

Innovations in the professional education of teachers and trainers in the field of sustainable agriculture development

Tonya Georgieva^{1*}, Yvonne Grau², Malgorzata Berova¹, Rumyana Georgieva¹ and Yordan Yordanov¹

¹Agricultural University, Faculty of Agronomy, Department of Plant production, 4000 Plovdiv, Bulgaria

²PECO-Institute for Sustainable Development, 10117 Berlin, Germany

*Corresponding author: tonia@au-plovdiv.bg

Abstract

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European, and in particular Bulgarian agriculture, faces serious challenges. In addition to produce high-quality food, it must meet the growing needs of environmental protection; while providing good and secure jobs. Technological changes and advancing digitalization have penetrated almost all production sectors, especially agriculture. According to the principles of Education for Sustainable Development and the Digital Education Plan, politicians require adequate professional qualifications.

The article presents a model for implementing Education for Sustainable Development in the system of vocational education with examples of soil quality management, water management and training in occupational safety and health. Training materials have been developed to be used for the development of systematic thinking through innovative pedagogical technologies. Methodological guidelines for using a 5-level pedagogical concept in the implementation of Education for Sustainable Development are presented.

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Keywords: sustainability; environment; education for sustainable development; pedagogical concept; sustainable management of agriculture

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 by the principles of Education for Sustainable Development and, most recently, an action plan for digital education (Kador et al., 2017).

Educational planners, trainers and instructors are thus constantly facing new challenges. On the one hand, new con-

tent always 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 (Werner & Mischo, 2010).

The article presents an innovative development of a pedagogical concept, which through an example from the Bulgarian agricultural science and practice develops a model for education for sustainable development, applicable both in the system of vocational education and in the system of higher education.

Material and Methods

During the development of the model a theoretical analysis of the 5-level pedagogical concept applied in the

pedagogical practice in Western Europe was made and the possibilities for its adaptation in the vocational education in Bulgaria were analyzed.

In interviews with principals and teachers from 7 agricultural vocational schools, the opinion and attitudes of teachers to introduce the idea of sustainability in agriculture in the curriculum of agricultural disciplines, as well as the participation of digital technologies in its application and development have been discussed.

The developed model offers an opportunity to develop systematic thinking (Bawden et al., 1984) by connecting soils and waters as a natural resource with the problems of ecology and crop production. In the context of the model, the 7 dimensions of sustainability at each stage of the 5-level pedagogical concept are interpreted. The model is presented graphically. In the long term, the development aims not to obtain new knowledge but to develop an idea and a model for changing the thinking of the trainees in the context of sustainability of the practiced agriculture.

Results and Discussion

The implementation of the concept of sustainability requires vocational education and professional training that is oriented towards sustainability goals and the development of sustainability competencies. Teachers in vocational schools and in-company trainers and persons in similar functions need competencies of vocational education and training for sustainable development to support trainees in the development of sustainability competencies.

“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 (Rieckmann, 2017).

Comprehensive sustainability competencies, i.e. beyond the possession of the relevant knowledge and the ability and the will (volition) to act for development towards sustainability, are necessary for transforming society and economy.

Education for Sustainable Development (ESD) must promote the development of sustainability competencies 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 competencies and has a long-term influence on the development of the economy.

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 Model of Complete Action and Vocational Education for Sustainable development

The model of “the complete action” (Figure 1) 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 informing, planning, deciding, executing, controlling and evaluating are carried out as central learning actions.

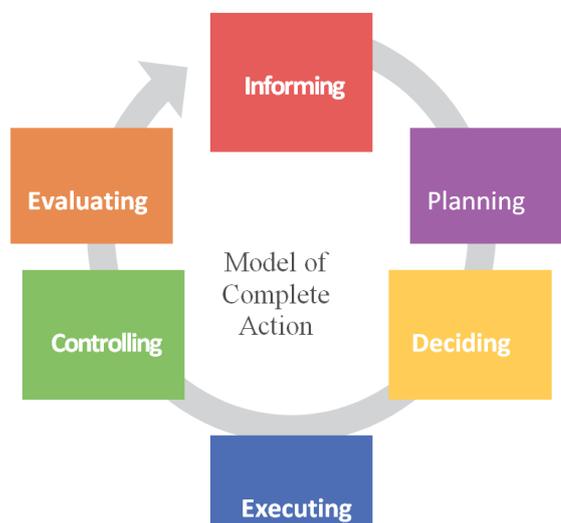


Fig. 1. Model of Complete Action

Informing: The description of the situation and the formulation of possible correlations require 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, which 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 to understand the observed situation.

Information can never be complete, especially as decisions are made on the 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.

Planning: In preparing a work plan, sustainability aspects must be formulated as an overall goal. In a given situation a specific goal may not only be 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.

Deciding: A decision is taken to favor 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, particularly when a decision has to be discussed within a group and arguments in favor of or against particular options are exchanged.

Executing: 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. 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.

Controlling: Looking back on the work plan, comparison of target and achievements is made to assess, whether the original goals were indeed achieved. The control 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.

Evaluating: An assessment completes the “complete” action. In vocational education and training, the development of assessment competencies, including assessing 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.

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.

Pedagogical Concept

In the sense of sustainable education in agriculture and horticulture, topics in soil science, water management and occupational health and safety are taught in vocational training to deal with specific aspects of flora and fauna in this occupational field and are focused on here.

The pedagogical concept (Figure 2) suggests a sequence of learning actions that build on each other (Figure 3).

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 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 an appropriate way 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.

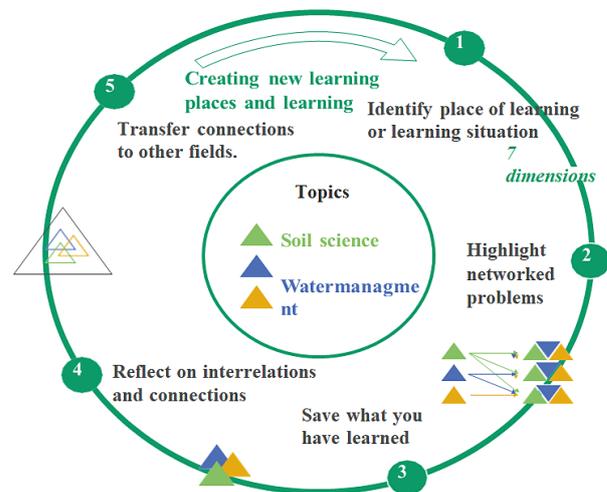


Fig. 2. A five-step procedure

A pedagogical concept in five steps:

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 (Hannan et al., 2013).

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)

External and internal factors shape every learning location or learning situation. 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, maybe worked out with the learners or by the learners themselves in independent work. The seven dimensions can help the learner think systematically and understand interconnections and interrelationships and may encourage acting in a sustainability-oriented manner. In terms of content, the dimensions describe the general status quo of the place of learning and /or learning situation and link facts seen from different perspectives (Shannon, 2017).

Highlight networked problems

In the second phase, starting from the learning location or learning situation and the theme, “problems” are highlighted on the 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 the learners should highlight. Teachers can choose different ways to introduce the learner to one or more of the desired aims.

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 specific questions or assignments for learners; invite students to prepare and deliver presentations on specific topics; encourage learners to formulate questions in an 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 learner’s inappropriate 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 groups.

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: *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.

- **Saving what you have 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 fur-

ther 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 their training institution or company. To stimulate further thought and action processes on the topics, the next step is to critically examine and reflect on the information gathered.

- **Reflect on interrelations and connections**

The newly gained contents and insights on the topics from the learning location/learning situation and their dimensions should be evaluated in reflection. 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.

- **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 sectors. 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.

Case study: Plant production in Bulgaria

Identify the Place of Learning or Learning Situation

Description of the place of learning

Securing food and livelihoods for an ever-growing world population is one of the great challenges in the future of humankind. The 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 considering the connections and interrelationships between the objects studied and other components of the respective system.

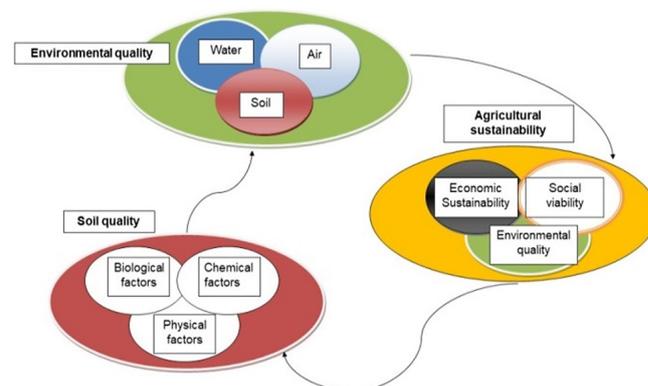


Fig. 3. Sustainable agriculture and plant production

Agroecosystems consist of interconnected elements and components such as soil, water and air (Figure 3). Soil in itself is a system of a multitude of chemical, physical and biological system elements. Soil quality is assessed along with a range of criteria that fall into three categories: Chemical analyses provide data on 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 af-

fect 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. The 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.

Dimensions in content and dynamics

Agro-ecological dimension

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 sustainability (Bachev et al., 2019) 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.

Cultural dimension

Productivity in Bulgaria averages 334 €/ha over a 9 year-period (as of 2006), compared to 2930 €/ha in neighboring Greece, 726 €/ha in Romania and 800 €/ha in the Czech Republic. The average in the other European Union countries is 2203 €/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".

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 8155.0 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 accounted 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.

Time dimension (past – present – future)

Following the restructuring of agricultural holdings (1990-2000) and substantial European subsidies since 2007, the Bulgarian economy share (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

production of the five dominant cereal and oilseeds (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 this sector’s gross added value.

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 the 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 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.

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 (Figure 4).

Insight- generating dimension (sustainable education and development)

Among its goals for sustainable development, the UN has 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” (Rieckmann, 2017).

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 is the teachers, who strive to respond to public attitudes and support comprehensive and appropriate knowledge. These new

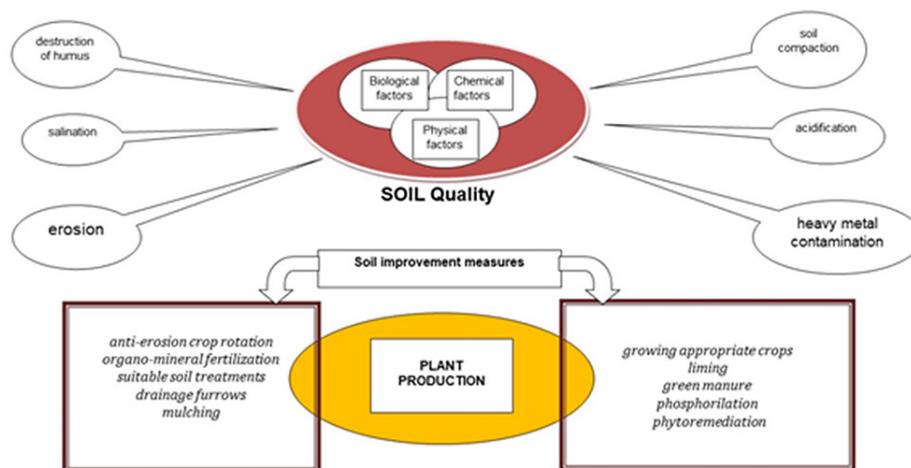


Fig. 4. Management of agriculture: plant production and soil quality

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.

Social-political dimension

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 a 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.

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 audio-visual 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 until now in terms of the number of em-

ployees, 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.

Saving What You Have Learned

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

Possible tasks: *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 the basis of sustainable development factors (environmental, economic, social and 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.

Reflect on Interrelations and Connections

In the 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.

Possible tasks: *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 presenting 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 to eliminate problems and preserve soil resources.

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 catching 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 the 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) (Figure 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 health and safety regulations. What similarities and differences do you see? *Describe* them in detail and *comment* on agricultural policy debates and discussions in Europe.

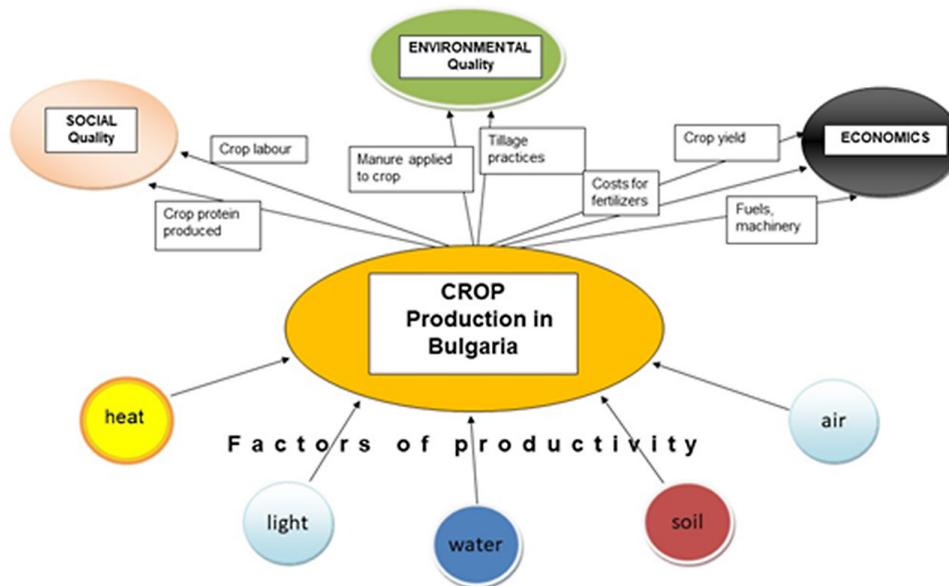


Fig. 5. Sustainable agriculture and plant production

Conclusions

Education for sustainable development in agriculture is becoming an increasingly intensifying problem that can not be postponed any longer. The development provides specific adapted models for the implementation of this approach, using three main topics in the agricultural training – soils and their role in the agro-ecosystem and agricultural production, water and their management and occupational safety and health. In the methodological aspect, the theory of comprehensive, systematic education and the 5-level pedagogical concept, suitable for the realization of the model, are considered.

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