact on the context, but most of the time farmers cannot influence them directly. Farmers can however find ways to adapt to the context and make their systems successful and benefit from the opportunities or overcome certain barriers created by these factors. **The focus of the discussion in our first Focus Group meeting will be on opportunities/barriers to maintain/reintroduce mixed farming systems and how to deal with them.** Below, several examples of opportunities and barriers are presented. These are to be complemented based on the Focus Group discussions. Subsequently, the Focus Group will discuss ways to promote opportunities and overcome barriers.

For instance, a major barrier for the adoption of mixed farming systems is the commercial barrier. Farmers have few opportunities to sell non-classical crops. Apart from the main crops (maize, wheat, sunflower, soybean, ...), markets generally offer few options to sell other crops. The limited knowledge combined with low opportunities to commercialise uncommon crops is therefore clearly limiting their use. To help farmers to (re)adopt or to maintain mixed farming systems, we need practical recommendations on how to grow alternative crops, the yields to be expected and how to include them strategically in crop rotations, research on the types of variety and the conception of new systems and relevant advice on technical practices needed to include uncommon crops in farming systems. A specific effort on advising is needed to develop the skills of technicians to help farmers to integrate crops and livestock. For instance, the use of diverse and diversified crops (buckwheat or developing complex mixed crops) could be studied and encouraged by i) technical references based on research and practical results, ii) specific commercial options that should be explained to farmers to help them adopt new crops. A parallel can be made concerning livestock production and the low diversification of products used in animal feed.

An example of maintaining of mixed farming systems at the farm level

Maintaining autonomous cattle-cash crops farms in difficult soil and climatic conditions

Drivers: In the French Côteaux de Gascogne case, global markets and CAP orientations favoured the specialisation towards cash crops, even though the agro-environmental subsidies of second pillar of CAP policy encouraged farmers to maintain grasslands and therefore livestock on their farm. Regional location has been

an important factor in maintaining mixed farming systems. Crop specialisation has been limited in this area due to upland, and difficult soil and climatic conditions.

Opportunities: *Considering the existence of these factors, farmers acted specifically to maintain their mixed farming systems. They maximised their on-farm autonomy to maintain their mixed farms. Farmers adapted in particular their practices by diversifying their crop rotations to benefit from the agro-environmental opportunities of the second pillar of the CAP and address the global market orientations. Developing forage intercrops including legumes is a successful practice that allows local farmers to benefit from on-farm produced herd feed while improving soil quality.*

Barriers: *A major barrier in the area is the low availability in staff, largely needed to conciliate both cash crops and livestock units. Local farmers have found new practices so that busy periods for each of the units do not happen at the same time or they have staff working for both farms at the same time.*

An example of reintroduction of mixed farming systems at the local level

Reintroduction of mixed systems through exchanges between already specialised farmers.

Drivers: *In the French Tarn-Aveyron Basin, the farmers had already specialised their farms due to the above mentioned drivers: i) global markets and CAP policy already and ii) a favourable soil and climate context with no slopes allowing them to get high yields in the major cash crops (cereals, sunflower, soybean). This context allowed them to specialise in cash crops if they wanted.*

Opportunities: *The farmers found an opportunity through collective organisation. They reintroduced mixed farming systems in integrating crops and livestock at the local level, through exchanges of crops, straw and organic manure. This integration had both economic and environmental advantages, while not being threatened by the lack of agricultural personnel in France. The specialised crop farmers and livestock keepers have organised their land-use together to achieve exchanges of crops and manure. They are then more autonomous on a collective level but do not need more labour to achieve the work on their own farms. They are therefore less dependent on the local markets as they can diversify the crops produced to adapt to livestock farmers' needs.*

Barriers: *A major barrier is logistics. Farmers have to deal with the storage of crops and the transportation of manure, straw and crops that is both an economic and an organisational barrier. Their decisions on land-use should be collective and even if a crop farmer wanted to readjust it according to the climate, he would have to discuss with the livestock keepers first to adapt to their needs for the herd feed.*

Discussion questions:

What opportunities and barriers can enable/hamper the maintenance or reintroduction of mixed cash crop-livestock farming systems both at the farm and territorial level?

What innovative solutions and strategies can be put in place to address them? By whom?

Which technical gaps and research needs should be covered to help farmers succeed in mixed farming systems? What support is needed?

4. Economic, environmental and social impacts of mixed farming systems

Mixed farming systems are expected to provide economic, environmental and social benefits. For this reason, mixed farming systems are regaining a worldwide interest⁹. Mixed crop-livestock systems are the highest level of integration among agricultural systems. One of the specific questions for the Focus Group is: 'Where relevant and possible, describe environmental, economic and social impacts produced by the (re)-introduction of mixed systems into specialised farms/territories.'

One way to allow this to be done more systematically could be by developing simple indicators that can enable farmers to self-assess their performance and that can be used to determine the economic, environmental and social impacts of mixed farming systems. Such indicators are needed to evaluate the mixed farming systems in line with their supposed positive impacts on economic, environmental and social sustainability. Already existing sustainability indicators are mostly conceived for specialised farms and not easily usable by all farmers for self-assessment. A specific easily-applicable indicator framework should be defined to consider these three sustainability aspects and evaluate the real benefits of mixed farming systems. This does lead to the question why farmers would be interested to do this. **It is expected that the second meeting of the Focus Group will address these questions.**

Below, some examples of environmental, economic and social benefits of mixed farming systems are presented to help start the Focus Group discussions. Ideally, the case studies should be complemented with this type of information where possible.

On the environmental side, the interrelations between crops and livestock allow the mixed system to improve nutrient cycling. Mixed farming systems are in particular supposed to provide essential ecosystem services; such as CO₂ sequestration, soil fertility, water quality. Mixing crops and livestock allows re-coupling the nitrogen and carbon cycles, increasing CO₂ sequestration through the use of grasslands and increasing soil quality through the diversification of rotations and the use of organic manure. Moreover, the diversification of rotations including cash crops, crops and grasslands to feed the animals increases landscape heterogeneity, which has a positive effect on biodiversity.

On the economic side, mixed crop-livestock systems generate higher economic efficiency in saving production costs through complementarities between crops and livestock¹⁰. For example, the use of organic manure will limit the need in mineral fertiliser inputs; the recycling of crops, crops residues and straw will limit feed inputs. Economies of scope occur as mixed crop-livestock systems reduce their production costs through combined elaboration of products¹¹. Diversifying production is also a way for farmers to reduce risks with respect to market fluctuations¹². In a same area of South-western France, fluctuations of crops or meat/milk markets had less impact on mixed farming systems that were selling at least two different products rather than one¹³.

Social aspects such as labour organisation problems or the level of technical skills required to manage both cash crops and livestock are underlined as key factors to be addressed. In this respect, for example, the integration at the regional level is seen as a success factor to overcome a lack of staff encountered at the farm level. Work organisation and lack of staff are limiting the sustainability of mixed farming systems at the farm level, social aspects should be considered through relevant indicators and not only based on economic and environmental aspects as it is often the case.

An example of maintaining mixed farming systems at the farm level

⁹ (Lemaire et al., 2015; Ryschawy et al., 2013; Schiere and Kater, 2001)

¹⁰ (Wilkins, 2008)

¹¹ (Vermersch, 2007)

¹² (Russelle et al., 2007)

¹³ (Ryschawy et al., 2012)

Maintaining autonomous cattle-cash crops farms in an area where climate and soil are not ideal for agriculture

At the farm level, most indicators are linked to either livestock or cash crops but not both of them, such as yields, mineral fertiliser amount and costs for cash crops and feed inputs, proportion of permanent grasslands, forage needs for livestock. To evaluate the success of mixing cash crops and livestock, indicators are needed: i) to help farmers self-assess the impacts of their farms and ii) to help researchers lead multicriteria assessments of mixed farming systems. For instance, the proportion of crops used to feed the animals, the saving in mineral fertilisers, or farm-gate nitrogen balances could be interesting indicators. Concerning social aspects, knowledge is needed for farmers to integrate crops and livestock through relevant practices, the workforce dedicated to integrate work conditions should be evaluated too.

An example of reintroduction of mixed farming systems at the local level

Reintroduction of mixed systems through exchanges between already specialised farmers.

At the local level, the challenge is significant as there are new indicators to consider to quantify the exchanges, in addition to the above mentioned farm-gate indicators. To integrate crops and livestock through exchanges, farmers need to consider new logistics aspects such as collective storing of crops and manure and transport distance and means. Social aspects should be considered too: simple social indicators such as autonomy in decision should be added to classical indicators considering autonomy in inputs for instance.

Discussion questions:

What are the expected impacts of reintroducing mixed farming systems into specialised farms/territories?

Which existing indicators could be of interest to consider economic, social and environmental impacts of mixed farming systems? Which indicators are missing?

5. Next steps

The first Focus Group meeting will be held end of November. Here the Starting paper and the case studies provided by the Focus Group experts will be discussed. The questions provided at the end of Chapters 2, 3 and 4 will help guide the discussion. These discussions should contribute to the Focus Group report by:

- Identifying, describing and comparing different combinations of livestock/cash crop systems at farm and local level;
- Describing environmental, economic and social impacts produced by the (re)-introduction of mixed systems into specialised farms/territories;
- Analysing cases of re-introduction of mixed farming at farm and/or at local level: what made it possible? What stopped the process? Lessons learnt;
- Identifying remaining research and innovation needs and provide ideas for Operational Groups and other innovative projects.

It may be difficult to thoroughly address all these points during the first meeting. Therefore the Focus Group experts will be requested to provide further contributions between the first and second meetings. These will be collected and circulated for further discussion at the second meeting. The second meeting should result in an outline and content for the Focus Group report, which should include the Focus group answers to the general and specific questions listed at the start of this document. The date for the second meeting will be agreed upon during the first meeting.

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APPENDIX A. Definitions of mixed farming systems relevant for the Focus Group

Mixed farming systems have been defined in many ways. This appendix presents a summary of the most common definitions currently found in literature. It illustrates the context of the definition chosen for the Focus Group

Commonly, mixed farming systems are defined as "the association of crops and livestock in a coordinated framework, more often at the farm level, even if the association can be considered at the regional level" (Schiere and Kater, 2001).

European definitions

European research studies use the terms "mixed systems" or "mixed farming systems" to consider all farming systems involving both crops and livestock (Havet et al., 2014; Schiere and Kater, 2001; Wilkins 2008). The definition is large and includes all systems having at least one livestock unit and some crop production, dedicated either for cash crops or for animal feeding only. A combination of crops and livestock is considered but not clearly defined.

Mixed farming systems were first considered at the farm level (Ryschawy et al., 2014; Schiere and Kater, 2001). Through the EU FP7 CANTOGETHER project, the concept has been more recently enlarged to local or district level, considering exchanges between crop farmers and livestock keepers within a small area (Moraine et al., 2014). Moraine et al., 2014 considered that "animals represent groups of animals (e.g. species, breeds, age groups), while crops (cash crops, forage crops) and grasslands (cut/grazed, permanent/rotated) represent

a range of species or species mixtures. The three components are interconnected to differing degrees. Direct interactions occur in space, either simultaneously (e.g. grasslands grazed by animals) or over time in the form of a sequence (e.g. temporary grasslands could be integrated in crop rotations). Indirect interactions correspond to flows of material (e.g. manure) or energy. By varying the size and degree of overlap of the three components, it is possible to represent the structure of a wide range of crop–livestock systems.”

Specifically, in European statistics, Standard Gross Proceeds is used to define mixed crop-livestock systems: more than 1/3 of Standard Gross Proceeds should be obtained through cash crops and more than 1/3 of Standard Gross Proceeds should be obtained by livestock production. This definition is used to classify farms within a specific class by the Farm Accountancy Data Network (FADN). FADN or national databases such as AGRESTE for France are considering mixed farming systems according to these thresholds of Standard Gross Proceeds considering both the economic weight of cash crops and livestock at the farm level but no integration between them.

Non-European definitions

The FAO considers mixed farming systems as “The best known form of mixed farming is when crop residues are used to feed the animals and the excreta from the animals are used as nutrients for the crops.”

Mixed farming is considered by the FAO as probably the most benign agricultural production system from an environmental perspective because it is, at least partially, a closed system (Schiere and Kater, 2001). The waste products of one enterprise (crop residues), which would otherwise be loaded on to the natural resource base, are used by the other enterprise, which returns its own waste products (manure) back to the first enterprise. Because it provides many opportunities for recycling and organic farming and for a varied, more attractive landscape, mixed farming is the favourite system of many agriculturalists and environmentalists.

More precisely, Seré et al. (1996) defined mixed farming systems as “having more than 10 percent of the dry matter fed to animals coming from crop by-products or stubble; or where more than 10 percent of the total value of production comes from non-livestock farming activities.”

American research studies use the term “integrated crop-livestock systems” with the specific acronym ICLS (Franzluebbers et al., 2014; Hendrickson et al, 2008). The integration between crops and livestock is better explained here and spatially explicit. For Hendrickson et al. (2008): “Integrated agricultural systems have multiple enterprises that interact in space and time, resulting in a synergistic resource transfer among enterprises. Dynamic-integrated agricultural systems have multiple enterprises managed in a dynamic manner”.

Franzluebbers et al. (2014) underlined that ruminants associated with arable cropping when associated spatially and temporally with arable cropping is an essential foundation for integrated crop-livestock systems (ICLS), either within single farms or among specialised farms within a region. The farm and landscape level were both considered at least theoretically since Russelle et al. (2007) introduced the local level.