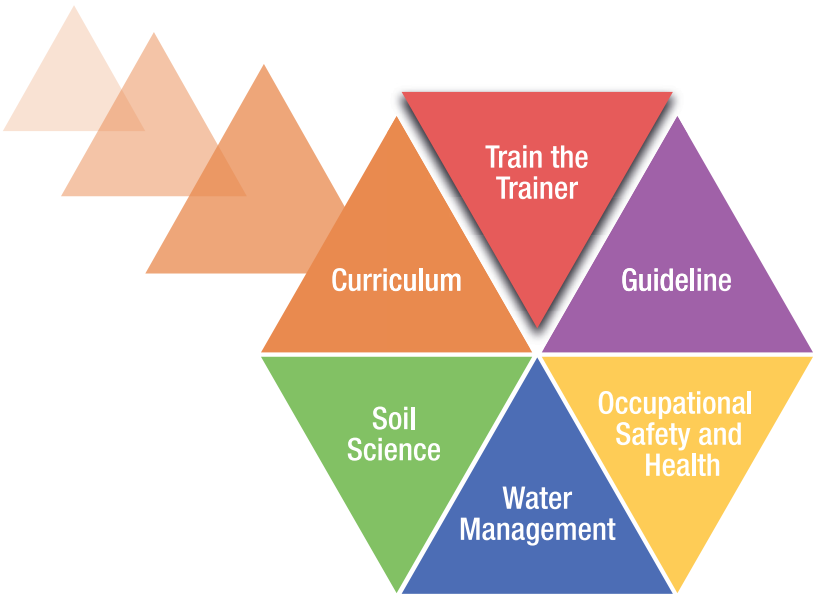
AGRITRAIN

Training Curriculum

Training for Teachers and Trainers in the Field of Sustainable Development



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PECO Institut e.V.
Luisenstr. 38
D – 10117 Berlin
www.peco-ev.de

Project Consortium AgriTrain
PECO Institut e.V. / Lead Partner / www.peco-ev.de
Humboldt-Universität zu Berlin / www.hu-berlin.de
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Content

Introduction

European Agriculture is facing major challenges. In addition to the need to produce high-quality food, it has to meet increasing demands of nature conservation and environmental protection, and provide at the same time good and secure jobs. Technological change and advancing digitalization have permeated the work of almost all production sectors, especially in agriculture. Politicians have called for comparable and compatible vocational qualifications - as envisaged in the „Bologna Process“ - and training in accordance with the principles of Education for Sustainable Development and, most recently, an action plan for digital education.

Digital Education Action Plan

The European Commission has adopted a Digital Education Action Plan, which covers 11 action areas to support the use of digital technologies and to promote the development of digital literacy in education. The Action Plan focuses on concrete implementation and the need to stimulate, promote and expand meaningful use of digital and innovative forms of teaching. The action plan names three priorities:

1. Making better use of digital technology for teaching and learning
2. Developing relevant digital competences and skills for the digital transformation
3. Improving education through better data analysis and foresight

The Digital Education Action Plan can be freely downloaded from: https://eur-lex.europa.eu/legal-content/DE/TXT/?uri=COM%3A2018%3A22%3AFIN

Educational planners, trainers and instructors are thus constantly facing new challenges. On the one hand, always new content has to be taught, and on the other hand, they are encountering increasingly heterogeneous groups who need innovative methods. There is currently no broad discussion about how those requirements may be implemented in practical and theoretical training. The experiences of the preceding project AgriSkills „An educational package for more sustainability in agricultural animal production“ (www.agriskills.eu) showed that it is crucial for a reorientation of vocational training to develop together with teachers and trainers innovative practical models in which these different requirements can be implemented.

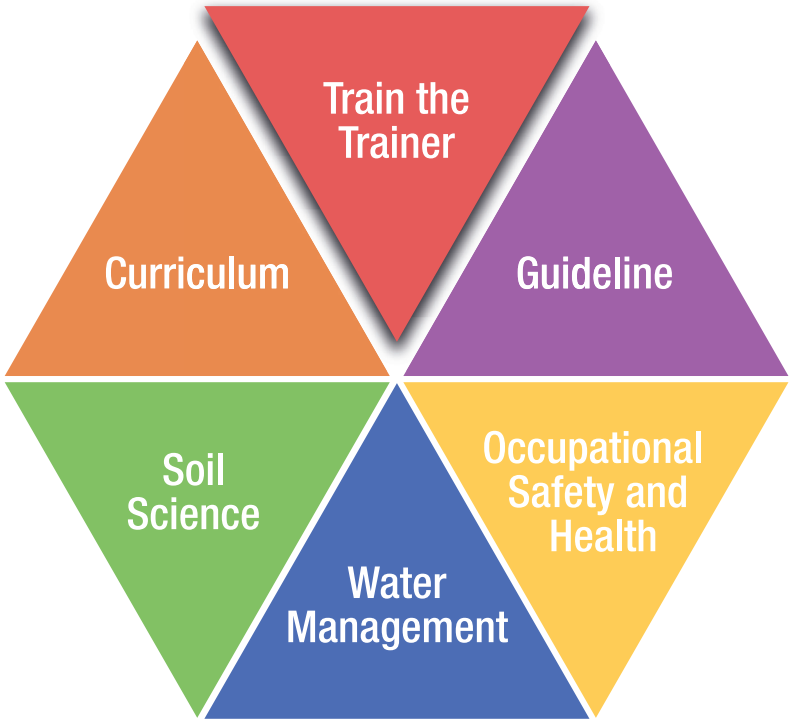
In the AgriTrain project a pedagogical concept as a guideline for teachers, students and trainers was developed together with partners from four European countries with different educational systems and based on the different didactic and methodological approaches that are prevalent in these countries. The concept can be applied both in schools and in in-company training and ideally may be used in an integrative manner in schools and partner companies. After the development of the pedagogical concept, various examples of places of learning emerged from and in the practical application of the concept. In the following, a choice of six case studies is presented. The pedagogical concept is to be implemented with a focus on chosen essential topics. In order to emphasize the European context, the thematic fields soil, water and human work were chosen. They stand for important basic principles of agriculture and are regulated by uniform standards in European guidelines. In the field of human work these are occupational safety and health issues, but also questions of digitization.

It thus became clear that the partners chose different approaches due to their different origins. Concretization was achieved in a joint discussion, taking into account the key data of the pedagogical concept. The pedagogical concept was applied in practice in two transnational trainings. The experiences and the discussion with the participants were incorporated into the final version of the training curriculum.

The curriculum is considered a practical and methodological supplement to the *Guideline - Vocational Training for Sustainable Development*. In addition to the agricultural mission statement VETSD, the Guideline provides various test criteria for the ecological, economic and social dimensions by defining appropriate indicators.

In this way, teachers and in-company trainers can test teaching materials for sustainability and criteria of systemic thinking. In addition to the *Training Curriculum* presented here and the Guideline, the Strategic Partnership has developed supplementary materials such as the *explanatory video „Resilience of agroecosystems“*, project posters as well as the „Pedagogical Concept“ and other implementation tools.

All material is freely available at www.agri-train.eu



1 Bringing sustainability into practical and action-oriented learning

The AgriTrain project aims to promote sustainability competencies for teachers and vocational trainers in agriculture.
The implementation of the concept of sustainability in work life requires a vocational education and professional training that is oriented towards sustainability goals and the development of sustainability competencies. Teachers in vocational schools as well as in-company trainers and persons in similar functions in vocational education and training across the different education systems in Europe need competences of vocational education and training for sustainable development in order to and support trainees in the development of sustainability competences.

“Knowledge” about SDGs (Sustainable development goals) or of overarching sustainability issues alone is insufficient to achieve in general actions that are oriented towards global sustainability goals in business and society.
Comprehensive sustainability competences, i.e. beyond the possession of the relevant knowledge also the ability and the will (volition) to act for a development towards sustainability, are necessary for transformation of society and economy.
Education for Sustainable Development (ESD) must therefore specifically promote the development of sustainability competences that can be applied in the world of work, since the place for the decisive implementation of a sustainable transformation process is at work. Vocational Education and Training for Sustainable Development (ESD) is generally geared towards action competences and has a long-term influence on the development of the economy.
Our AgriTrain project focuses on the development of sustainability competencies in vocational education and training in agriculture. Some aspects of sustainability are already immanent in agricultural professional activities.
A cultivation of the land that does not destroy it for future use is an obvious goal. However, the concept of sustainability goes beyond the constant provision of the physical product, such as crops. Agriculture is also very closely linked to non-marketable and often intangible products and ecosystem services.

Since sustainability-oriented action must not end at the borders of the individual property of business, a comprehensive understanding of the effects of one‘s own action is required. This includes effects

- which go beyond the horizon of one‘s own economic interests
- which cross time horizons beyond one’s own lifetime
- which are not clearly attributable to one’s own action

The application of sustainability competencies in vocational action can be illustrated particularly well using the model of complete action[1].
The complexity of the possible effects of a certain action in an ecosystem as well as in economy and society is taken into account in models of systemic thinking[2,3].
Place- and object-based methods are particularly suitable to develop sustainability competencies taking into account of the complete action and systemic thinking in the field of agriculture[4,5,6].

The Model of Complete Action and Vocational Education for Sustainable development

The model of “the complete action”[7] provides a central orientation aid in the examination of action-oriented teaching and learning in vocational education. It describes an action-oriented learning process as a sequence of phases in which the activities of informing, planning, deciding, executing, controlling and evaluating are carried out as central learning actions.

In „Vocational Training for Sustainable Development“ based on the model of complete action, sustainability aspects must be taken into account across all phases and learning actions described. In agriculture, the consideration of the systems character plays a particularly important role.
A starting point for an appropriate learning activity can be the reconstruction of a „systemic situation“ related to a problem of sustainability. Possible examples could be the assessment of an eroded area or a salinated site or issues of occupational diseases.

The description of the situation and the formulation of possible correlations requires first a collection of **information** on the initial situation as well as about the goal and the conditions under which any action is taken. This ranges from direct observations at the site itself, that may be visual or involve other senses, to online research. In particular, it is important to question what kind of information needs to be collected in order to understand the observed situation. Even in the phase of information gathering, it is important to focus on sustainability issues if, for instance, information on buffer capacities or water storage capacities needs to be collected.
Information can never complete, especially as decisions are made on basis of current data that have an impact on the future, and may therefore take effect under altered conditions, such as changing climate, or in a fauna and flora composed of other species, such as newly arrived and expanding neophytes.

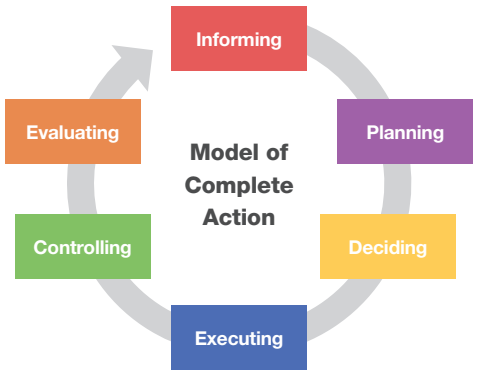


Fig. 1: Model of Complete Action.

In the preparation of a **work plan**, sustainability aspects must be formulated as an overall goal. In a given situation a specific goal may be not only to reduce soil erosion at this point in time, but to prevent it permanently.
In the definition of individual action steps, the respective effects of each individual step on the overall system must be taken into account. At this point, aspects of systemic thinking come into play.

Here, as in a lesson based on the concept of systems thinking, the use of graphic representations is recommended to show the connections, feedback mechanisms, causalities or possible emergent phenomena. Such representations can also be used as an aid to decision-making in the choice of a particular option for action.

Decide: A decision is taken in favor of a particular solution and priorities for certain options are set and risks are weighted. Particularly in a „system“, the decision is a significant challenge in view of possibly incomplete information or developments being projected into the future under uncertainty. In teaching, the decision-making process can be an essential learning act, in particular, when a decision has to be discussed within a group and arguments in favor of or against particular options are exchanges.

Performing the action: The educational focus here is on the „skills“, such as the correct handling of equipment or other resources. With each single step of the execution the basic conditions can change, e.g. by spilling gasoline or spraying agents. At the same time, new aspects could arise in the execution of a certain action, for example if an infestation with a certain pest is discovered during harvest.
In a teaching-learning situation, an option for a particular action may be chosen and this choice can also be justified. In instruction at school however, the actual, real-life execution of that action is often not possible, and even in practical instruction it can often be implemented only to a limited extent.

Control is an essential element of the ‘complete action’ and the learning action based on it. Looking back on the work plan a comparison of target and achievements is made to assess, whether the original goals were indeed achieved.

It is in the nature of things that the actual „greater“ aim of sustainable development lies in an unspecified future, since „sustainability“ refers to a „sustainable“ process that in principle continues for all eternity.

The control therefore refers only to „partial and intermediate goals“ or individual indicators that can be understood as indicators of a successful development towards sustainability of the overall system.

These could be, for example, biodiversity as measured by numbers of native species, water quality or the absence of erosion damage. With regard to the health of workers, data on successfully implemented occupational safety and health measures, prevention, the number of sick days or statements on job satisfaction may be used to monitor success.

An **assessment** completes the „complete” action. In vocational education and training, the development of assessment competences, including the competence to assess one‘s own work in terms of outcomes and processes, is an essential objective. An assessment that is based on clear objectives, such as a defined number of units produced in a certain time or the measurable quality of a product, is comparatively easy to achieve. However, assessment is much more complex if both the product and the sustainability of the production process as well as the sustainability orientation of one‘s own actions need to be considered in the systemic structure of agricultural ecosystems and social dimensions of agriculture.

Definition „Systems thinking”

Systemic thinking takes the systemic character of ecosystems, society and economy into account. This means that in thinking and decision-making processes a system is considered as a whole and the interrelation of different system elements, non-linear relationships and the emergence of unpredictable, emergent phenomena are considered holistically. Systemic thinking helps to make decisions that are effective in the structure of a system, especially when a system - such as an agro-ecosystem - is being interfered with and therefore possible consequences must be considered.

With regard to the requirements of sustainable management in land use, an action, is not „complete“, unless it takes sustainability aspects into account. Sustainability orientated action with natural resources in an ecosystem further requires approaches of systems systemic thinking, given that in agriculture a „system“ is being interfered with.

The planning of individual lessons is particularly challenging, facing a real-world situation in which certain phenomena can occur in various forms that the teacher may not be familiar with, and which is not prepared as a model. Special pedagogical concepts are required which take into account possible information deficits and the imponderables within a system, and thereby enable a complete action as a learning process.

2 Using the training curriculum

This project aims to provide recommendations on how to trigger learning actions that support learners in developing sustainability skills. Such learning actions can be initiated both in in-company practical learning and in the theory-based vocational school. A teacher's or trainer's role as an initiator of learning activities is complex and demanding, in particular in the light of the heterogeneity that is observed in every group of learners. For some learners it may be sufficient to suggest a particularly challenging professional situation to trigger activities that lead to the desired competence development. Other learners however may need additional support and specific instructions and tasks and an appropriate management. Not all learners will at once recognize the underlying complex system of interrelated causes and effects when confronted with a soil profile, an eroded site, a body of water or an employee suffering from an occupational disease. Successful teaching and learning with the aim of developing sustainability-related competences requires a concept of teaching and learning that considers the complexity of vocational learning and that takes into account that...

- learning processes are often non-linear.
- skills, previously acquired qualifications and thinking and working habits of learners are highly diverse
- learning in a vocational context that inseparably linked to work processes and to agriculture and related fields is naturally highly systemic, i.e. a large number of non-linear processes in administration, society and the economy are interlinked and so often lead to barely foreseeable, suddenly appearing emergent phenomena
- vocational training aims at the development of competences, i.e. both the knowledge required to make informed decisions and the skills and willingness to act in a work situation in the chosen profession.

To enable teachers and trainers to develop their own approaches in learning tasks for the development of sustainability competences, a pedagogical concept was developed that focuses on the topics

- **Soil science,**
- **Water management and**
- **Occupational Safety and Health.**

The pedagogical approach is complemented by case studies from the project partner countries in the three areas mentioned above. The case studies provide examples for teachers or trainers to apply the pedagogical concept and to initiate learning activities. The topics can be worked on for two to three days or even several weeks. The sequence of the five-step plan in the pedagogical concept supports the development of a holistic project in the educational institution or training company. Before teachers or trainers-initiated learning processes, general and individual conditions ought to be analyzed and a specific implementation strategy developed.

This requires in particular

- to consider educational systems in participating countries
- to take EU directives and regulations into account
- to check technical conditions and local situations in what is to become the place of learning and the situation, respectively.
- to analyse the target group
- to work out contents specifically for the target group
- assessing methodological options and adapting them to the target group
- adjust material
- to include appropriate ICT measures
- to highlight systemic relationships

Guideline

The materials developed in this project, such as the Explainity video on „Soil resilience of agroecosystems", can be used for further work. Additional resources are provided in the project Guideline.

3 Pedagogical Concept

The AgriTrain pedagogical concept – Instructions for teachers and trainers

Global agriculture is shaped by rapid ecological, economic and socio-political developments. Vocational education and training needs to take account of processes of change and has to prepare future decision-makers and experts for their tasks in forming a sustainability-oriented industry. The development of sustainability competences requires sophisticated learning activities within a technically and methodologically suitable pedagogical concept.

Sustainability Competencies

„By sustainability competence (SCC) [we understand] the sum of cognitive abilities and skills and the associated motivational, volitional and social willingness to solve sustainability-related problems and to shape sustainable development in private, social and institutional contexts“ (WEINERT, 2014).

Based on the concept of green pedagogy of the University for Agricultural and Environmental Education in Vienna , the vocational agricultural pedagogy (vocational action competence) according to Bräuer and the general experience of the AgriTrain project partners in training and education, a pedagogical guide was developed for teachers and trainers in the agricultural and horticultural sector in four European countries.

In the sense of a sustainable education in agriculture and horticulture, topics in soil science, water management and occupational safety and health are taught in vocational training as a basis for dealing with specific aspects of flora and fauna in this occupational field and are focused on here. The pedagogical concept (Fig. 2) suggests a sequence of learning actions that build on each other (Fig. 3).

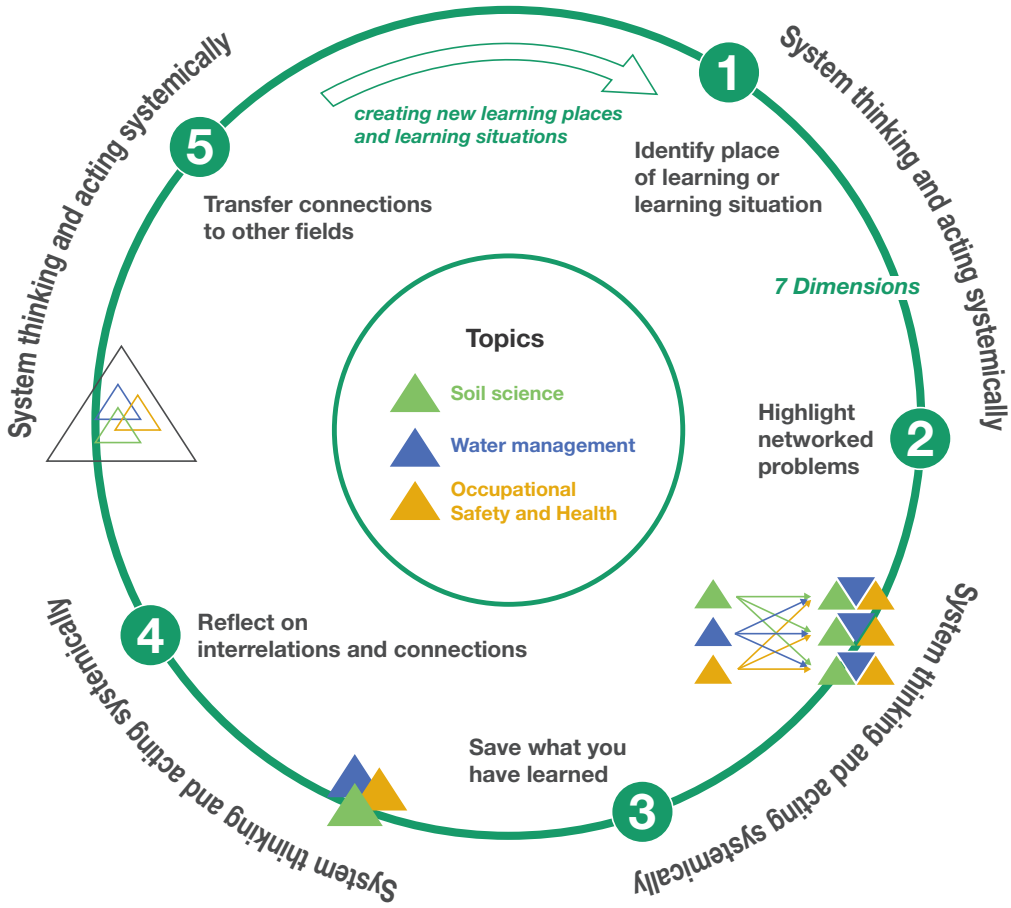


Fig. 2: Pedagogical concept.

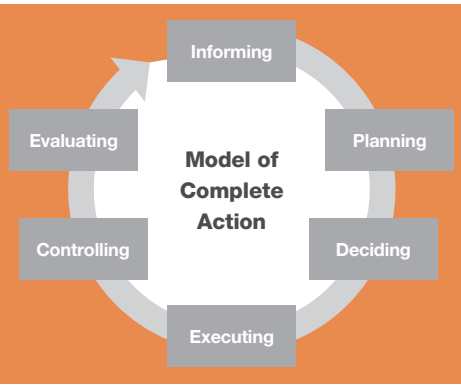


Fig. 3: Complete action with learning actions.
Learning actions are continuous actions that are embedded in a learning process and that are to encourage the learner to pursue independent action. Competence-oriented teaching builds on learning actions as described in the model of the complete action. The complete action includes the learning actions of informing, planning, deciding, executing, controlling, assessing and, again, informing.

The pedagogical concept describes these learning actions and expands them by components of systems thinking and acting in a systemic context. In terms of Education for Sustainable Development, systems approaches are expected to lead to holistic knowledge. The sustainability skills learners acquire enable them to base decisions they take for themselves, others and future generations on sustainability considerations involving ecological, economic and socio-cultural perspectives.

The pedagogical concept is merely a guideline for teachers and trainers for teaching in the sense of VETSD. The following actions of teachers and students can be described:

Trainers or teachers
Understand and apply the pedagogical concept and five-step approach.

Trainers to students
Highlight learning actions, initiate systemic ways of thinking and acting

Students (learner)
Reaching sustainable decisions

The five steps of the concept are the basis for the development of competence from specialist content, learning actions and their methodical implementation.

A five-step procedure:

System thinking and acting systemically

1. **Identify place of learning or learning situation**
2. **Highlight networked problems**
3. **Save what you have learned**
4. **Reflect on interrelations and connections**
5. **Transfer connections to other fields.**

The individual five steps may be understood as corresponding to learning phases. Learning phases are interlinked periods in which learners carry out different learning activities and that were previously planned by teachers in a framework adapted to the target group in an action-oriented manner. It is recommended to apply the concept in its chronological order. However, this may be altered depending on the actual subject and the objective of the learning unit.

The contents and appropriate methods are to be selected by the teachers or trainers at each step in a way that is appropriate for the target group. The use of information and communication technologies (ICT) by learners is to be encouraged. Digital methods such as online research, use of the interactive whiteboard, writing a digital learning diary, use of tablets and smartphones with learning software in the form of quizzes and games, or the creation of learners' own videos and role-play sequences are only a few possibilities to create a modern teaching offer. The AgriTrain Guideline contains reports from the project partners on the use of ICT. The pedagogical concept can be applied in a differentiated way to each learning group and is also transferable to other areas of vocational training. The project partners refrained from dividing up the learning phases and learning activities in terms of time, as this depends on the individual topics, methods and objectives of the learning units.

A pedagogical concept in five steps

1. Identifying places of learning and learning situations

The first step of the „learning location or learning situation" (theoretical or practical) refers to a real, geographically defined place or a fictitious neutral situation embedded in professional practice. This means that the place or situation does not evoke any positive or negative aspects or positive or negative connotation. The learning location or learning situation typical for the occupation is located out of doors in nature (field, forest, green spaces, etc.) or in a building (city, company, school, etc.) The learning location or learning situation may also be generated virtually.

The place of learning or learning situation is determined by directly visible and indirect influences, the so-called dimensions. Here, seven dimensions are distinguished:

- Agro-ecological dimension (environment)
- Cultural dimension (rural area)
- Local dimension (regional - national - global)
- Time dimension (past - present - future)
- Economic dimension (supply - demand/market)
- Insight-generating dimension (sustainable education and development)
- Social-political dimension (integration into the social context)

Every learning location or learning situation is shaped by external and internal factors. These factors also decide on further development, stagnation or regression. The seven dimensions form a framework for teachers to assess external and internal influences.

For a holistic description of the learning location or learning situation, the dimensions can be presented by the teachers or, depending on the time frame and learning level, may be worked out with the learners or by the learners themselves in independent work. The seven dimensions can help the learner to think in a systemic way and to understand interconnections and interrelationships and may encourage acting in a sustainability-oriented manner. In terms of content, the dimensions serve to describe the general status quo of the place of learning and or learning situation and to link facts seen from different perspectives.

2. Highlight networked problems

In the second phase, starting from the learning location or learning situation and the theme, „problems“ are highlighted on basis of the seven interlinked dimensions. Each previously identified place of learning or learning situation can be described as the result of systemic interactions in space and time. The decisive factors that have a negative or positive impact can be named and described by the learners. The main focus is on the acquisition of information. The „problems“ always involve a need for action, which should be highlighted by the learners. Teachers can choose different ways to introduce the learner to one or more of the desired aims.

For further guidance and to introduce the seven dimensions, criteria and indicators are explained in the Guideline.

➡ **Guideline**

Teachers may …

- invite students to decide on the direction of their work by formulating research questions on the place of learning and learning situation
- provide specify questions or assignments for learners
- invite students to prepare and deliver presentations on specific topics
- encourage learners to formulate questions in exploration of a core topic
- motivate learners to explore the learning location or situation, to observe and to collect questions
- Introduce the seven dimensions or have them worked out by the learners in appropriate work assignments
- use ICT and encourage learners to use digital media (e.g. geographic software)

The newly arising or pre-defined questions concerning the learning location or the learning situation can then be worked on in groups, so-called core groups. The focus on the content helps the teacher to structure and define the topic.
One example might be the development of the topic of „Irrigation of fields“. Here, the three individual topics „Underground irrigation“, „Irrigation“ and „Drip irrigation“ are developed by the core groups prior to being brought together and information being shared in new groupings.

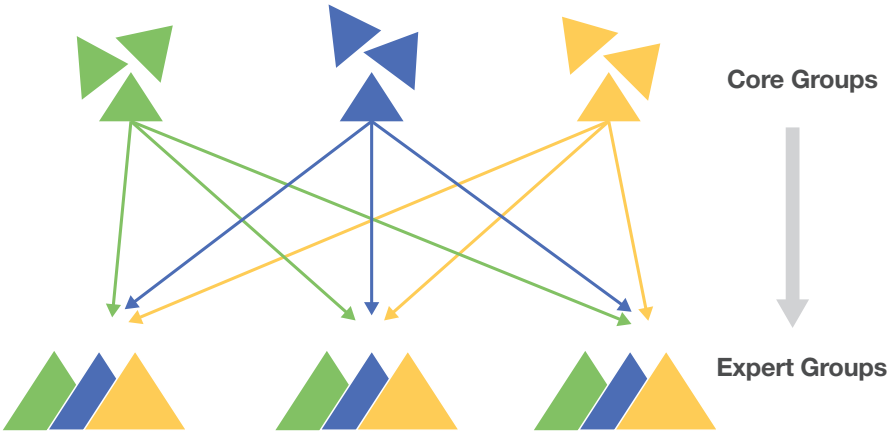
▶ **Methodological options:**

Teachers should, if possible, visit real places or create fictitious places linked to involved businesses or vocational schools and using their grounds. Learners are thus offered a practice-oriented learning situation, either in real-life or virtually, in the classroom.
Some methodical suggestions for the teacher are:

Some methodical suggestions for the teacher are:

- do an outdoor walk (park, terrain, forest, school environment, etc.)
- show a video on the learning location or learning situation
- show pictures, maps (historical and current) or posters
- invite students to collect soil samples from their companies grounds or take them from the school collections.
- have learners read the story of an employee, for example a biologist, gardener, farmer, etc.
- do a GPS hike or „scavenger hunt“, geocaching or a GIS program with learners searching a location using coordinates.

The teacher or trainer decides on appropriate methods depending on the group, content and objective.



Group work:
First, so-called **core groups** are formed. There should be a minimum of two core groups, but there is no upper limit. Each core groups should work on a different aspect or topic. To ensure a fruitful exchanger there should be a minimum of 2 and a maximum of 5 learners per group. In larger groups communication and participation of all in work processes typically turns out to be difficult. Tasks are allocated to the groups by the teacher. A range of different methods should be used to motivate learners. After successful content development in the core groups, groups are rearranged with only one learner from each core group joining each new group. Each new group thus has an "expert" on a given subject who will share his/her knowledge with the other group members. The in-group information exchange can take place in a discussion, an input presentation or a question and answer session. At the end of the exchange there should be a joint product of the **expert groups** e.g. as a lecture, a wall newspaper, a digital or analogue presentation (either digital or analogue), or objects that are created. In this way, the content is saved and can be further developed.

3. Saving what has been learned

Information gathering and clarification of the content is a central element in teaching. It is not sufficient to confront learners with new facts. They also need to secure the content for later use and further development. In the third phase of the concept, the results generated in the core groups are worked on in the new groups. This step can be used by the teachers to check on students' progress or to generate further insights. The students can go back to their previously acquired knowledge, continue their work independently or enquire on further content.

Following the example in step 2, groups are now brought together so that one topic from each core group is brought into the new group. During the exchange on the three topics, important issues are highlighted and included into any product developed in the groups. Learners exercise their ability to transfer from one area of knowledge to another. Teachers may offer support in the form of a worksheet or working protocol.

In businesses, the trainee may interview other employees at different hierarchical levels and different roles and functions in the business. He or she may thus develop into an expert in a specialized topic within his or her training institution or company. In order to stimulate further thought and action processes on the topics, the next step is to critically examine and reflect on the information that was gathered.

4. Reflect on interrelations and connections

In reflection, the newly gained contents and insights on the topics from the learning location/ learning situation and their dimensions should be evaluated. Reflection takes place in two steps: Self-reflection of the individual learner is followed by a group reflection i.e. exchange of thoughts and opinions, positions in the group). In this process, at first personal conclusions can be drawn and then discussed and expanded in the group. Thus, an information network is created, which finally allows all connections, networks and correlations to be uncovered in the plenum and evaluated according to sustainable aspects. External assessments by experts from the individual subject areas of research and business are also useful to broaden learners‘ perspectives. The method of taking up perspectives (learner adopts the role of an outside observer) also broadens the learners’ critical view. Opinion-forming and critical reflection are in the foreground in this learning phase and must / can be methodically guided by the teachers. In terms of methods, digital media or graphic representations in the form of diagrams can be helpful. Students are introduced to possible solutions and learn to act in the sense of ESD.

The Guideline provides more references and background information for transfer to other industries and professional fields. Interdisciplinary approaches enable the transfer of perspectives.

➡ **Guideline**

5. Transfer connections to other fields

After reflecting on the contents, parallels to other professional areas may be drawn. These may be outside the agricultural and horticultural sector. An example presented by the teacher or instructor may initiate such thought processes. Situations from agriculture are often transferable to forestry or horticulture. Situations involving farm animals can be transferred to veterinary medicine, the food industry or other branches of industry in other countries.

A suitable method for documenting this transfer is expected to help learners to understand this content and create awareness that processes can be comparable and transferable. The transfer to other areas creates new places of learning places and learning situations, which can be further processed following the pedagogical concept and illustrate the interconnection of systems.

Systems thinking and acting systemically

Through the transformative analysis of the previously developed and discussed content, new questions arise and individual gaps and prior existing personal patterns of thinking and acting of learners become apparent. Within one topic only a part of the system can be studied, i.e. the complexity of such systems can never be grasped in a holistic manner. Systems of nature-human relationships that surround us usually are insufficiently addressed in terms of content in vocational education and continuing training.

To implement such an educational project, such systems will be explored in the following agricultural and horticultural case studies and developed for use by teachers following the educational concept. The competences of systems thinking and acting are strengthened by means of learning actions that are derived from these examples. Also, learners’ competencies to learner is also to acquires a competence to shape their own learning processes.

4 Case studies for the implementation of the pedagogical concept

The partners in the AgriTrain project have compiled in close collaboration a choice of relevant case studies. In doing so, the different starting conditions of academic theory and agricultural practice in an EU context in the four partner countries Bulgaria, Spain, Germany and Austria became apparent. The following case studies are practical real-world examples. They aim to clarify the concept for teachers and trainers and to stimulate transfer by encouraging teachers and trainers to development their own examples based on their own teaching.
The case studies open with a description of learning situations and places of learning. An illustrative graphic, a description of the associated dimensions and of possible tasks and work assignments are presented. No distinction is made between learning levels. There is no time limitation for learning activities and assignments, as this has to be decided upon by the teachers themselves. In practice, trainers can work with the case studies by adapting them to their own geographical situation and using them for comparison.

Case study:
Water Management in the Werder/Havel region / Germany

1. Identify the place of learning or learning situation

1.1 Description of the place of learning

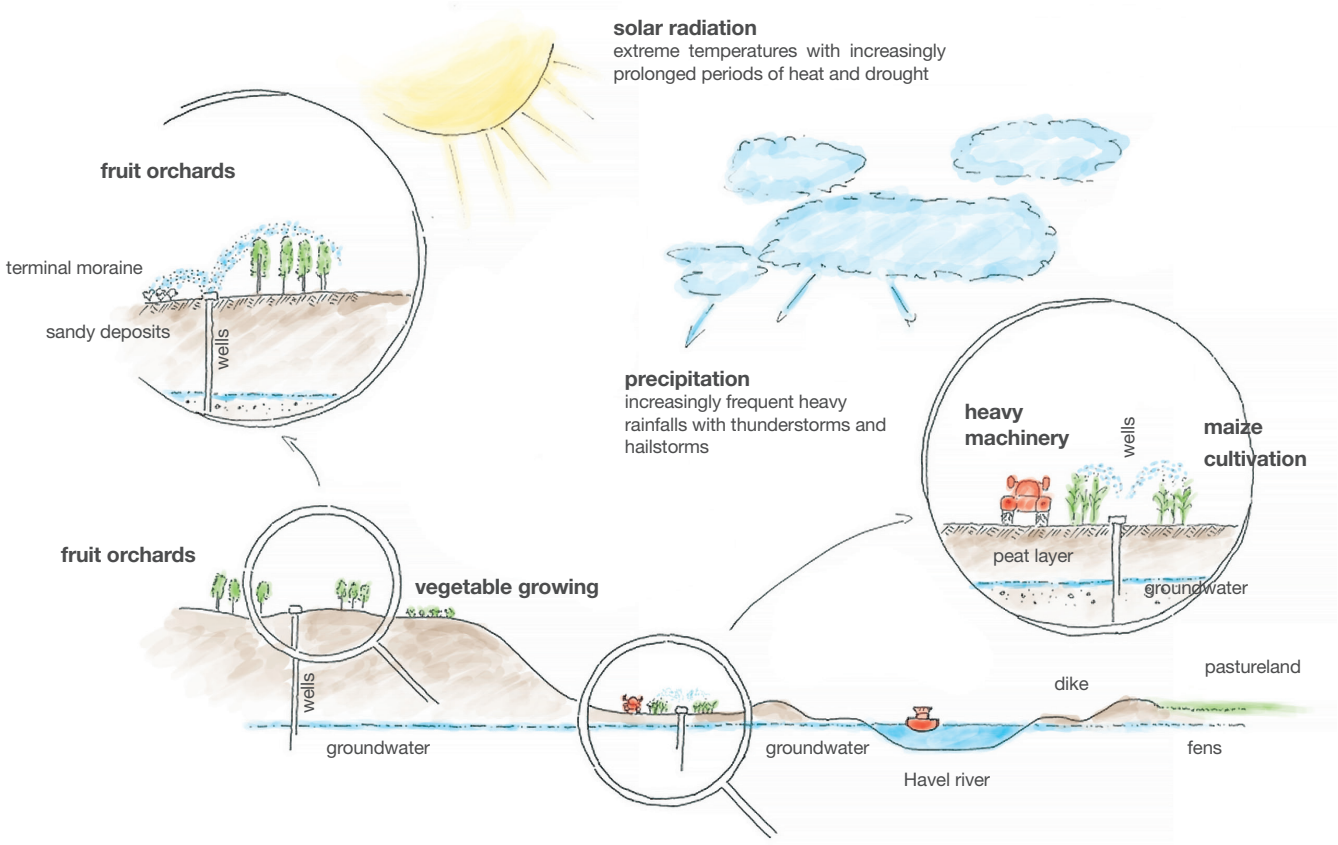


Fig. 4: Water management in the Werder/Havel region, Germany.

The learning location chosen to explore the core topic of water management in the Werder/Havel region, is characterized by production of fruit and vegetables on sandy sites and energy crops such as maize and woody species on former pastures. In order to achieve good productivity, the fruit plantations are continuously irrigated with large-surface sprinklers over the growing season. For this purpose, groundwater is pumped from wells into the sprinkler systems, which requires a high energy input. For an economically effective biomass production, also maize fields are irrigated. In addition, nitrate fertilizers and herbicides are applied. For large tracts of land heavy machinery, such as tractors, is employed.

1.2 Dimensions in content and dynamics

a. Agro-ecological dimension (environment)
The region around Werder is characterised by sandy and rapidly warming soils. Therefore, local arable soils have a low water storage capacity. The cultivation of vegetables and fruit is suitable for such soils and has a long tradition here. Prior to German reunification the entire fruit-growing area was irrigated with surface water from the Havel river via large scale irrigation systems.

In connection with the structural change in the 1990s, not only were these technologies outdated, but also the previous sales system collapsed completely. Most of the orchards were cleared because their low profitability. In the last 20 years, due to the good production conditions and the ideal situation for direct marketing in the Berlin metropolitan region, many former production cooperatives were transformed into the now predominant large vegetable and fruit farms, which mainly produce asparagus, fruit and berries. The fens of the Havel lowlands are used for pasture. Meanwhile many areas were converted for growing maize as an energy crop. The heavy machinery used for this purpose causes soil compaction with further ecologically negative effects. The continuous decrease of precipitation in this region is problematic for agriculture and horticulture. The proximity to Berlin is a decisive factor for a range of research projects at universities and institutes in the field of climate change, land use and resource-friendly irrigation systems. The comparatively low annual precipitation and the sandy soils with their low storage capacity are factors that make Brandenburg particularly vulnerable to the effects of climate change[12].

b. Cultural dimension (rural area)
Fruit growing in the Werder region has a long tradition that reaches back several centuries. As early as 1600 the nobility had orchards planted to supply the local population. Around 1800 the region was relevant for the fruit supply of Berlin. Since then, numerous festivals and regional rural traditions linked to fruit, wine and vegetable growing are maintained and have become an economic factor. Extensive clearing of fruit plantations in the post-reunification period (1990s) has changed the regions' characteristic landscape.

c. Local dimension (regional – national – global)
The region is characterized by its physical proximity to the city of Berlin and is part of the greater Berlin Metropolitan Region. Because Berlin is located in the Urstromtal and possesses good groundwater resources, there is currently no pressure on the surrounding regions to supply the capital with drinking water. Berlin is the only German city of more than a million inhabitants that covers its drinking water needs exclusively with groundwater from within city limits. However, there are already some problematic changes due to a continuous rise in groundwater temperatures[13].

The European subsidies of the Common Agricultural Policy (CAP) and national subsidies such as the Renewable Energy Sources Act (EEG) have an impact on agricultural activities and on a restructuring of the rural region Werder/Havel. Maize cultivation has strongly increased and pasture has been transformed into arable land. This went hand in hand with a growing need irrigation and use of fertilizers and herbicides. In addition, the conversion of pasture into arable land lowered CO_2 storage capacity[14].

d. Time dimension (past, present and future)
The groundwater balances in the Werder/Havel region has shown a decline over time. A scientific and technical report by the German Research Centre for Geosciences in Potsdam (GFZ) provides data and forecasts for the coming decades. Brandenburg is one of the regions in Germany with the lowest rainfall. This situation has exacerbated in recent dry summers. In parts of Brandenburg, surface water extraction was banned in summer in 2019.
The parallel rise in temperatures leads to an increased need for irrigation in agricultural production. The water is taken from the groundwater reservoir, which could not fill up after the last droughts of summer and winters with little rain. Recent summers (2017-2019) with a negative water balance were limiting for agricultural production, both crop cultivation and animal husbandry. Irrigation agriculture is expected to grow in Brandenburg and will eventually compete with the municipal drinking water supply and industrial demands[15].

e. Economic dimension (supply and demands and markets)
The proximity to large city of Berlin with a very high demand for fruit and vegetable offers a range of very good marketing possibilities. Especially the production and marketing of ecologically produced products is an economic factor of growing significance in the metropolitan region. The increasing need for irrigation in agriculture leads to a rise in production costs. In addition, drought has caused considerable harvest losses in recent years. Because of reduced supply, also expenses for animal feed for livestock production rose sharply. Organic farms obtained permission to buy and use conventional feed.

f. Insight-generating dimension (education for sustainability and sustainable development)
Much knowledge on effective and resource-saving irrigation systems has been generated in projects of applied research. Similarly, research findings on soil and water conservation in agricultural land management and the cultivation of heat-bearing crops are at hand.
The Potsdam Institute for Climate Impact Research (PIK) conducts research on the links and interactions between agriculture, climate, changes in land use and water scarcity.
Information and communication technology (ICT) are used to enhance the efficiency of cultivation, e.g. resource-saving irrigation technologies, management, harvesting and marketing. This has or will change work processes and working conditions. In this respect, there is a wealth of approached to generate knowledge that can be connected to sustainability education.

g. Social-political dimension
After the political change in the GDR in the 1990ies, the restructuring of the agricultural and horticultural production cooperatives into limited liability companies and businesses of other legal forms began. This was accompanied by changes in production, in company organization and employment structure. Numbers of employees decreased by about 80 %. By 2001 of about 820,000 agricultural workers in the 5 new federal states only about 161.000 remained[18].

At the end of the 1990s and after 2000 there were further drastic structural changes across the entire agricultural sector and agricultural land. Non-agricultural holdings and investors buy up agricultural land and convert and adjust production according to the current CAP and national subsidies. Agricultural work is outsourced to contract farming companies. Simple seasonal work in harvest is carried out by temporary and seasonal workers from South-Eastern Europe. The share of employees that are social insurance contributors and year-round employees has continued to decline in recent years.

2. Highlight networked problems

Grün-Agrar GmbH is an agricultural business with fruit orchards (apples, pears, etc.), biomass production for energy and agricultural crops (maize, wheat and others). It is situated in the Werder/Havel region in Brandenburg/ Germany.
Expenses for energy and salaries for operating and maintenance of technology to irrigate the orchards and maize fields has increased by about 30 % over last 3 years. It is also foreseeable that irrigation by groundwater will face restrictions in the future.

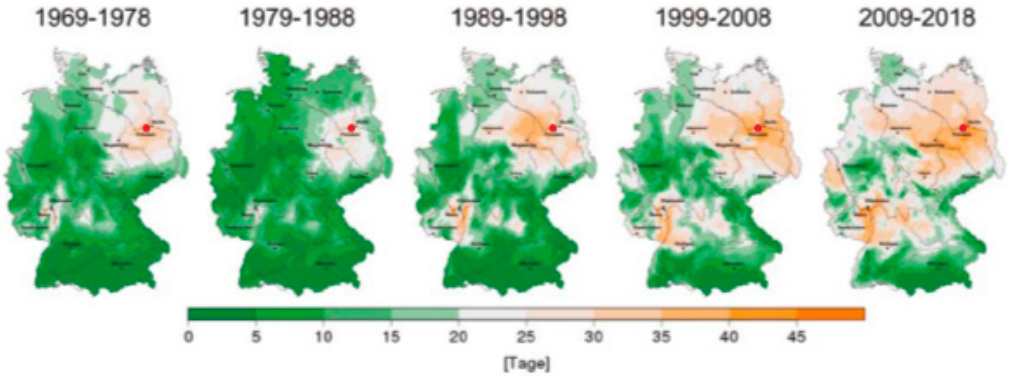


Fig. 5: Average annual number of days with soil moisture below 30% nFK (usable field capacity) on a light soil (loamy sand)[17] */ ● Werder/Havel region*

Task: The manager and her employee are looking for short- and medium-term feasible operational solutions to reduce this cost factor.

▶ **Possible assignments:**
Collect information about the *Grün-Agrar-GmbH* farm. Use the media, communication and audio-visual tools.

Determine the current weather data and climate changes (amount of precipitation, sunshine hours, temperatures, etc.) of the last decade and **present** them in a table.
List the irrigation times and evaporation rates at different times of the day.
Describe the cultivation processes of fruit on plantations and maize fields in the region.
Provide an overview of the annual consumption of water, fertilizer and herbicides.
Quantify the costs incurred for irrigation (monthly, and annually for the last 10 years).
Describe alternative irrigation technologies, their efficiency and cost factors (purchase, operation, application of technology and maintenance).
Describe the current conditions of regional agricultural production with regard to the water balance using regional rainfall and weather data.
Describe the water retention in the local soils.
Describe the application of ICT in *Grün-Agrar-GmbH* and changes in work processes.

3. Saving what has been learned

The **aim** is to identify possible solutions for *Grün-Agrar-GmbH* for short and medium term implementation.

▶ **Examples of assignments:**
Explain from your perspective how the company should act in the short and medium term.
Explain options according to the dimensions of sustainable development (ecological, economic, social) and determine possible prioritizations and present them graphically in a mind map.
Explain how water consumption can be reduced using irrigation systems that are currently in place or otherwise installing new and innovative equipment.
Calculate and explain how savings may lead to amortisation of cost for new system in the medium term.
Form working groups of 3-4 members each. Discuss the issue within your group and present our proposed solutions to each other.
Discuss with all your group members and draw up possible solutions and alternatives to reduce the water consumption of *Grün-Agrar-GmbH*. This plan should include all factors of sustainable development (e.g. energy consumption, human resources).
Present and explain this plan in a plenary discussion.

4. Reflect on interrelations and connections

After the presentation of all group results it is the aim of the reflection is to assess and evaluate the circumstances and solutions and to discuss which problems might arise for the *Grün-Agrar-GmbH* in the future.

▶ **Possible assignments and other topics for discussion:**
Discuss advantages and disadvantages of technology and ICT. What effects on the environment and work can you identify? **Describe** them.
Discuss irrigation systems, their advantages, disadvantages and alternatives, and problems in conversion of agricultural use of a given area, e.g. from fruit to maize.
Discuss optimization of crop cultivation from an ecological and economic point of view.
Discuss alternatives in running a farm enterprise, e.g. direct marketing or water recycling and develop hypotheses.

5. Transfer connections to other fields

On basis of the results and products that were developed, possibilities of the transfer of findings and positions can be discussed. Many of the findings for the Werder/Havel region mentioned above can be transferred onto other agricultural or horticultural areas as learning locations and other learning situations.

▶ **Possible assignments and further transfer:**
Assess the local conditions in Brandenburg and neighboring federal states of Germany.
Discuss the hypotheses developed in view of other regions.
Design scenarios for the transfer of insights from the Werder/Havel region considering the sustainability dimensions.
Create media for presentation (wall newspaper, graphic, cluster, mind map, etc.).
Explain your proposals in writing.

▶ **Possible approaches and solutions:**

- Application of irrigation systems that conserve resources and meet the plants requirements, as for example drip irrigation for fruit growing.
- Adjusting irrigation times according to the time of day: Irrigation at night may reduce the evaporation rate.
- introducing water-saving cultivation and increasing water infiltration by adding a grass cover or other soil-covering vegetation in fruit orchards.
- Changing cultivation methods by integrating agroforestry systems and hedges to improve water retention on agricultural land.
- Cultivation of heat-resistant crops that consume little water.
- Exploring alternative water sources for irrigation such as irrigation with filtered greywater or installing rainwater retention basins
(see example: Braunschweig model www.abwasserverband-bs.de)

Examples of possible fields for transfer:
The pedagogical exploration of the Werder/Havel region as a place of learning can be similarly conducted in other regions and areas that are predominantly used for vegetable and ornamental plant cultivation. For horticultural production in greenhouses, irrigation costs are less of a problem, but there is a need to study alternative ventilation systems and options of saving expenses for heating. Further studies regarding increased costs in agricultural and horticultural production due to climate change can, explore for example, the use of cisterns and associated opportunities and risks. A resource-preserving management of arable land using ecological cultivation methods and thus reducing use of fertilizers can be a further area of study.

Case study:
Cultural landscape Dehesa / Spain

1. Identify the place of learning or learning situation

1.1 Description of the place of learning

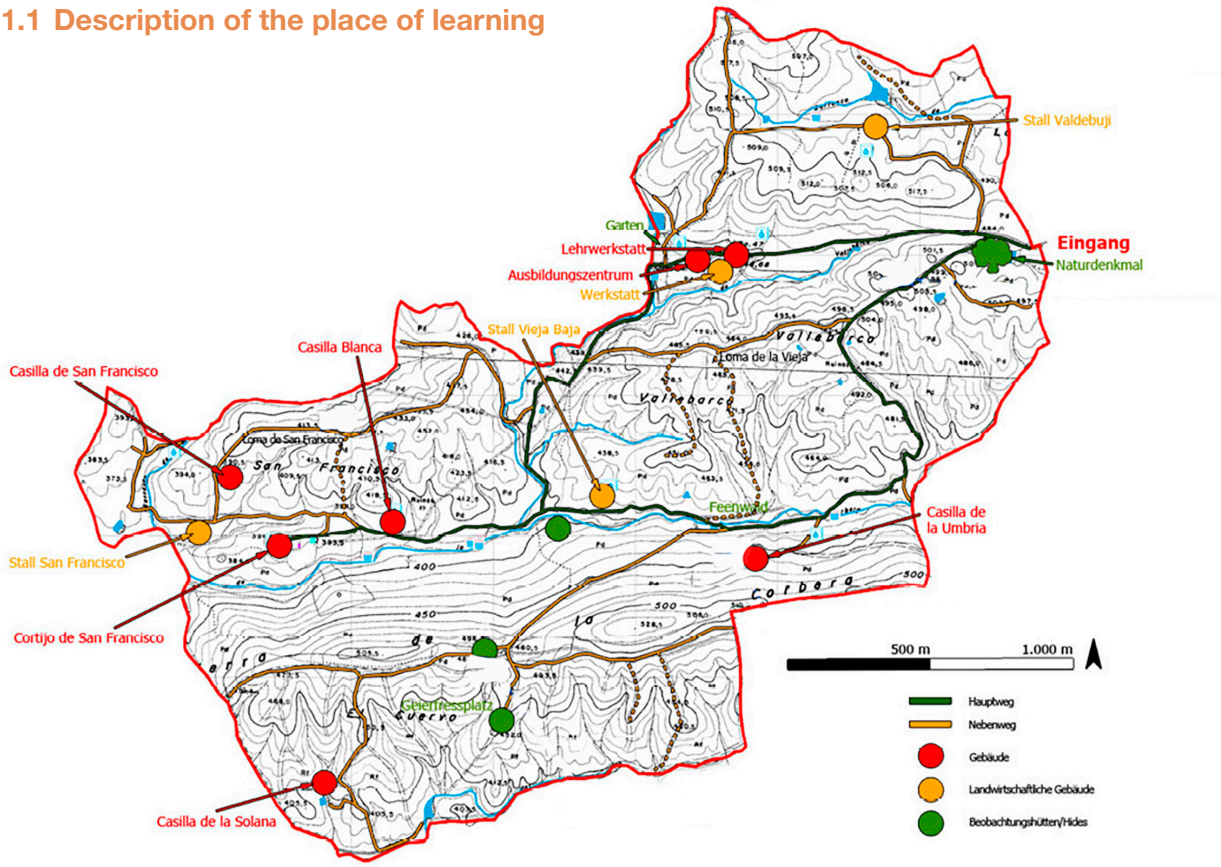


Fig. 6: Geographic overview map Dehesa San Francisco[19].

The place of learning used in this case study is the Dehesa San Francisco in Santa Olalla del Cala in the Spanish province of Huelva/ Andalusia. It has a total area of approx. 700 hectares, of which about 500 hectares are suitable for agricultural use. Differences in altitudes across the property of the Dehesa San Francisco can reach more than a hundred metres in places. There are only few flat areas with little inclination, which are suited for agriculture and gardening. The agricultural at San Francisco Dehesa consists mainly of extensive grazing

Dehesa

Dehesa is „an agroforestry system which combines the components of wood, pasture, livestock and agriculture so interact under a specific management in an economically and ecologically beneficial way“[20]. The Dehesa as an agro-silvopastoral ecosystem is a cultural landscape of the Iberian Peninsula that developed from native Mediterranean hardwood forest over a long history of human exploitation and management. Arable farming and extensive grazing created a park-like landscape of meadows and pastures with extensive groves of cork oak (Quercus suber) and holm oaks (Qurercus ilex) and other tree species. Dehesas are considered a prime example of promotion and preservation of structure and biodiversity of an ecosystem by traditional land use. In these systems closed nutrient cycles with the components soil and water in harmony with animals and plants can be observed. Today, traditional management of the dehesas is severely threatened by the intensification of agriculture, a continuing rural exodus, increasing globalisation and climate change. Without extensive use, this unique cultural landscape will disappear. In their traditional form of cultivation, dehesas are a barrier to the advancing desert.

of pigs, sheep, cattle and goats. In addition, the cork harvest of approx. 20,000 cork oaks is to be mentioned. For the feed supply, hay is harvested on approx. 20 hectares. The acorn production of approx. 40,000 cork and holm oaks is used to feed the free-range pigs (grazing). For the needs of employees and trainees in Vallebarco training centre organic fruit and vegetables are grown on a plot of about one hectar. The farm is supplied with firewood from windthrow and deadwood. The Dehesa San Francisco is managed and operated by *Fundación Monte Mediterráneo (FMM)*.

1.2 The dimensions with content and dynamics

a. Agro-ecological dimension (environment)

Agriculture in the San Francisco Dehesa area is shaped by rare and irregular but often heavy rainfalls. The rainy season lasts from October to April. Average rainfall is about 600 mm/m^2. Thus fertile soil is easily washed away. The incipient erosion is a risk to agriculturally usable vegetation, especially tree stands and areas used for fodder cultivation. On the 700 hectares of dehesa properts of mostly hilly and often steep terrain, the southern slopes are frequently exposed to strong sunlight and high temperatures, especially in summer. The soil therefore dries out and cracks form in the hardened surface. The first rainfall can only be absorbed by the soil if the precipitation is light and long-lasting. With sudden heavy rainfally there is a risk of erosion as described above. For more than two decades (approx. 1995), traditional soil-improving or soil-creating measures have again been implemented on the Dehesa since about 1995, i.e. fore more than two decades. The penning of the sheep at night is a well established method: excrement and urine act as soil improving fertiliser and promote humus production. Seeds excreted promote the development of the plant cover. When the grass starts to grow, the excrement serves as a water-absorbing layer, which also inhibits erosion. During the nocturnal pen periods, the plants (leaves, flowers and young shoots of rock roses, maquis, etc.) are browsed in narrowly defined area. This reduces combustible fule material and thus the effects of forest fires.

Due to changes in livestock farming systems on the dehesa since the middle of the 20th century, including the ceasing of transhumance, an increased livestock density per hectare and the reduction of rotational grazing, measures of soil-improvement and soil-preservation became necessary. Also in the forestry sector, forest management became increasingly inconsistent between 1950 and 1995.

Only since 1995 forest management measures such as reforestation with germinated acorns (young plant cultivation of approx. 500 to 600 oaks per year) and natural regeneration including browsing protection were resumed.

Due to the limited food supply in the summer months, sheep could not be kept on the dehesa all year round. Therefore, they were moved to the mountain pastures of northern Spain from May/June to October/November. This also prevented soil compaction on the dehesa. As the cattle were moved first by railway and later on trucks, the ecologically valuable corridors, the so-called Cañadas Reales (driveways for animals) also disappeared.

Transhumance

Transhumance is a form of pasturalism in which cattle (typically sheep and goats) are kept on mountain ranges in summer and in snow-free lowlands in winter. In contrast to nomadism, the herds are owned by a sedentary population and are accompanied by shepherds to pastures, which complement each other in the seasonal climate rhythm. In contrast to alpine pasture farming, transhumance the cattle is not kept in a stable. The main area of transhumance is the Mediterranean (Spain, Greece, Turkey, Tunisia and Lebanon)[21].

Transhumance, the driving of sheep from Andalusia and Extremadura to the mountain pastures of the northern provinces of León and Palencia, is a method of animal husbandry that looks back onto a thousand years of tradition and secures an intelligent use of natural resources. The *FMM* is committed to reviving this endangered form of animal husbandry, through various projects.

The meadows and pastures of the southern Spanish Dehesas have for many years been trodden on by the large animal population in summer, which eventually causes severe erosion. The thin humus layer is washed away, which also reduces germination and growth of grass in the autumn rains. In very rainy years, torrential rainfalls also cause major damage to

paths and water basins as the soil is no longer able to absorb the water. Transhumance allows the pasturelands in the dry south to recover over the summer. Soil compaction and overgrazing is avoided, and so the soils are able to better absorb the first autumn rains. The work on the Dehesas is reduced due to the absence of sheep and the agricultural workers have a lower workload over the hot summer months.
In the mountain pastures of the northern provinces of León and Palencia, scrub encroachment is prevented and pastureland is kept open by browsing. This reduces the risk of forest fires and contributes to the preservation of traditional mountain pastures and their biodiversity.
In the creation of grazing areas, night pens near the shepherd's huts as protection against wolves adds another positive factor, namely the sheep's' manure. The sheep do their „natural job" by eating fresh, green grass, fertilizing it naturally, thereby creating pasture land and improving the mountain pastures with their „golden tread".
Thanks to the revival of transhumance, seasonal employment is generated in disadvantaged areas and lost professions can be re-established and integrated into modern, ecological processes. In addition to its importance for animal husbandry, transhumance takes into account the cultural and historical significance of sheep farming, which has been a dominant feature of Spain for many centuries. The great wealth of knowledge and experience regarding nature and animal husbandry that has been accumulated over centuries is in danger of being lost with the disappearance of the profession. In order to counteract this, training and internship programs are part of the project.
Every summer since 2009, *Fundación MM*, jas joined forces with other sheep farmers from the region, to send their sheep and protection dogs to the Palencian and Leonese mountains by truck. Inititally there were about 400 sheep. Today there are about 7000 sheep from 20 different farmers. In this „transhumance project" shepherds are supported, the training of young people is promoted, shelters are built or modernized and beekeeping is promoted. The revival of transhumance is intended to promote shepherding as a profession in the north and south of Spain and make it more attractive again. It is to promote a new appreciation of the natural products wool, sheep meat and also honey and last but not least, to contribute to the protection of species and ecosystems. Sheep farmers who participate in these measures can use this as a unique selling point in the marketing of their products.

b. Cultural dimension (rural area)
Traditional Dehesa management has shaped the cultural landscape in southern Spain for centuries and has contributed to the economic importance of Spain. Traditional skills of shepherding, animal husbandry and related fields, such as technical knowledge and experience, other crafts, rural traditions and cultural heritage such as songs, etc. have been largely lost. Temporary transhumance, pasture grazing or temporary coupled husbandry are increasingly replacing traditional transhumance. The reasons are manifold and go hand in hand with the rapid social changes, which leads to changes and extensive adaptations also in adjacent fields (e.g. traffic, common pastures, occupational profiles, epidemic hygiene, forage areas). The profession of the wandering shepherd, which was a carrier of cultural exchange in the days of transhumance, has today been degraded to marginality and low prestige.
The earlier north-south migrations led to a lively exchange of information and knowledge and a flow of people. This does no longer take place in this way today, resulting in the isolation of the individual production areas. The multiple use of the Dehesas led to a broadly diversified knowledge of sustainable forms of use in a circular economy, passed on from generation to generation.

c. Local dimension (regional - national - global)
Due to limited possibilities of land use (extensive animal husbandry, cork) also possibilities of work and generating an income in the region were very limited. Since the 1950s of the 20th century, rates of migration of the rural population were on the rise leading to a rural exodus. Workers migrated to other Spanish and European conurbations that offered industrial employment. Attempts to convert the agrosilvopastoral areas, for example by cultivating eucalyptus, led to monocultures with negative ecological and economic consequences.

d. Time dimension (past - present - future)
Parallel to the migration of workforce from rural areas, since the 1950s, low-yield agricultural land was subject intensification and mechanisation, which led to the aforementioned loss of soil and soil fertility. Intensification of animal husbandry has exacerbated the associated soil degradation. Even the if the only or predominant use is hunting a negative impact on the fragile cultural landscape can be shown. Since 1995, this trend has been successfully counteracted at the San Francisco Dehesa by employing various traditional farming methods. With the help of various projects embedded in a circular economy, it is attempted to reverse the negative development and in future to include effects of climate change in forestry and agricultural management decisions.

e. Economic dimension (supply - demand / market)
Since the 1950s, one-sided, intensive pressures have caused the loss of soil and productive land, employment and regional culture. The traditional agricultural products of the Dehesa, such as cork, merino lamb, merino wool, products from the Ibérico pig, were the basis of Spain's economic prosperity for centuries, until the middle of the last century. Today, San Francisco Dehesa is again being cultivated ecologically and its high-quality products with unique selling points (merino wool (2016), jamón de bellota (ham), 100 % Ibérico de producción ecológica (2002), cork - FSC-certified (2001), etc.) is being promoted) can contribute to an economically stable viable operation. Current consumer demands and changed consumer behavior require innovative production lines and new marketing strategies that employ digital techniques and work supra-regional. These have been developed and successfully tested for about 25 years. The combination of proven means of production and processing with new digital methods can contribute to the profitability of this agricultural landscape.

f. Insight-generating dimension (sustainable education and development)
In Spain, the transition from traditional informal knowledge transfer to regulated vocational training did not happen. As a rule, training traditionally consisted in transferring knowledge and experience from one generation to the next. This makes it difficult, and at times even seems impossible, to integrate modern and current knowledge into education, training and further education. This phenomenon also occurs in other European countries with challenging conditions in agriculture, making problems comparable.
After Spain joined the EU in 1986 and in particular after 1995, there have been a number of changes in the Spanish vocational training system. Major reforms after 2002 are strongly influenced by EU policies. In-Company practice is to be made a higher priority in vocational training. For Andalusia networking and participation in European educational and scientific programs is a most valuable opportunity. Through exchange and transfer of experience and knowledge concerning soil fertility and measures of soil improvement can be learned from European partners.
New technical possibilities, such as solar-powered electric fences make management options such as portioned and roaming pastures possible. Such management approaches can counteract the loss or deterioration of soil conditions without drastically increasing personnel. There are, for example, innovative research projects, carried out in the African savannah that offer a comparison. Results on humus-formation through animal husbandry for instance may also be applied or adapted in other regions, such as Andalusia ..
Transfer of knowledge and experience, for example in European innovation and transfer projects in strategic partnerships (Erasmus+ KA2), can also offer opportunities here.

g. Social-political dimension (integration into the social context)
In addition to production factors (water, soil, people), political and social developments influence the situation of *FMM* as a business. In the context of society and social developments, organic products from organic farming will find better marketing opportunities today. In addition, climate change is raising awareness among politicians and the general public for protection of natural environments.
Damage limitation with regard to further conversion or intensive use of the Dehesas is achieved through application of national and European protection guidelines (landscape protection areas, Natura 2000, *Flora-Fauna-Habitat* (FFH), etc.). Currently, managers of Dehesas do not always respond positively to designations of protected areas. They feel restricted in their agricultural activities and are often left alone: care and maintenance of natural and cultural areas is no easy task

and is often labor-intensive without any direct monetary benefit. In addition to the other factors listed above Ecology and economy are not always easy to reconcile.
After Spain's accession to the EU (January 1st, 1986), an afforestation programme financed by EU subsidies was set up in the 1990s. This enabled many landowners to reforest their Dehesas. In 1995, Dehesa San Francisco was also able to benefit from this and initiated an extensive and highly differentiated reforestation program.

2. Highlight networked problems

The *Fundación Monte Mediterráneo* (FMM), as the manager of the San Francisco Dehesa, aims to improve quality and to increase and preserve fertility of soils, which have been degraded by many years of overuse. The type of animal husbandry with extensive grazing and adapted measures (portion grazing, night pens, transhumance, etc.) is chosen to support this aim.

Task: Which measures are conducive to soil improvement and restoration of soil fertility? What time schedule do employees need to consider until the measures take effect?
Which personnel resources are needed and which measures can ensure economic viability?

▶ **Possible assignments:**
Collect information on *FMM* operations over the last 70 years.
Use medial, communicative and audiovisual possibilities, such as the Dehesa Primer.
Name important events concerning the development and history of the Dehesa.
Inform yourself about the geographical and geological location of the San Francisco Dehesa (*FMM*).
Inform yourself about the water situation on the *FMM* and describe it in a graphic.
Use the overview map with contour lines.
Compile ecological, economic and social factors for the management of a Dehesa using the example of *FMM*.
Summarize the ecological benefits of transhumance in terms of soil improvement (both on the Dehesa and in the summer grazing areas).
Gather information about the flora and fauna in the Dehesas of Andalusia and Extremadura.
Write all down in an overview (e.g. table).

3. Saving what has been learned

After the development of the possible assignments, the newly learned contents and potentially derived connections are studied in more detail.

▶ **Possible assignments:**
Explain on basis of the information gathered which possibilities exist from your point of view for soil conservation or soil improvement measures.
Name short- and medium-term feasible solutions for *FMM*.
Explain why the company should act in the short and medium term.
Assess the sustainability of your measures in terms of soil, profitability, animals and their welfare, personnel and the ecological factors of the region.
Document your decisions in writing.
Present your results to the plenary.

4. Reflect on interrelations and connections

The fourth step is to reflect on the contents and evaluations. Which interrelationships emerge and play an important role in the management of Dehesa *FMM*?

▶ **Possible assignments and further areas for discussion:**
Consider the water situation at the Dehesa, including advantages and disadvantages of the current water management and alternatives and discuss the conversion of animal husbandry methods (e.g. transhumance, horse husbandry)
Discuss the optimization of animal husbandry from an ecological and economic point of view.
Gather information on the effects on water and soil balance.
Discuss possibilities as well as advantages and disadvantages of the use of technology and ICT. What effects on the environment and work can you identify? Describe them.
Discuss alternatives for specific companies, e.g. direct marketing, use of service water, and **develop** hypotheses.

5. Transfer connections to other fields

Other influences that may be relevant:

- National terms of use, e.g..: Specifications by the Ministry of Agriculture, State Ministry of Agriculture, Nature Conservation Agency
- Political framework conditions (EU directives, support measures, requirements of the certifiers, e.g.: Eco, FSC)
- Social requirements (climate protection, sustainability, culture)
- Personal disposition

On basis of the presentations and findings on the site of Dehesa *FMM*, transferable findings and positions. Many of the previously mentioned findings about the Dehesa/Region Huelva as a place of learning can be transferred to other agricultural or horticultural areas as places of learning and learning situations.

Which comparable site conditions and measures are you familiar with from your surroundings (global perspective)?
Describe similarities and differences.
Review the transferability of your results to other conditions and/or regions.
Show first approaches for implementation and **document** them.
Discuss the consequences of climate change and possible future consequences.

Alternative method for the development of steps 3 to 5:

The Cultural landscape of the Dehesa - Sustainability over time
The working module consists of a playing field (2 axes), event cards and evaluation cards (+, -, and 0). The event cards name different external influences (weather, climate, political changes, support measures, etc.), which are adapted to the respective region, country or cultural area.

The playing field consists of 2 axes (**horizontal time axis and vertical dimension axis**). The horizontal time axis reflects the generational change from 1970-2070, i.e. the **past**, **present and future**. The vertical axis is divided into the **7 dimensions** (either a.-g. or 1-7), which determine the learning location or learning situation. The time axis can be shortened or lengthened outside the example given here. This depends on the learning location or learning situation.

The **event cards** are assigned to the horizontal time axis on the playing field. Depending on how many events occur on the playing field, the greater the basis for discussion of the assessment cards and dimensions. The **evaluation cards** with +, - and 0 are then distributed vertically upwards to the events in the seven dimensions. The game can be used as a basis for discussion or as a final or review tool. The duration of the game is not fixed, as it is determined by the teacher and depends on the students‘ willingness to discuss.

Aim of the working module
The aim of the game is for the learners to deal extensively with the contents of the place of learning or learning situation and to learn to critically confront and evaluate new topics and influences. In addition to the basis for discussion, a new graphic of the place of learning or learning situation is created at the end of the game using the game board.

In the template there are possible patterns to print out, which can also be changed according to your own ideas. These can also be created by the learners in the development phase. The game is „real“ and can also be played digitally.

If the production of too many evaluation points is too laborious, only a few may be sufficient. The event cards (are numbered) or the respective number is then noted on the evaluation point. So they can be assigned later on.

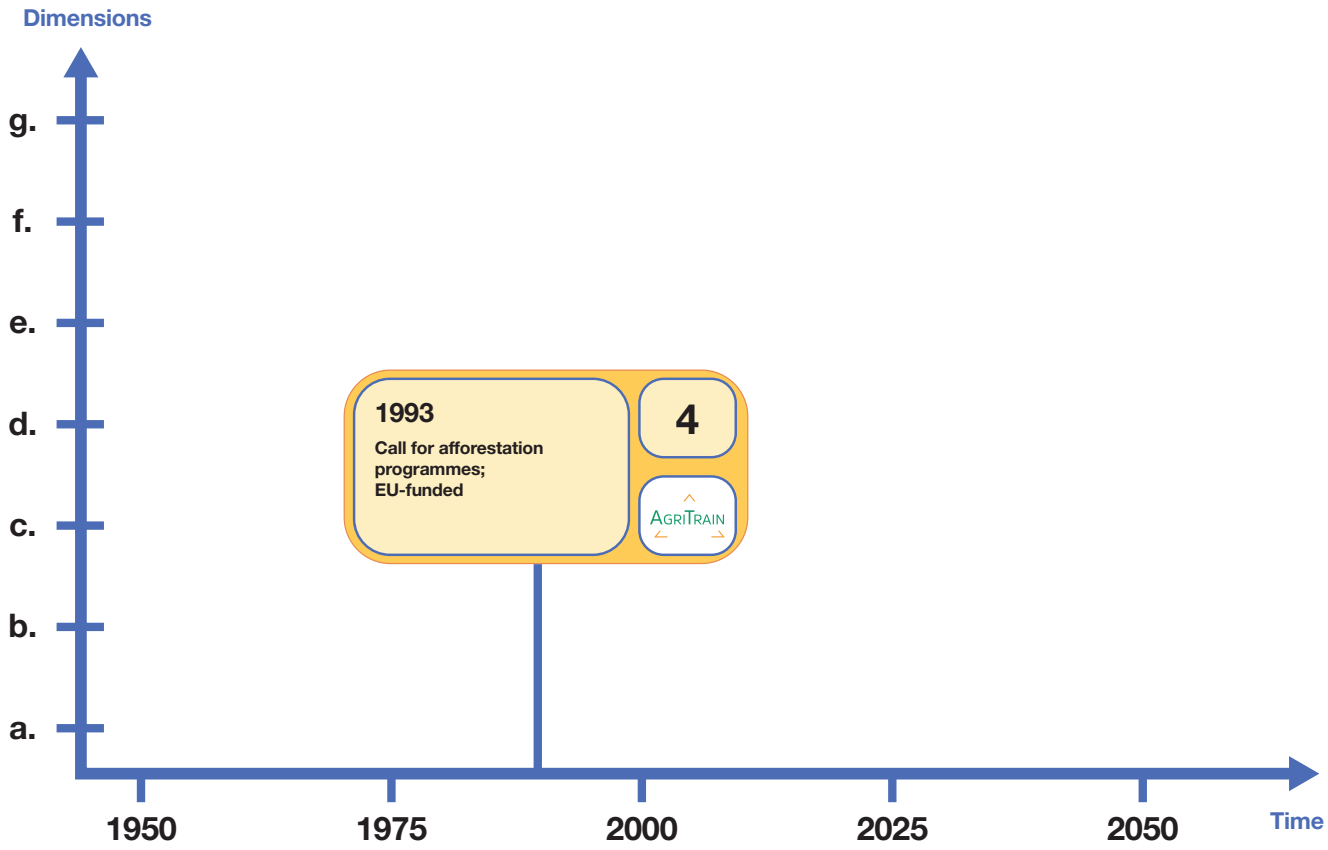
Possible event cards:

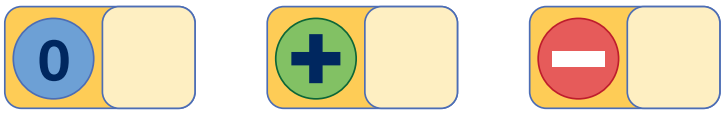
Event card emigration of agricultural workers 1950
Event card participation in the Transhumance 2009
Event card forestry subsidies 1995

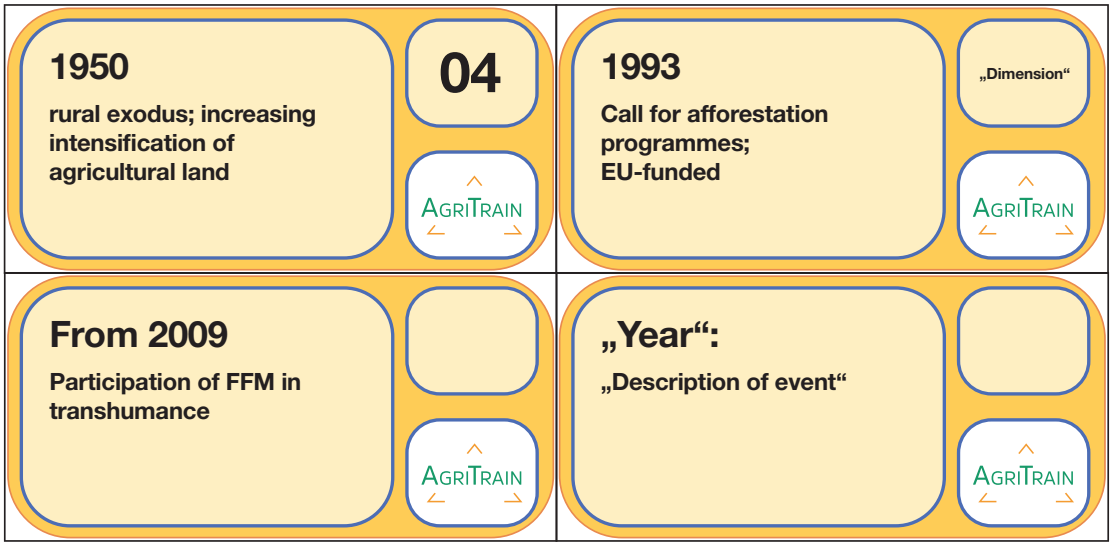
Example: The map is placed on the time axis at e.g. 1995 and the effects/evaluations are placed onto the 7 dimensions. It has to be decided how forest subsidies may have affected the individual dimensions (+=positive, - =negative, 0=no effect). Several evaluation cards are possible. How strong the positive or negative impact of an event is, is decided by the students either on their own or supported by their teacher. Then they move on to the next event and arrange it in a chronological order before continuing with the evaluation points. Correlations and relationships may have already been created. The systemic character of the events and their effects is illustrated.

Decide how to assign the events to the dimensions in the game. **Arrange** them in order of importance for Dehesa *FMM*.
Evaluate the events using the evaluation cards and **create** an overview naming positive, negative and neutral effects on the soil fertility of Dehesa *FMM*.

Copy template: playing field (reduced), evaluation cards and event cards







Case study:
Plant production in the Plovdiv region / Bulgaria.

1. Identify the place of learning or learning situation

1.1 Description of the place of learning

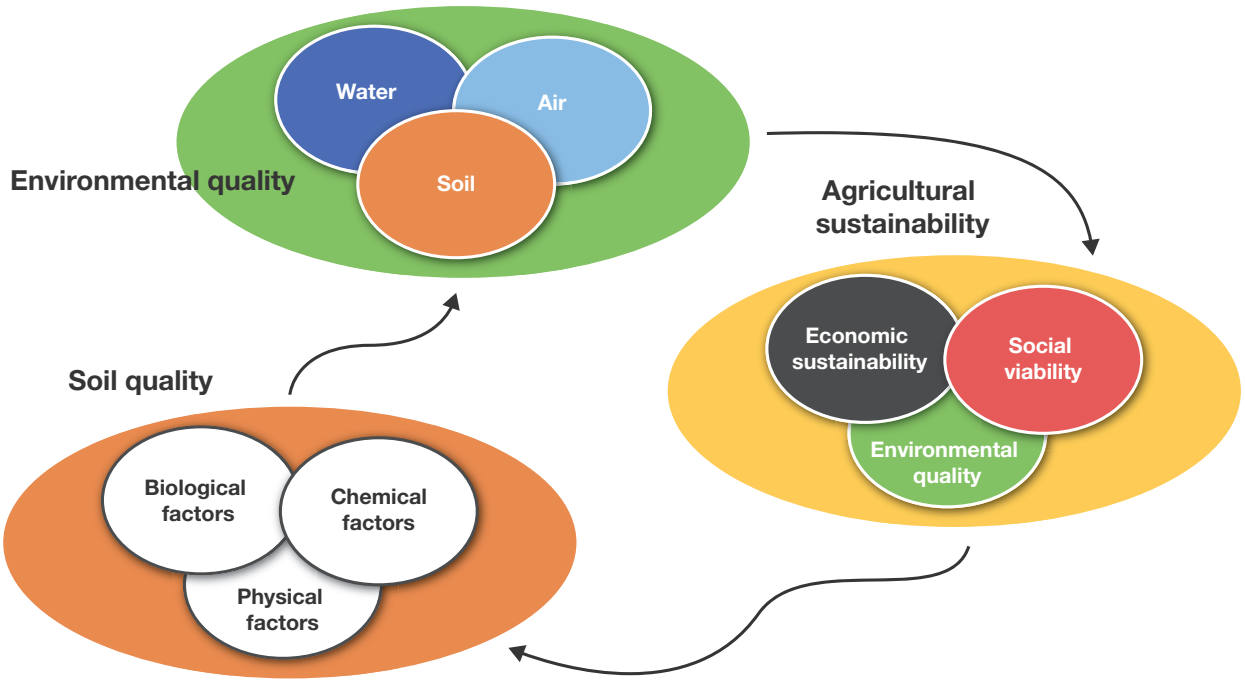


Fig. 7: Relations between soil quality, environment and agricultural sustainability.

Securing food and livelihoods for an ever-growing world population is one of the great challenges in the future of humankind. Main factors that are likely to limit the production of affordable food in the future include climate change and resulting changes in soil, water, air and energy supply.

Educational institutions are often not yet in a position to prepare their students to actively tackle such complex and systemic global problems. Traditionally, teachers have focused in their curricula on specialist expertise. Systemic thinking requires consideration of the connections and interrelationships between the objects studied and other components of the respective system.
Agroecosystems consist of interconnected elements and components such as soil, water and air. Soil in itself is a system of a multitude of chemical, physical and biological system elements. Soil quality is assessed along a range of criteria that fall in three categories: Chemical analyses provide data on the balance between the composition of the soil solution (water and nutrients) and the solids (clay, organic matter). Physical data describe hydrological soil properties, such as water absorption and retention, which affects both plant nutrient uptake and root system development and soil aeration. Some data can provide information on the risk of erosion. Biological data reflect the activity of living organisms (higher plants, microorganisms and animals) in soil formation.
In agriculture, sustainability is thought to be achieved by measures that aim to maintain conditions that enable and secure production indefinitely. These measures are closely linked to the national interest inherent in the concept of sustainable development and focus on environmental stability, cost-effectiveness and social importance of agricultural production.

Indicators used for assessing the economic dimension of sustainable agriculture include the net yield of farms, soil productivity or crop diversity. Social aspect includes education and training, support for individual development and social commitment. Environmental impacts are managed through integrated management of water resources, nutrients and pesticides, and generally through the preservation of soil quality and biodiversity.

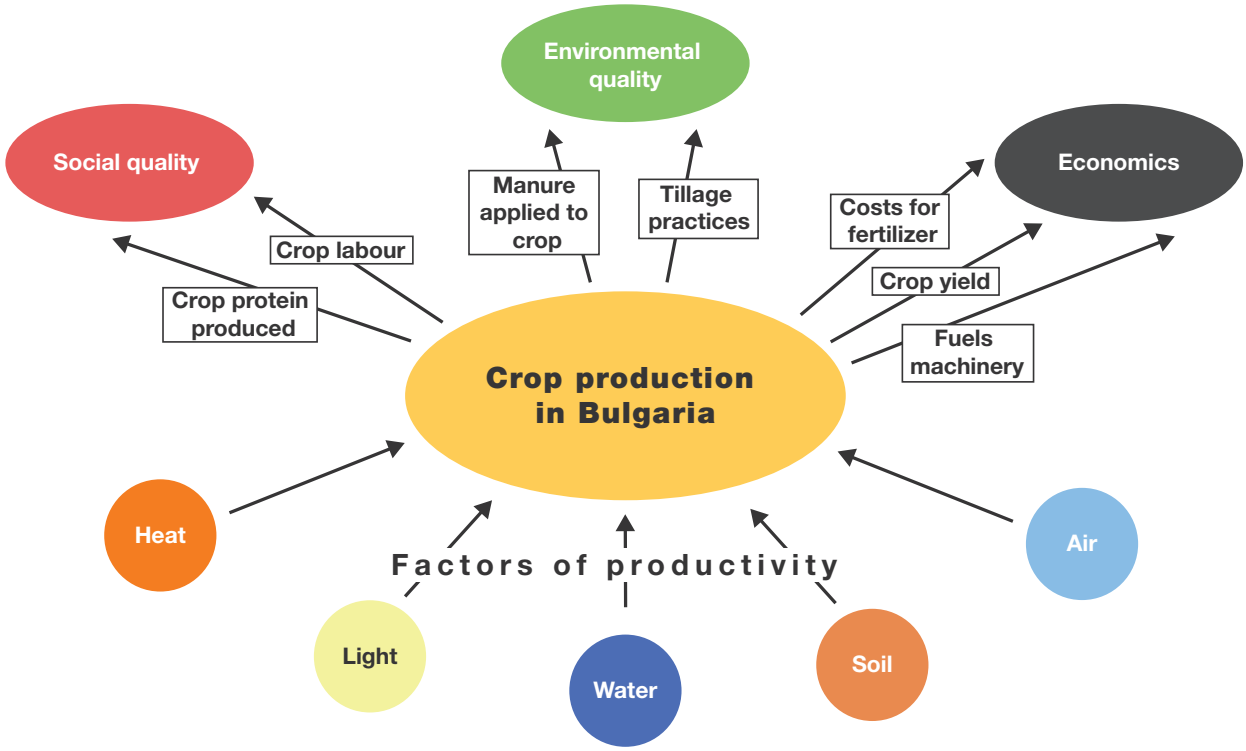


Fig. 8: Sustainable agriculture and plant production in Bulgaria.

1.2 Dimensions in content and dynamics

In 1997, Bulgarian scientists Velchev, Valev and Borisov **defined sustainable agriculture** as follows: „*Contemporary ecologically sustainable agriculture means, in practice, striving to achieve the potential yields for a given agro-ecological region with high biological values of the crops through an appropriately chosen agro-technology that guarantees best economic results at market conditions, while preserving and improving soil fertility and protecting the environment*".

a. Agro-ecological dimension (environment)
The agricultural sector is pivotal to sustainable development, as it feeds the population and is directly linked to the exploitation of natural resources.
In Bulgaria the concept of sustainability is mostly associated with ecology and agricultural systems. Agricultural systems are considered to be unsustainable if they cause environmental damage.Bulgaria's agricultural sector is undergoing profound reforms that aim to mitigate the lasting consequences of the collapse of the planned economy.

In a Bulgarian context, sustainability needs to be assessed not only in view of its strong development prior to the crisis, but also in terms of its compatibility with the objectives of environmental protection and social security in rural areas. To this end, economic, social, environmental and institutional indicators are used. Scientific analyses indicate that development in this sector is stagnating and requirements of sustainability are still not met. Its economic development is also unstable and only reaches half of its potential.

b. Cultural dimension (rural area)

Productivity in Bulgaria averages 334 €/ha over a 9 year- period (as of 2006), compared to 2.930 €/ha in neighboring Greece, 726 €/ha in Romania and 800 €/ha in the Czech Republic. The average in the other European Union countries is 2.203 €/ha and in the Netherlands, it is 10.423 €/ha. Bulgarian agriculture is still low in productivity, highly dependent on climatic conditions, unsustainable and therefore not competitive. The low productivity since 1997 suggests an urgent need for modernization and restructuring.

Sustainable agriculture is less intensive. However, as it is based on so-called good agricultural practice with crop rotation and integrated pest management, it requires high professional qualifications and technical skills.

Massive emigration and substantial population decline, especially in rural areas of Bulgaria (2001-2011 loss of about 600.000 inhabitants), has severe consequences for traditional agriculture. Entire villages are turning into „ghost villages".

c. Local dimension (regional – national - global)

About 47 % of the Bulgarian territory is used for agriculture. Main crops are wheat, sunflower, maize, oilseed rape, barley and legumes. As of mid-July 2019, there are only slightly more than 87.000 registered farmers. Gross production of the Bulgarian agricultural sector in 2018 amounts to BGN 8,155.0 million. Of this 69 % is from plant production, 22 % from livestock farming and the remainder from agricultural services.

In recent years, high temperatures and drought have increasingly damaged harvests. In 2018, for example, wheat yields fell by 10.2 % due to unfavorable weather conditions during the growing season. Support for Organic production is growing in Bulgaria. There are objective conditions for this - ecologically protected regions, awareness of the benefits for the environment, increased demand for healthy food. In 2018, organic producers, processors and traders were accounting for about 7.2 % of all registered farmers.

Plant production both depends on and influences environmental quality. Climate change, loss of biodiversity, pollution and increasing issues with water quality and quantity are factors that determine the sustainability of agro-ecosystems. In contrast, high yields are only achieved by applying manure or other chemical and organic fertilizers. The chosen soil treatment system also influences the environment through its impact on the soil. The dynamics of its processes result from the quantity and type of soil treatments, the organic matter content and erosion. Excess production of fertilizer and added nutrients and general soil quality can be used as indicators of sustainability.

d. Time dimension (past - present - future)

Following the restructuring of agricultural holdings (1990-2000) and substantial European subsidies since 2007, the share of agriculture in the Bulgarian economy (GDP) fell from 9.6 % to 5.1 %. An important issue in the current state of agriculture is its structure: 1.5 % of all farmers cultivate 82 % of the land. The situation the production of the five dominant cereal and oil seeds (wheat, barley, maize, sunflower and rape) causes an impression of a modern and efficient agriculture in Bulgaria. However, cereals and oilseed account for a major share of subsidies and have no positive impact on the gross added value generated in this sector. A serious issue in agriculture is the choice of new varieties and hybrids. The discrepancy between the availability of varieties and modern standards restricts competitiveness. There is a risk that Bulgarian varieties and hybrids will be permanently displaced by imported seeds in the coming years.

In the following needs for a development of sustainable agriculture in Bulgaria are outlined:

- Framing of a comprehensive model for the development of the agricultural sector - creation and introduction of new technologies and approaches, with the ultimate goal of transition to integrated organic farming;
- Large-scale introduction of precision farming methods that use of advances in computer science, electronics and precision engineering, chemistry and biotechnology;
- Creation of a single integrated management both for the individual farm and for the entire sector. This would optimize cost efficiency for farms, ensure stable yields, their forecasting and management, easier access to financial resources, etc.

e. Economic dimension (supply – demand / markets)
The economy of agriculture is characterized by the temporal variability of cash flows in the sale of agricultural products (plants and animals). Producers have access to the market, their businesses are subsidized via several programs, and loans are available. The economic evaluation of production must necessarily consider risks caused by changes in environmental factors and fluctuations in market prices for the means of production. The costs of crop production include the costs of irrigation, fertilizers, fuel, purchase and operation of machinery, tillage and other mechanized activities in crop production.

f. Insight-generating dimension (sustainable education and development)
Among its goals for sustainable development, the UN have identified in its Goal 4 for inclusive, equitable, quality education and lifelong learning subgoal 4.7 that: „*By 2030, all learners must acquire the knowledge and skills necessary to support sustainable development, including through education on sustainable development and sustainable lifestyles, on human rights, on gender equality, on promoting a culture of peace and non-violence, on global citizenship and on valuing cultural diversity and its contribution to sustainable development*".
At the beginning of the 20th century, a new philosophy of school education emerged in Western Europe and subsequently in Eastern countries, focusing on international understanding and the need for societies to develop in order to improve their lives. Over the decades, other educational themes emerged and a new emphasis was placed on knowledge of the world and global processes, the formation of critical thinking and the promotion of values.
The main driving force in this process are the teachers, who strive to respond to public attitudes and support the acquisition of comprehensive and appropriate knowledge. These new forms of education above all involve Development Education and Global Education. In addition to international issues, the school also provides a forum to discuss other current issues that are not listed in the curriculum, including sustainable development, human rights, peace or civic competence. All these topics are of great relevance and unfold with the development and changing interests and challenges in society. These issues in school education are grouped under the umbrella-term - problem-based learning.
It is crucial in Education for Sustainable Development, to enable students to analyze the situation by answering questions on the „what" and „why" in a given scenario, rather than receiving ready-made answers. Interactive methods provide excellent ways to initiate such processes of learning and competence development. The most common forms of study work are case studies, debates, presentations, role-plays.

g. Social-political dimension (social context)
Social indicators for sustainable agriculture suggest two trends: On the one hand, incomes of those employed in agriculture are slowly rising, while on the other hand demographic characteristics of the rural population are deteriorating. The average wage of employees in agriculture has increased several times over. At first glance, this appears to be positive sign. However, the development is still unsatisfactory in comparison with further developed economies, where incomes are at least ten times higher.
The social importance of agriculture is mainly due to its role in food production. Agricultural production also contributes to social justice in society. Farmers and workers can benefit from social benefits. Equal rights are guaranteed in the distribution and use of quality food.

2. Highlight networked problems

The region around Plovdiv/Bulgaria includes an agricultural area of about 800.000 ha with the main crops being cereals, oilseeds, fruit and vegetables. Soils are severely affected by intensive cultivation and require a most careful management. What opportunities do farmers have and what factors may influence their decisions in this process of economic and ecological transformation?

▶ **Possible tasks:**
Gather information about the region around the city of Plovdiv. Use digital media and audiovisual communication tools.
Gather information about transformation processes in the Plovdiv region's agriculture post-after 1990 and after Bulgaria's accession to the EU in 2007. Compare the initial situation around 1990 and the process up till now in terms of number of employees, technological development, use of fertilizers, etc. in tables. Include the seven dimensions.
Inform yourself about the current weather data (amount of precipitation, sunshine hours, etc.) of the last 10 years and compare them in tabular form.
Describe the changes in agricultural production that are attributed to climate change.
Gather information on regional cultivation of fruit, vegetables, oilseeds and cereals. Create an overview of the annual water consumption of agriculture using a self-chosen example
How has production in your chosen example changed over the years? Create an overview and consider digital methods of presentation. Choose a format that suits you and **present** your results.

3. Saving what has been learned

The aim here is to show practicable short and medium-term solutions for increasing agricultural production in Bulgaria. Please note the sustainability dimensions.

List possible short- and medium-term solutions for the farmers.
Explain from your own perspective why farmers should act in the short and medium term.
Evaluate the options for action on basis of sustainable development factors (environmental, economic, social, cultural) and **justify** any possible hierarchical prioritization.
Show how those chosen priorities are interlinked.
Create a graphic/figure/mind map and highlight where your ideas and positions overlap.
Explain which innovative solutions farmers may find for their production and their employees! List pros and cons.
Form working groups (3-4 people).
Discuss the problem with your group members and present their possible solutions to each other.

4. Reflect on interrelations and connections

In a following step, results and findings are discussed and critically reflected in the groups. The weighing of the seven dimensions and positive as well as negative implementation possibilities and their sustainable influence on economic, social and ecological factors in Bulgaria decide on the chosen answers to the questions asked.

Discuss with your group members possible solutions and alternatives for plant production in Bulgaria, taking into account all factors of sustainable development.
Develop an action plan for farmers and present it together with your group in a plenary session.
After the presentation of all groups: **Reflect** on the circumstances and solutions: What problems could plant production have in the future? Consider the seven dimensions.
Derive new learning situations and include the chart „Management of agriculture" in your considerations! Be creative and design a tour of the results in your classroom.

▶ **Potential approaches and solutions:**
Soil health is crucial for sustainability in agriculture. Due to climate change, inappropriate soil management and other factors, soil can suffer from compaction, acidification, heavy metal contamination, erosion, salinization, humus destruction and other forms of deterioration. The idea to achieve sustainable development on behalf of farmers through agriculture inevitably requires rigorous management of production - so that in achieving high production and financial results efforts to keep the soil clean and in its ecological balance are not neglected. Where problems have arisen over time, farmers with advanced systems thinking skills exercise strict controls on their production, aimed at eliminating problems and preserving soil resources.

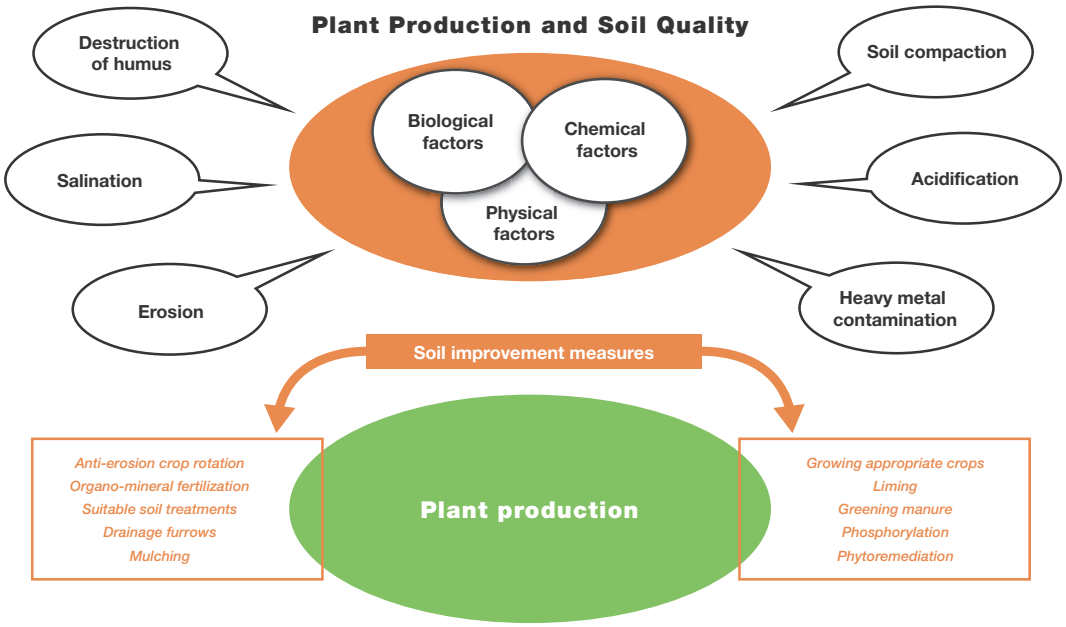


Fig. 9: Management in agriculture: plant production and soil quality.

Sound management relies on specific activities such as…

- Anti-erosion crop sequence - establishing crop-rotation systems that prevent soil erosion, including for example sowing of grassy belts of perennial species, giving preference to winter cereals and catch crops instead of spring cereals, etc.
- Organo-mineral fertilization - recommended for raising humus content and maintaining soil fertility;
- Suitable soil treatment - use of shallower tillage, or even to reduce frequency of treatments, if possible;
- Drainage furrows - basic melioration activity for drainage of moist soils and flushing salts from salinated soils;
- Mulching - soil moisture is maintained and fertility is increased;
- Growing appropriate crops - different soil types are, depending on their structure and chemical composition, suitable for growing different crops;
- Liming - promotes improvement of soil properties and humus quality, increases fertility, and contributes to the development of beneficial soil microflora;
- Green manure - with its green mass, after plowing, the plants enrich the soil with organic matter and nitrogen, improving soil fertility;
- Phosphorylation - soil acidity is eliminated by treatment with phosphate powder.
- Phytoremediation - a technology which uses plants to extract toxic substances from the soil, thus cleaning the soil of contaminants (e.g. heavy metals).

5. Transfer connections to other fields

The production of cereals, fruit and vegetables in Bulgaria can be compared to the situation in other countries.

▶ **Possible tasks:**
Identify countries where similar soil conditions, climate and range of products can be found and compare them with Bulgaria.
Describe similarities and differences.
Compare the chosen countries with Bulgaria in terms of soil conditions, water management and occupational safety and health regulations. What similarities and differences do you see?
Describe them in detail and **comment** on agricultural policy debates and discussions in Europe.

Case study:
A Sustainable agrosilvopastoral system: Integration of sheep farming in olive groves

1. Identify place of learning or learning situation

1.1 Description of the place of learning

Andalusia has the highest concentration of olive groves worldwide. 30 % of the region's agricultural land, i.e. more than 1.5 million hectares are planted with olive trees, a crop with two main products: table olives (5 % of acreage) and olive oil (95 % of acreage). Andalusian olive oil represents 33 %, and sometimes up to 45 % of global total production. Apart from highly mechanized production systems there is still the traditional olive grove using only non-intensive techniques. Traditional olive groves are usually located on less productive soils and, frequently, with steep slopes. Mechanization is difficult or impossible on such sites that however make up about 57 % of the Andalusian with olives growth areas.

This case study explores traditional systems that integrate olive groves and sheep farming. Traditional olive groves have a wider spacing allowing for herbaceous cover as forage for sheep. Animals' grazing and browsing controls vegetation and thus reduces competition for water and nutrients for the olive tree. In addition, grazing reduces expenses for fodder. However, employing sheep for controlling vegetation in olive groves requires careful grazing plans that favor consumption of herbaceous plants and thus avoid browsing damage in the canopy.

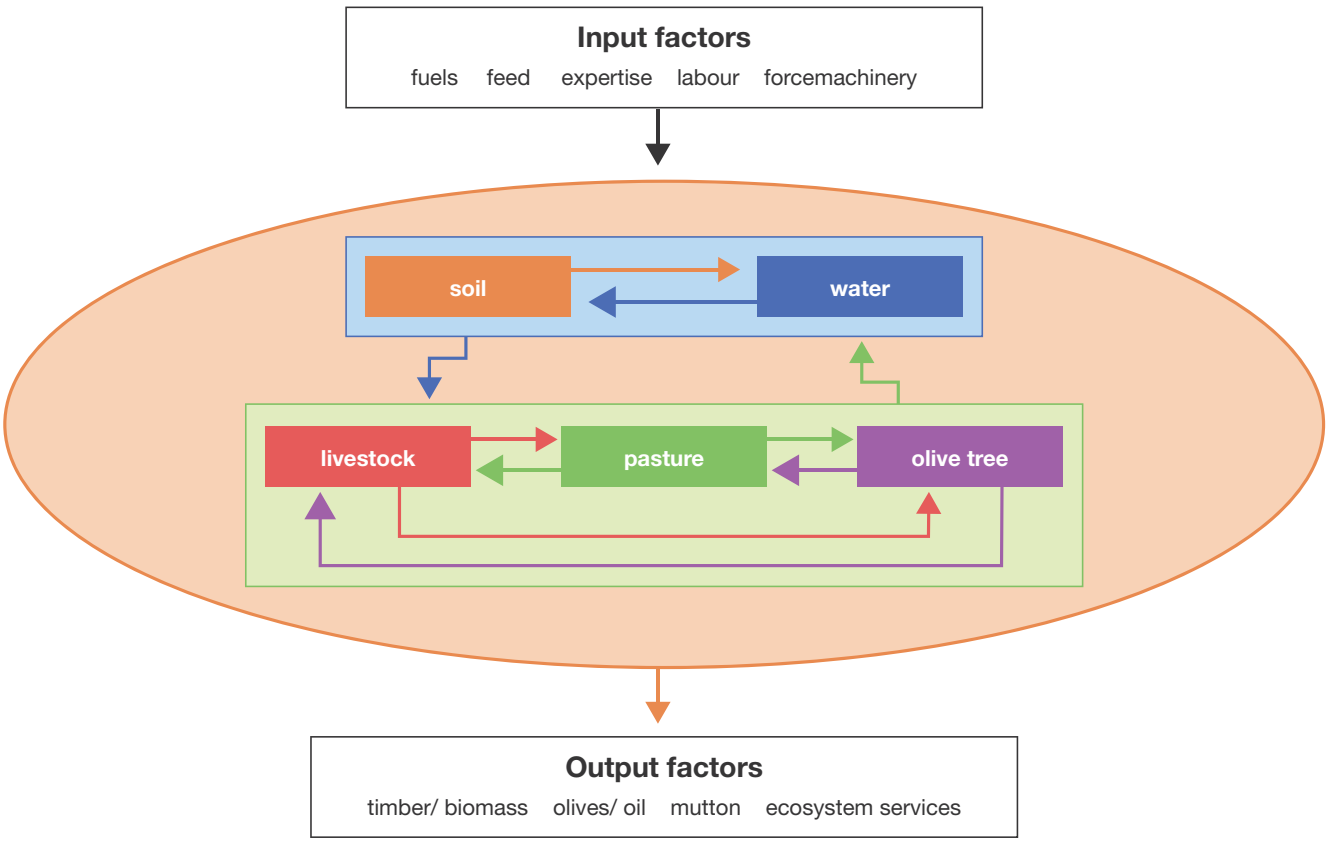


Figure 10: Structure and functioning of the olive-sheep agrosilvopastoral ecosystem.

Processes of management of olive groves and sheep are closely interlinked. For animal management, peaks in labor input are around the parturitions, due to a risk of predation and the ewes' higher nutritional needs. Tree work can easily be organized around processes of animal management. Productivity differs significantly from year to year. Olive production mainly depends on rainfall, temperatures and the production system. Agrosilvopastoral systems of olive production yield between 800 and 2000 kg /ha. The olive crop is either sold to oil mills, usually owned by local cooperatives, or processed on farm. Sheep production is limited to a single lamb per ewe and strongly depends on herbaceous fodder availability.
Such traditional systems are under pressure due to competition with cheaper oil produced from the most intensified plots. High quality certified organic products are one way to ensure economic viability.

Figure 10 represents a general description of the case study, with internal and external relationships. The olive-sheep agrosilvopastoral ecosystem involves non-living (soil, water and climate) and living elements (sheep, pasture and olive groves with many other species). All these elements are interlinked: soil erosion decreases fertility and adds to water scarcity, reducing plant growth and thus availability of forage for livestock. Purchase of additional fodder increases production costs.

As shown in Figure 11 the living system-elements are closely interlinked. Olive trees provide their fruit, branches from pruning for feeding livestock and timber for carving, woodturning and fuelwood. With proper management livestock contributes to controlling vegetation that competes for water, improves biodiversity by seed dispersal, and increases edaphic stability and soil fertility.

Any ecosystem is connected to its surroundings through flows of energy, matter and information. In agrosilvopastoral ecosystem, there is some artificial input in the form of petrol, supplementary fodder, fertilizers and pesticides, machinery and external knowledge. The outputs includes marketable products (olives, biomass, lambs and wool) and ecosystem services. Fire prevention, seed dispersal, preservation of biodiversity, carbon sequestration, landscape services, keeping cultural traditions or livelihood for rural population are services that agrosilvopastoral systems provides to society.

1. Biotic resources
2. Manure is used as fertiliser
3. By-products from olive and pasture production are used as animal feed
4. Grazing prevents water competition between herbaceous plants and olive trees
5. Grazing between olive trees simplifies harvesting
6. Animal stocking increases biodiversity of the pasture land
7. Soil organic matter increases
8. Closed olive grove canopies prvide a shaded place for livestock to rest.
9. Erosion reduction

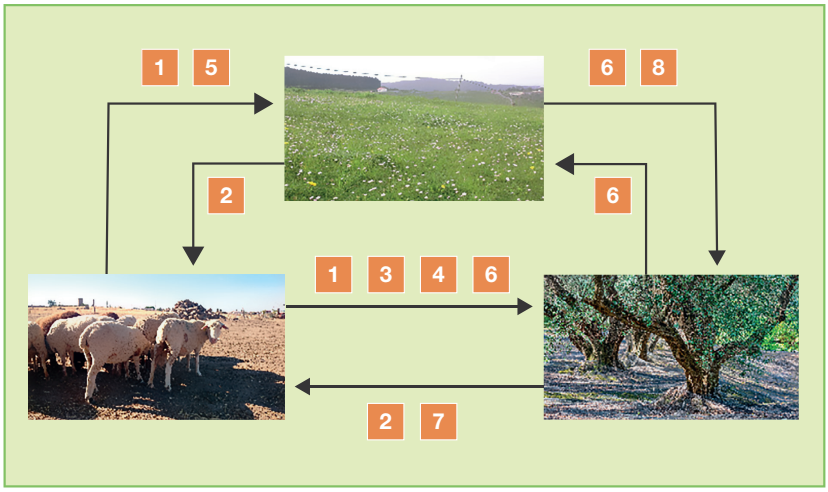


Figure 11: Relationship between the biotic components of the agrosilvopastoral system.

1.2 The dimensions with contents and dynamics

a. Agro-ecological dimension (environment)

Traditionally, olives used to be a non-intensive crop grown on less productive soils. From the 1970's onwards, olive groves were intensified and expanded into more fertile areas. This caused increasing environmental problems (loss of biodiversity, soil erosion, over exploitation of water resources, decline of traditional agriculture and soil and environmental pollution) and producing excess supplies of a little differentiated product. Acreage continues to grow, though at a slower rate.

Main activities on olive trees are pruning, canopy thinning, removal of sprouts and olive harvest. Pruning takes place after the olive harvest, in December, although it can last until March. Canopy thinning and removal of sprouts, when necessary, are carried out in July. Olives are harvested in November, although an earlier harvest may produce a tastier oil. Fertilization is often done in four-plot rotation system with pruning being followed by compost fertilization and sowing vetch and a fourth plot being left to recover. Sheep can enter any plot, but mainly stay in the one with canopy pruning. Grazing can be managed plot-wise or in rotation. The ground can be covered with vegetation or remain bare. Minimum land cover keeps vegetation, including grasses and legumes only on alleys. Nitrogen fixation is achieved by sowing vetch in autumn for cattle grazing in April. Typically native, meat breeds, mainly Merino and Segureña are kept. Sheep are mainly fed grass from the olive grove, although fodder from outside the farm may be added. Grazing is limited to certain months to prevent sheep from damaging trees. All-year grazing is possible only at a low and constant stocking density (1 sheep per hectare) or a variable number depending on the abundance of pastures (from 2.5 to 0.4 sheep per hectare). When grazing occurs only during certain months, sheep enter the olive grove during the winter and spring months, immediately after pruning, with the animals feeding on cut olive branches and fresh grass. For animals that remain in the olive grove over summer, when grass is dry, canopy pruning can provide fresh fodder.

Reproductive management of sheep depends on the intensification level of livestock. To reduce costs as much as possible, feeding of livestock is based either on grazing or using by-products of the olive grove. Then, parturitions should take place at the end of winter or in early spring in order to cover greatest feeding animal's needs with greater amount of natural grass. Lambs are fed by, without any need for supplements, and they are sold at 3 months and 23 kg of weight. Production costs are low, but so is productivity, with, on average, only one single lamb per ewe and year. In order to increase productivity, greater intensification is chosen. In this case, two periods of parturitions are planned: September and April-May. If there is not enough pasture, sheep and lambs receive in addition some externally purchased feed. Lamb can reach 23 kg in 2.5 months, productivity reaches up to 1.8 lambs per sheep per year, but cost of production double in that case.

b. Cultural dimension (rural areas)

Olive groves are Andalusia's most representative agroecosystem and a crop deeply linked to regional culture. They have a high socio-economic, environmental, cultural and landscape value. Their presence in the region dates back to prehistoric times and is documented in the Roman Empire. The definitive development of the monoculture of olive groves occurred in the years 50-70 of the last century, when the profitability of other crops declined and olive groves appeared to be the only alternative. Olive cultivation has evolved in its techniques and work, going from traditional management systems to an industrialized sector. The plot structure of the olive sector is closely related to its cultural roots. In olive groves, with many small and medium producers, the plots have been divided due to successive inheritances inside the families. At present, 60 % of the olive groves are smaller than 5 hectares. This property structure limits managements systems.

c. Local dimension (regional – national – global)

Olive groves represent the main source of income for more than 250.000 Andalusian families. For many more olive groves complement other income. If sheep are raised in Andalusia, but product finishing and commercialization happens elsewhere, Andalusia loses much of the added value. The lower income in rural areas causes younger people to migrate to the cities. As a consequence, the rural population is rapidly aging, with serious consequences for agriculture. Trend can be reversed only by improving the rural population's living conditions.

d. Time dimension (past – present – future)

Nowadays, agriculture and livestock are the main source of income for a mere 3 % of the rural population in Spain and 7 % in Andalusia. This reflects a dramatic historic decline. Mechanization, intensification of production systems, rising prices of land, withdrawal of many traditional activities, the lack of social recognition for the farmers and the low product (the price for lamb has not increased in 40 years), make is difficult for the younger generation to take over business. Consequently, traditional management knowledge is lost and cultural landscapes of great ecological value are endangered.

Traditional agriculture, such as extensive olive groves with grazing sheeps, is a key element to allow for making a living in the country and to combat unemployment, climate change and ensure sustainability of agrifood systems, in the face of water shortage and expensive energy.

It is essential to recognize and value this ecosystem to prevent extinction of activities involved in their management.

e. Economic dimension (supply – demand/ markets)

Olive groves provide Andalusia's most important crop, with a total value ranging between 3.000 and 4.000 million €. This yield is subject to annual variation. The bulk of income is generated by oil production, which in Andalusia amounts to an average of 1.000.000 tons with climate-dependent fluctuations between 800.000 and 1.300.000 tons. Forty percent of the total olive oil produced in Andalusia is sold nationally, with an upward trend. Exports are increasing, subject to annual fluctuations in production. The European market is the most important outlet, with Italy purchasing 29 % of exports. Portugal and the US follow with 12 % each.

Product prices vary greatly, depending on the category of produced oil. Prices for extra virgin olive oil have fluctuated in recent years between 1.28 and 4.05 €/kg. Profitability depends on management systems: in non-mechanized, traditional ones, profitability is around 2.7 €/kg, while in the superintensive systems is 1.6 €/kg. In agrosilvopastoral systems, profitability is around 3 €/kg. Therefore, the differentiation of oils is a key issue for supporting traditional slope systems. With low prices, production costs are not covered.

The Spanish sheep sector counts more than 16.5 million heads. However, domestic consumption of fresh sheep and goat meat is decreasing. Per capita consumption fell from 3.40 kg in 2008 to 1.36 kg in 2018. Lamb meat is only eaten occasionally because of its high price – which however has not increased in 30 years. As a result, production costs are not covered by product prices and farms are highly dependent on EU subsidies.

Diversification of the farm's production, either with other livestock such as Iberian pig, beef or goat or with agriculture (e.g. olive grove) contributes to economic viability.

f. Insight-generating dimension (education, promotion, knowledge)

Traditional olive grove systems also have non-productive functions that increase their value for society: enabling the population to stay in rural areas, monitoring territories, preserving local production systems and landscapes, contribute to mitigate climate change, erosion and desertification and the protection of biodiversity.

Any purchase of products from these agroecosystems supports them. However, they can not be differentiated from other products in the market. Therefore, the main tool to maintain these systems and the ecosystem services provided are CAP grants.

Various actions can improve the situation of a productive sector. For example, interprofessional association for Sheep and Goats of Meat – (INTEROVIC) represents the interests of producers, industry, marketers and tanners involved with the sheep and goat meat sector. It aims to increase national and international markets, to improve product quality and agri-food chains, to promote research and innovation and sheep and goat production, to improve the public image of the sector and to adapting products to market demands. Such initiatives certainly contributes to improving sustainability of the sheep meat sector.

g. Social-political dimension (social context)

Andalusia's per capita income is around 73 % of the European average. With an unemployment rate of 22 % it is one of the Spanish regions with the highest unemployment rates (7 % above Spanish average and more than 12 % above national average in unemployment of young people).

Olive groves are referred to as “social crop” due to its major contribution to employment. More than 15 million working days (23 million in the best campaigns) can be guaranteed, with 50 % of the wages used on harvest. Olive groves are the main source of employment for three hundred Andalusian municipalities. Only 17 % of jobs in this field are occupied by women, with a downward trend due to mechanization. 94 % of employment is generated by farms smaller than 20 hectares, including 47 % of family employment, 48 % salaried and only 5 % as permanent employment. Traditional olive groves generate about twice the employment per hectare compared to superintensive systems. In low-productivity areas, as in this case of study, sheep farming has a dual purpose: on the one hand it allows the population to stay in rural areas and on the other hand it contributes to the survival of these ecosystems. These important functions are not sufficiently recognized by CAP subsidies which is dependent on acreage, not number of livestock.

2. Highlight networked problems

The olive groves in southern Spain, in the Jaén region are the most productive in all of Spain. Olive trees are cultivated here on 550,000 hectares. More than 60 million olive trees provide the basis for 20 % of the world‘s yearly olive oil production. The exact production fluctuates depending on weather conditions. The most widespread olive variety is Picual. Other varieties that are grown here are Royal, Arbequina and Corbicabra.

▶ **Possible assignments:**
Gather information about the Jaén olive groves. Use media and communication technology and audiovisual tools.
List current weather data and data that reflect climate changes (amount of precipitation, hours of sunshine, temperatures, etc.) of the last 10 years and present them in tabular form.
Present the soil types, terrain and growing regions in the province of Jaén.
Describe advantages and disadvantages of agricultural land used for olives.
Describe the cultivation processes in olive groves.
Provide information on the annual consumption of water, fertiliser and herbicides.
Calculate the costs of soil maintenance (per month and year over the last decade).
Identify alternative cultivation methods. **Describe** their efficiency and cost factors (purchase, operation, use of technology and maintenance). **Describe** advantages and disadvantages of olive growing with and without livestock, considering the socio-economic and environmental context. **Describe** the use of ICT in olive groves and state whether work processes have changed.

3. Saving what has been learned

Next, **identify** problems specific for dry olive groves (without livestock) on slopes and steep terrain. Choose one of the listed topics and **discuss** it in your group. Record results on a poster and **present** them together.

▶ **Different topics may be discussed:**
- lack of a young generation of managers,
- low product prices and profitability, price of olive oil and its fluctuations in recent years, problems of adapting to globalised and standardised markets,
- Difficulties in field work due to steep slopes and rugged terrain,
- Dependence on the climate, exacerbated by climate change, development of the production system in a scenario of water scarcity and expensive energy.

Discuss options for action to manage a hillside olive grove within your groups. In doing so, take a closer look at the main topics you discussed earlier!
Prioritize issues in a plenary session and **decide** according to which criteria the management of the olive grove will be maintained or improved in the long term. Create a ranking and substantiate your decision!
Design a structure and draw a graphic of the plenary decision-making process.

4. Reflect on interrelations and connections

After the plenary discussion and presentation of your structure and graphic illustration of the decision process, you should work out, evaluate and critically question the component „integration of sheep into olive groves“.

▶ **Possible assignments:**
Compare olive groves with and without sheep (extensive and intensive olive production)
Describe advantages of integrating sheep into olive culture systems.
Discuss and **evaluate** the advantages of an integrated system over systems that separate olive groves and sheep according to sustainability dimensions:

- interaction between plants and animals (as a goal)
- income diversification
- closure of nutrient cycles,
- principles of circular economy

Define, based on the available information and complementary reading, key practices for good management. Consider in particular work quality and value chains of olive oil and lamb.
Comment on the topics below and discuss them in the context of „integration of sheep in olive groves“:

▶ **Possible focus on the topics:**

- local population structure, income, main economic sectors, relevance of agricultural production
- links between agricultural, social and economic aspects
- Characterization of large-scale olive groves and superintensive cultivation techniques in terms of energy consumption, capital investment and labor input
- description of limiting factors, considering account agri-food models and the market share of products from superintensive olive groves
- energy consumption and availability
- environmental services and intangible contributions of olive groves with sheep to local and global society
- the resilience of these systems in a context of water scarcity and high energy cost
- significance of autonomy as an element of sustainability.

5. Transfer connections to other fields

The model presented in this case study can be transferred onto other traditional agricultural production systems that integrate animal and plant production. This may include Dehesas, Mediterranean forests, sheep farming with grazing in almond groves or feeding from crop residues.

▶ **Possible assignments:**
Discuss in your previous groups what lessons that may have been learned can be transferred to other agricultural systems. Think of animal and plant production.

Create a networking graph to show the relationships within these different systems. (e.g. sheep in olive groves vs. sheep in almond groves)
Justify their suggestions, opinions and critical evaluations in writing.
The product can be a wall newspaper, a game, a poster or a digital product.

A further method that may be used here is the structural analysis of „dry olives and sheep“ production systems. With the help of the structural analysis, learners can prioritize the problems in this ecosystem. The analysis must include both socio-economic and ecological aspects.

Case study:
Occupational Safety and Health in the use of plant protection products in fruit and vegetable production

1. Identify the place of learning and learning situation

1.1 Description of the learning situation

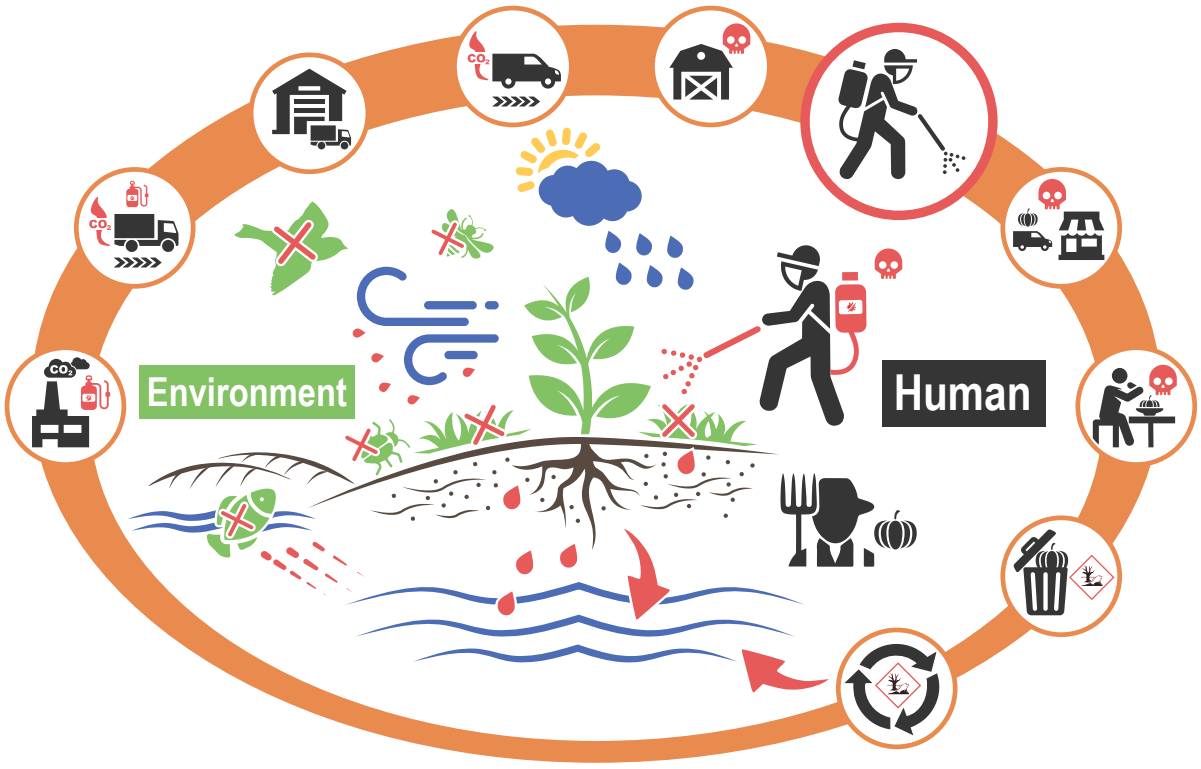


Fig. 12: Effects of plant protection products on humans and the environment over the production and application cycle.

The learning situation for the subject area of occupational safety and health covers the use of plant protection products (PPP) in companies that produce fruit and vegetables in a conventional manner. For a description of the overall situation we consider the effects on humans and the environment in the entire production and application cycle and beyond (fig. 12).

Crop protection products are transported from the production site, to a dealer or distributor for storage. After purchase by a business, they are delivered from the warehouse to the farm.
The products may only be used by personnel (see info box: certificate of competence) certified who are competent and certified fir handling plant protection products or who have been instructed in the current rules of handling and conduct by a certified person. The latter applies especially to trainees or unskilled workers in the company. Furthermore, workers also must wear personal protective equipment (PPE).

„What are plant protection products (PPPs)?

Plant protection products are chemical or biological compounds designed to protect plants or plant products from damage by animals (for example insects or rodents) or diseases such as fungal infections. Products used to control plants, such as undesirable weeds, are also included in plant protection products. Oftentimes the term pesticides, which also includes biocides is used instead of plant protection products“[26].

Certificate of competence

Anyone who
- works with plant protection products,
- sells plant protection products sold,
- instructs or supervises non-specialist persons in the context of a training relationship or simple auxiliary activity, or
- advises on plant protection

must have a certificate of competence. This implements EU law into national law. https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX:32009R1107 [27]

After harvesting, the pesticide-treated fruit and vegetables are loaded for sale and delivered to the dealer. When end consumers purchase conventionally grown and treated fruit and vegetables there is a risk that they will absorb residues of the pesticide when consuming the product. Residues and surplus of the produce are disposed of in the garbage. Residues of PPP can be discharged into the sewage system and ultimately into the water cycle via the consumer's excretions. The application of PPPs on fruit and vegetables has a variety of effects on humans and the environment. Improper use can significantly impact human health and the environment and can also damage the crop itself. In addition to intended effects on undesirable weeds and pests, PPPs have serious environmental impacts. For example, they can be accumulated in the food chain, leached into the groundwater and stored in soils, thus disturbing the ecological balance significantly. The loss biodiversity in agriculture is largely due to the application of PPPs.

Effects on human health
PP chemicals of can enter the human body via different routes when applied, for example through direct absorption via inhalation through the mouth and nose. The compounds subsequently travel through the body and may cause for example visual disturbances. Uptake may also occur via skin contact causing irritation and skin burns. Improper application and inadequate protective clothing enhance the risk.

Effects on ground and surface water
Highly mobile hazardous substances can be rapidly washed out into the groundwater. Residues of PPPs in upper soil layers can be transported to nearby streams and other bodies of water by surface runoff. This occurs particularly in the absence of a plant cover and during prolonged heavy precipitation.

Effects on soils
The PPPs can either be adsorbed to soil particles or dissolved in percolating water. Degradation of these substances is initially rapid, but then decreases slowly and residues therefore remain in the soil over a long period of time. The accumulation of PPPs in the soil reduces its quality as a habitat in the long term. This leads to a loss of biodiversity and its function in the cycle of materials is impaired. Soils can hardly recover from such disturbances and loss of soil quality.

Effects on air quality
In dry and warm weather, active ingredients can evaporate into the air and be blown further into the environment. Subsequently compounds are sometimes detected in rainwater. In addition, improper application, such during strong winds, can cause drifts and unintentional contamination of other surfaces.

Effects on fauna and flora
PPPs interfere with natural biotic processes and massively alter flora and fauna, so that organisms that are useful for agriculture are also killed. Pollutants can accumulate in a food chain. Pollutant concentration is increasingly higher in the top levels of food networks (plant ➡ herbivore ➡ carnivore ➡ etc.).

1.2 Dimensions in contents and dynamics

In the further elaboration, we will include a concrete **place of learning**, in addition to the learning situation that exists throughout Europe in the application of PPPs in conventional agriculture and, with other rules, also in organic agriculture, which is also subject to the same European rules. This **learning situation** is a conventionally managed fruit and vegetable farm in Brandenburg using integrated plant protection.

a. Agro-ecological dimension (environment)
Chemical plant protection is of major economic importance for plant production by controlling harmful organisms including animals, plants, fungi, bacteria or viruses. The active ingredients used are sometimes highly toxic substances that can harm both the environment and people.

Both users and people who are not involved but are exposed to the substances may be affected. The use of PPPs has not only desirable effects on the crop and the accompanying flora. Long-time application may lead to the development in both, the crop plants and the accompanying flora as well as in the target pests.

PPPs attack both, pests and beneficial insects. Effects such as drifts of technically unavoidable residual dusts of the spray agent also affect adjacent plots and their crops and other flora as well as desired fauna such as pollinating insects. Heavy metals and other toxic substances can leach into the groundwater and adjacent water bodies. Finally, residues in fruit, vegetables and cereals can also reach end consumer, thus causing health risks and triggering allergies.

Integrated Pest Management

In practical terms, integrated plant protection means „As much as necessary - as little as possible!“ The following measures should also be applied:

- Select plants suitable for the location
- Resistant varieties
- Fertilizing according to needs
- Plant strengthening agents
- keep to crop rotations
- Green manure
- Combination of physical and biotechnical plant protection measures
- Biological plant protection has priority over chemical plant protection
- Use substances that are as environmentally friendly as possible[28]

A place of learning: In Brandenburg, most agricultural land is cultivated conventionally or according to the principles of integrated plant protection. For the most part soils in the example region are sandy and partly interspersed with clay. Temperatures rise sharply in the summer months and there are increasingly persistent heat waves. High temperatures and the lack of water supply affect plant health. This aggravate drought damage and renders the plants more susceptible to pests. In recent years, climate change has led to a much higher frequency of extreme weather situations with prolonged drought or heavy rainfall, thus posing further risks to crops. The milder winters with fewer days of frost promote weeds that germinate in autumn and are difficult to control. Warm and humid weather conditions enhance the growth of a number of pests and heat-loving insects leading to various types of damage to crops.

b. Cultural dimension (rural area)
There has been a cultural change in the way PPPs are handled. For a long time, the use of spraying agents in particular was seen positively, but with the strengthening of the environmental movement and sustainable environmental awareness, an increasingly critical attitude towards the use of pesticides has emerged. Personal protective equipment (PPE) for employees was improved. The use of pesticides also increased the use of optimized (dressed/pilled) seed. This reduced biodiversity in crop species. Old crops were pushed back and some became extinct. Site-specific, old heirloom seed-bearing crop species, which as regional specialties enhanced culinary diversity and were regarded as cultural assets, were eventually superseded.

c. Local dimension (regional-national-global)
Within the European Union, there are uniform regulations for the approval procedure for the use and handling of pesticides. A certificate of competence in handling pesticides is required in all EU countries. The training is obligatory and subject to European regulations. National states are required to draw up National Action Plans (NAPs) for the appropriate use of PPPs and to incorporate EU regulations.
Throughout the entire production and application cycle of PPPs, considerable impacts on humans and the environment may be observed. This may be in seed production, production of pesticides, on transport routes, at the headquarters of horticultural business, on arable land, and during further processing and storage. Depending on the location of the different activities, there are different working conditions and burdens that affect farmers and employees.

A place of learning : The Brandenburg-based company markets its products at farmers markets in neighboring small towns as far as the outskirts of Berlin. The company is well-known there. Customers appreciate regionality and expect healthy and good products.

d. Time dimension (past – present – future)
The use of PPPs has changed significantly over the recent decades. In the 1960s it was „normal" to apply poisons such as „E605" (highly toxic insecticide) to the fields and protective regulations for users were often not implemented. Meanwhile there is strict European legislation on PPPs, which must be implemented in national legislation. The use of PPPs and protection of humans and the environment are therefore now subject to European directives. However, serious infringements of these directives are frequently detected.

European Union regulations concerning the use of PPPs

"The basis for EU legislation is Regulation (EC) No 1107/2009 (https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX:32009R1107) - download available in all EU languages) concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. The Regulation also regulates the Community examination of active substances. It replaced Directive 91/414/EEC on 14 June 2011.
Plant protection products are subject to authorization under the Regulation. Authorizations are granted by the Member States. Authorizations may be applied for in several Member States simultaneously under the „zonal procedure", which then cooperate in the procedure. Under certain conditions, existing authorizations must be recognized by other Member States in a simplified procedure.
Already directive 91/414/EEC had harmonized the data requirements for plant protection products and their active substances, established uniform authorization criteria and introduced uniform rules on packaging and labelling. The most important element of harmonization is an EU-wide positive list of active substances approved for use in plant protection products […]" [29]

A place of learning : The horticultural company in Brandenburg was established around 2000 and has built up a good reputation in recent years. Recently, the conventionally managed company has increasingly been working according to the methods of integrated plant protection. This is also due to the adaptation to the customer demand for regional products, but also for „healthy" and residue-free food, which has become increasingly important.

e. Economic dimension (supply and demand/ markets)
The production of PPP is a most profitable economic sector. Most chemical companies that produce PPPs operate worldwide and are often also involved in seed production and breeding. The influence on politics and legislation is considerable, and even sensational scandals such as the glyphosate Monsanto/Bayer indictments in the US do not seem to cause substantial damage to the companies or make them rethink their business models. European restrictions on the approval of substances that are highly toxic to humans and the environment do not prevent companies from using them in South America or Africa, where far fewer approval restrictions apply. In these regions however people and the environment are mostly exposed to these highly toxic substances without any protection. Small farmers and farm workers do not have the means to afford protective clothing and usually are not equipped with such clothing by companies. In addition, pesticides are also sprayed from crop-dusting planes, which in Europe is now only permitted in exceptional cases. The Federal Government of Germany would be able to legally prohibit the export of pesticides produced in Germany to these countries, as has been done by law in France.[30]

A place of learning: The company makes its main turnover through direct marketing to a large, regional customer base (direct consumers and gastronomy). They expect „their business" to supply them with residue-free and healthy regional food. Organic production is less in demand, as it would also involve considerably higher product costs. Careful and transparent handling of PPPs at farm level is therefore particularly important for customer confidence.

f. Insight-generating dimension (education for sustainability and sustainable development)
From the complex interrelationships - environment - people - society - economy, future-oriented decisions must be made on basis of the available information. As a key competence to promote responsible thinking and acting, sustainability is to be focused in the educational sector. This also

includes the necessary restrictions on use, proof of expertise and rules of conduct for handling PPPs. By envisioning the S-T-O-P principle a work safety culture can be implemented among the employees. This includes the protection of their own work force and the safety of the workplace in their work before starting any professional activity. In addition, the long-term protection of the environment and resources should also be included in the sense of a sustainability-oriented way of thinking and acting.

A place of learning: The horticultural business makes every effort to continuously inform and train all trainees and employees, in particular with regard to safety and health regulations. Risk assessments of the workplace, especially regarding the handling of PPP, are carried out with the entire workforce.

g. Social-political dimension (social context)
Legal regulations on the use of PPPs have been increasingly tightened in past decades, and controls by state authorities have become more stringent. With the expansion of organic farming, the rules on the use of PPPs have become stricter, particularly in this sector. With growing civil society protests and demands around the major issue of environmental policy, politicians are also faced with the challenge of translating the three pillars of sustainability „ecology, economy and social affairs“ into ordinances and laws and ensuring compliance. Since 2009 there has been a Community framework for action at European level for the sustainable use of pesticides, in which the member states are obliged to draw up national action plans for PPP use of s. In these action plans, education and training are also laid down. As all other activities the use of PPPs requires a risk assessment.

A place of learning: The company is faced with a wealth of rules and regulations, all of which must be complied with. In addition, on top of work in production, certificates of competence must be renewed at least every three years.

2. Highlight networked problems

Pest infestation is expected in the H1 greenhouse as well as in the open field crops (all strawberries) of the company *Gemüse-Gartenbau e.G.* due to the persistently high temperatures and water shortage. In this marketing year, an extreme dry spell has been recorded, in addition, UV radiation is extremely high. The crops are still in good condition and it is as yet uncertain what damage will remain to the crop.

Task: What measures are to be taken for stocktaking and integrated plant protection? Which measures for the protection of man and environment have to be taken by the employees of the company *Gemüse-Gartenbau e.G.*?

▶ Possible assignments:
Collect information about the company *Gemüse-Gartenbau e.G.* using media and communicative and audiovisual means.
Inform yourself about current weather data (amount of precipitation, hours of sunshine etc.) of the region of Brandenburg/Germany and compare them to historic data. Observe changes since the 1950s.
Describe the cultivation processes (approx. 4 varieties of strawberry plants, different harvest times) at the company *Gemüse-Gartenbau e.G.*.
Discuss the technical equipment in the field of plant protection (technology and equipment, PPE, ICT).
Describe which pests may occur and have to be controlled sustainably from an ecological and economic point of view to protect the harvest. Use digital techniques. Arrange the facts in a table. What measures

▶ Possible steps of action in risk assessment

There is no mandatory way of conducting a risk assessment. Rather, the scope and methodology of the risk assessment should always consider the concrete operational conditions.

1. Defining work areas and activities
2. Identification of hazards
3. Assessing the hazards
4. Determination of the protective measures
5. Implementation of safeguard measures
6. Verification of effectiveness
7. Updating risk assessment

are to be taken by employees in the short term?
Develop an A3 poster of measures in a group (3-4 people). Present these results in a plenary session.
Address potential dangers for the plants/harvest from pests and diseases, using both digital techniques and experience-based knowledge.
Discuss the current pesticide laws and permissible agents in the Brandenburg region in writing.
Explain the potential danger to humans and the environment (especially soil and water) on basis of the information collected. Visualize the results in a separate presentation.

3. Saving what has been learned

▶ **Assignment:**
First, work on the tasks individually. Afterwards, form groups (core groups) of 3-4 people and **discuss** the solutions, covering different possible solutions and alternatives with your group members, including all factors of sustainable development. Find a strategy together and write it on a (digital) poster. Present it to the plenary session.

▶ **Tasks:**
Name solutions that are feasible for the company *Gemüse-Gartenbau e.G.* both short and medium-term.
Describe from your perspective how the company should act in the short and medium term. Which adaptation strategies have to be implemented in the long term? Evaluate the employees' options for action based on factors of sustainable development (ecological, economic, social) and justify possible hierarchical prioritization of strategic adjustments.
Name measures for environmental protection and personal protection (risk assessment) using the STOP principle.
Explain further health risks, e.g. stress in decision-making and review of measures, musculoskeletal risks - e.g. wearing of equipment, safety clothing.
Put this list in relation to each other. Create a graphic or mind map and mark the interfaces of the measures in color.
Explain how savings and reductions in hazardous substances (PPP) can be achieved using both, the resources currently used in the company and new innovative approaches. Define protective measures using the **risk assessment tool**.

4. Reflect on interrelations and connections

The presentation of possible solutions in the plenum gives all trainees the opportunity to reflect individually on what has been presented. Uncertainties can be resolved by asking questions.

▶ **Possible assignments:**
Form new groups (expert groups) so that each new group contains one person from the previous groups.
Reflect on solutions for short, medium and long-term crop protection management measures within your groups or together in plenary sessions. **Discuss** in the light of sustainability the ecological, economic and social factors which problems will be faced by *Gemüse-Gartenbau e.G.* in the future.
Describe which further measures the company's employees have to expect in the course of climate change (rising temperatures, higher UV radiation, heavy rain and storm events, warm and humid conditions, immigration of new pests, increase in biodiversity due to harmful plants, milder winters, etc.) and how this will affect possible measures in occupational safety and health.
Present the results on a results poster in a plenary session. Do a gallery walk and **discuss** the individual results.

▶ **Further possible focal points to deepen the topic:**
- Advantages and disadvantages of using technology, digitization 4.0 and effects on the environment;
- Conversion of farms to organic production;
- optimization of crop cultivation;
- ecological/sustainable aspects of crop protection;
- Use of beneficial organisms, economic viability of use and benefits;
- Invasive animals and plants, etc.

▶ **Possible solutions and alternatives:**

Please apply the S-T-O-P principle:
- **S**ubstitution: find alternatives in the use of agents; other cultivation methods
- **T**echnical measures: Use of technical controls in the crop; promotion of „beneficial organisms"; growing other more resource-efficient and resistant crops; preventive measures
- **O**rganisational measures: Good management of plants
- **P**ersonal and behavioral safety measures: Renewal of the certificate of competence; training; prevention

5. Transfer connections to other fields

After the group work, presentation of results and possible solutions for the *Gemüse-Gartenbau e.G.*, the insights gained can be transferred to other areas. Further questions can also lead to new learning situations. Plant protection and occupational safety and health are opposed to each other in all agricultural and horticultural businesses. This also applies to organic cultivation. The application of the chemicals can have far-reaching consequences on the health of the employees. Also the surrounding towns and districts as well as the countryside are affected if pesticides are deposited or enter the groundwater. This is the same in all parts of the world. In many countries in Europe and the world, precautions for handling PPPs are not sufficiently regulated to protect workers. Comparisons and new research may be a useful basis for trainees to discuss the laws of other countries in comparison with Germany and the EU states and their agricultural policies. Various other areas offer possible points of connection and can be found in Fig. 12 „Production and application cycle".

▶ **Possible areas of transfer:**

- Other forms of vegetable cultivation in Europe, especially specialty crops such as asparagus, artichokes, blueberries or strawberries
- Special cultural practices (e.g. aquaculture, fisheries, permaculture, etc.)
- Cereal farming
- Grassland farming
- Livestock farming; ewe management, grazing
- Forestry
- Transfer to application of fertilizer regulations, measures and restrictions, and the effects of climate change on fertilizer application
- Economic interest in agricultural policy and opinions of the population/activists (Greenpeace, Fridays-for-future, etc.)

▶ **Possible assignments:**
Study the conditions and regulations of PPP in Germany. Compare these with EU regulations in a table. **Describe** similarities and differences.
Discuss the findings of the example business with real companies in your area.
Draw a diagram to illustrate the relationships.
Discuss them in your groups (expert groups) or in the plenum.
Finally, **evaluate** the thoughts and actions of each individual. Think about the employees of the company, governments, politicians and economic actors.

5 Analysis of practical trainings and perspectives for vocational education

Analysis of practical trainings

Curriculum and Guideline were tested in two **practical trainings** (Short Term Training - STT) with teachers and practical trainers working in the agricultural sector. The first STT was conducted at Dehesa San Francisco in Andalusia/Spain in October 2019 with a group of 11 participants from four partner countries. The training focused on **Dehesa cultural landscapes as learning location**. In the course of **three days**, participants became familiar with the AgriTrain pedagogical concept to soil science, **water management** and **occupational safety and health** and explored transfer to the local situation at the Dehesa and their own learning locations. In the implementation of the pedagogical concept, emphasis was on „the complete action“ and transfer content knowledge and methodology. Participants exchanged on their experience working with trainees and students in their countries. The training was evaluated with both, participants and trainers. The concept was adapted accordingly.

A second STT was conducted in February 2020 in Berlin with seven participants from Spain, Bulgaria and Germany. The vastly different **urban learning location** stimulated a change of perspective, while maintaining the same overall process and communicating the five steps of the pedagogical concept as before.

The training met with a positive response from all participants. The mix of methods, including games, discussions, presentations, practical exercises and the sharing of experiences across national borders and educational systems was evaluated positively. Participants saw great potential for transfer and application in their own work context. So far, most of the participants‘ pedagogical approaches were of a rather linear, chronological and subject systematic nature. The training introduced participants with the principle of the „complete action“ and the inclusion of the learning location in the practical teaching. Knowledge of **Vocational Education and Training for Sustainable Development** (VETSD) in day-to-day vocational schooling and practical training varied. Discussions on the integration of the pedagogical concept into the cross-cutting task of ESD and on systems thinking and acting led to „aha” moments. In addition to the pedagogical concept of AgriTrain, also the educational package of the precursor project AgriSkills inspired participants. Access to comparable materials was generally considered to be difficult and it was pointed out by participants that this required a great deal of research. Finally, yet importantly, technically correct translation was mentioned as a particular challenge.

Furthermore, important points emerged both during individual evaluation interviews, and in the group discussions:

- Materials that are suitable for use in different EU countries are mostly unavailable in national languages (especially BG and ES).
- There is often a lack in methodological guidance on materials and their implementation in theoretical and practical teaching.
- As the effort of creating new materials is very high teachers and trainers tend to continue using materials that already exist and are available,
- In the training educational awareness of the participants was raised and the understanding of systems-thinking based teaching approaches was promoted.
- Participants requested more materials and aids, such as the results of the AgriTrain and AgriSkills projects, for their use throughout Europe.
- Connections between sustainability and systems-approaches in thinking and acting, and their implementation in vocational training, turned out to be not sufficiently known.
- There is a need for a wider spectrum of methods for teaching and using ICT.

- For some participants the cross-sectional task of ESD in vocational schools is challenging to integrate, for lack of expertise and methods and there is a dearth of further and continuing education).
- European cooperation of teachers and trainers wants further development.

Perspectives for vocational education

In the process of developing the pedagogical concept, describing of the case studies and implementing, analyzing and evaluating the practical trial runs, the orientation and focus of a vocational training for sustainable development emerged in greater clarity.

- As a methodological-didactic approach in vocational education and training towards understanding ESD, learning with concrete examples such as specific learning locations or situation is pivotal. This approach helps illustrating the complexity of many processes of relevance to sustainable development. A **learning location** offers a plethora of individual phenomena that want to be recognized, understood and reflected upon.
- In engaging with and analyzing individual phenomena, their interaction and integration in the (extended) dimensions of sustainability is expected to trigger **cognitive processes** that lead to insights in possible courses of action and promote the development of competences of designing and shaping a work situation. The use of **ICT** supports learning processes.
- This approach requires a different handling of traditional subject-oriented curricula. The contents of a simplified canon of subjects can be consolidated in specific tasks and assignments within learning-location based projects. Experience, from AgriTrain, its forerunner project AgriSkills and other projects suggests that innovative and motivating forms of learning improve students' and trainees' „learning appetite" and participation and, by being action-oriented, promote the development of **competences of designing** and shaping their own learning processes. Highlighting problems and deriving possible solutions in concrete tasks also fosters the development of the **learners' competences of independent learning** and **self-efficacy**.
- The importance of **lifelong learning** needs to be widely recognized and the potential of both content and methods taught within the framework of ESD to foster the joy of learning wants to be utilized. Structural changes in the countries of Europe require improved access to new occupational fields, not least because of digitization.
- By placing the learning location and its individual phenomena in the extended dimensions of sustainability, **systems thinking** is promoted and constant reflection is integrated into all learning steps.
- Teachers need to be empowered to place their educational concepts within an ESD context. Transparency and constant review of **quality criteria and indicators** can be a valuable support. To this end, there is a demand for quality-checked material.
- Work in **transnational strategic partnerships** highlighted differences between individual countries as to their concept and understanding of ESD. For a fundamental adaptation and implementation drafting principles, e.g. in the context of qualification frameworks such as the EQF, does not suffice. Constant processes of constructive dialogue are needed.

6 Sources and references

[1] Vgl. Gudjons, H. (2009): Handlungsorientiert Lehren und Lernen. 7. Aufl., Bad Heilbrunn: Julius Klinkhardt.

[2] Vgl. Riess, W., Mischo, C. (2010): Promoting systems thinking through biology lessons. *International Journal of Science Education*, 32(6), 705–725.

[3] Vgl. Bawden, R.J., Macadam, R.M., Packham, R.G., and Valentine, I (1984): Systems Thinking and Practices in the Education of Agriculturalists. *Agricultural Systems* 13:205-225.

[4] Shannon, D. (2017). Teaching on the Farm: Farm as Place in the Sociology of Food and Sustainability. D. Shannon, J. Galle (eds.) Interdisciplinary Approaches to Pedagogy and Place-Based Education: From Abstract to the Quotidian. Springer.

[5] Hannan, L., Duhs, R. and Chatterjee, H.J. (2013). Object Based Learning: a powerful pedagogy for higher education. In: A Boddington, J Boys & C. Speight, (eds.) *Museums and Higher Education Working Together: Challenges and Opportunities.* Farnham and Burlington: Ashgate, pp. 159–168.

[6] Kador, T, Chatterjee, H & Hannan, L. (2017). The Materials of Life: Making meaning through object-based learning in twenty-first century Higher Education. In: D Fung & B Carnell (eds.), Disciplinary Approaches to Connecting the Higher Education Curriculum. UCL Press; London, pp. 60–74.

[7] Müller, H.J., Stürzl, W. (1990). Handlungs- und erfahrungsorientiertes Lernen – Ein methodisches Konzept zur integrierten Förderung von Fach- und Schlüsselqualifikationen. In: H. Herzer, G. Dybowski, H. G. Bauer (Hrsg.): Methoden betrieblicher Weiterbildung. Eschborn. S. 172–198.

[8] Weinert, F. E. (2014). Leistungsmessungen in Schulen. 3. Auflage. Beltz, Weinheim.

[9] Vgl. HAUP (2013). Hochschule für Agrar- und Umweltpädagogik. Weiterbildung und Forschung. Grüne Pädagogik. Wien.

[10] Bräuer; M. (2004). Handlungsorientiertes Lehr-Lern-Arrangement im Fachunterricht von Gärtnern und Landwirten. Beiträge zur Fachdidaktik Land- und Gartenbauwissenschaft. Studien zur Berufspädagogik, Bd. 11, Verlag Dr. Kovac, Hamburg.

[11] Vgl. Bieler, I. et al (2011): Obst im Havelland. Die Entwicklung des HOG. In: GSG mbH: http://www.gsg-netzwerk.de/fileadmin/content/projekte/obst_im_havelland/Tafel3.pdf) [Zugriff: 14.01.2020].

[12] Vgl. Leibniz-Zentrum für Agrarlandschaft (2009 – 2014): Anpassungstools für einen klimaplastischen Ökolandbau: www.inka-bb.de (Landwirtschaft) [Zugriff: 14.01.2020].

[13] Vgl. Nestler, R. (2019): Berlins Grundwasser heizt sich immer weiter auf. In: Tagesspiegel Nr. 23, 844 vom 04.06.2019.

[14] Vgl. Schulz, R. (2019): Der Raub des Landschaftszaubers/ Infokasten: Daten zum strukturellen und funktionellen Wandel der Landschaften. In: Naturmagazin Berlin-Brandenburg, 3/2019, S.7.

[15] Vgl. Wasserverteilung könnte zum Streitfall werden. In: Zeitung für kommunale Wirtschaft (ZfK) vom 08.07.2019: https://www.zfk.de/artikel/07ca6e7747b012bb8ad2dc23c7ccd4d4/wasserverteilung-koennte-zum-streitfall-werden-2019-07-08/ [Zugriff am 18.03.2020].

[16] Vgl. Landnutzung und Resilienz. In: Potsdam Institute for Climate Impact Research (PIK) e. V.: Müller, Dr. C., Arbeitsgruppe Landnutzung und Resilienz: https://www.pik-potsdam.de/forschung/klimaresilienz/forschung/landnutzung-und-resilienz [Zugriff: 12.03.2020].

[17] Umweltbundesamt (Hrsg.) (2019), Monitoringbericht 2019 zur Deutschen Anpassungsstrategie an den Klimawandel, S. 27, Bonn, 2019.

[18] Vgl. Jaster, K.; Filler, G. (2003): Umgestaltung der Landwirtschaft in Ostdeutschland. Working Paper der Humboldt Universität zu Berlin, Nr. 63, S. 21.

[29] CAMPOS, PALACÍN P. (1992): "Reunión Internacional sobre sistemas agroforestales de dehesas y montados.", in: Agricultura y Sociedad, 62. MAPA. Madrid. S. 197-202.

[20] Vgl. Landmann, et. al, (2018) Die Finca-Fibel.

[21] Vgl. https://www.spektrum.de/lexikon/geographie/transhumanz/8223 [Zugriff 02.06.2020).

[22] Vgl. www.fundacionmontemediterraneo.com / [Zugriff 10.10.2019].

[23] Vgl. Milolaza, A. (2013) Internationales Handbuch der Berufsbildung, Spanien, BIBB, Bonn.

[24] Vgl. Savory, Allan, (2005), Holistic Management.

[25] Godet, M. 1986. Introduction to la prospective: seven key ideas and one scenario method futures, 18(2), 134-157.

[26] Umweltbundesamt (2015): Was sind Pflanzenschutzmittel? Unter: https://www.umweltbundesamt.de/themen/chemikalien/pflanzenschutzmittel [Zugriff 04.06.2020].

[27] Verordnung (EG) Nr. 1107/2009 des Europäischen Parlaments und des Rates vom 21. Oktober 2009 über das Inverkehrbringen von Pflanzenschutzmitteln und zur Aufhebung der Richtlinien 79/117/EWG und 91/414/EWG des Rates

[28] Umweltbundesamt (2016): Was sind Pflanzenschutzmittel? Unter: https://www.umweltbundesamt.de/integrierter-pflanzenschutz-spart-arbeit-schont-die#1x1-des-integrierten-pflanzenschutzes [Zugriff am 16.06.2020].

[29] EU-Law (2019): https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX:32009R1107 ; BVL : Regelungen der Europäischen Union, unter: https://www.bvl.bund.de/DE/Arbeitsbereiche/04_Pflanzenschutzmittel/03_Antragsteller/13_Rechtsvorschriften/02_RegelungenEU/psm_regelungenEU_node.html, [Zugriff 05.06.2020].

[30] Vgl. Conseil-constitutionnel: Décision n° 2019-823 QPC du 31.janvier 2020, 31. Januar 2020.

[31] Siehe EU-Law: unter: https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX:32009R1107, [Zugriff 03.06.2020].

[32] BMJV: ArbSchG: § 5 Beurteilung der Arbeitsbedingungen. Unter: https://www.gesetze-im-internet.de/arbschg/__5.html, [Zugriff 04.06.2020].

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