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December 2015

Ministry of Agriculture Hungary

ORGANIC FARMING IN FOCUS

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Dear Reader!

The European Union has realized that because of the more severe and extreme climatic changes, the depletion of soil and the imbalance of ecosystems, urgent reaction is necessary in the field of agricultural production as well. In accordance with this the top goals of the new Common Agricultural Policy support the sustainable development of rural areas, the improvement of environmental conditions and reserving biodiversity.

As proof of the Hungarian Government's strong commitment to the implementation and the support of the program the calls for proposals in Agri-environment Management Scheme (AEM) and Conversion to and Maintenance of Organic Farming (OFS) were launched in the frame of the Rural Development Programme of Hungary in accordance with the Common Agricultural Policy. These measures were opened first in the 2014-2020 programming period.

One of the new elements of the Agri-environment Management Scheme is that medium and small farms are highlighted in the course of the allocation of the program's sources.

In the previous programming period the support of ecological farms was an integrated part of AEM, but in the Rural Development Programme it became a separate measure and its amount tripled. A total amount of 207 589 705 EUR is available for the measure until 2020. Ecofarmers are exempted from greening commitments and they shall be given preference at the application of some support.

Farmers undertake additional obligations in both measures (AEM, OFS) and the commitment period is of 5 years, from 1 January 2016 to 31 December 2020.

The Agricultural and Rural Development Agency as the only Hungarian Paying Agency for EU and national funds is willing to ensure the correct, transparent and „farmer friendly" transfer of supports to clients by all means available. This is in line with one of top priorities of the Hungarian Government and the Ministry to significantly increase the proportion of organic farming areas in Hungary.

Csaba Gyuricza
chief editor

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Cover photo: Organic farms in pictures (Apolka Ujj)

WEED SUPPRESSION EFFECT OF COMPOST MULCH. NO-TILLAGE SYSTEMS IN SMALL-SCALE ORGANIC VEGETABLE PRODUCTION[1]

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ABSTRACT

With growing agricultural demands from both conventional and organic systems comes the need for sustainable practices to ensure long-term productivity. In Hungary small scale vegetable growers face challenges in producing their crops due to the lack of effective weed control practices and viable methods of sustainable soil fertility management based on local or regional soil amendment resources. There is a demand for cultural practices that reduce hand labor requirements and black plastic mulches whereas long-term productivity would be held or increased. To identify effective alternative weed control and soil fertility management options for the management of intensive organic vegetable systems, our research focuses on the evaluation of compost and paper mulches, in conjunction with reduced-tillage practices. In 2015 determinate tomato (cv. Roma) is grown in five different soil treatments using yard waste compost (YWC) mulch and combination of YWC and paper mulch (PM) plus bare ground control under intensive and reduced tillage variants to evaluate their effectiveness on weed suppression. Since most organic tomatoes at present are grown on small acreage in Hungary, and are direct-marketed, the application of organic mulches can be assumed financially feasible. Our preliminary results after the first year of our trial shows that the combination of organic mulching materials together with reduced tillage may be a viable option for organic vegetable growers. However, further research is necessary to meticulously justify this statement.

keywords: alternative weed control, compost, compost mulch, paper mulch, organic, no tillage, vegetable, tomato

INTRODUCTION

The objective of this publication is to review the effects of composted organic mulches, and the combination of mulches and different tillage intensity systems as alternative weed control methods and viable soil fertility management solutions. Practices for vegetable and fruit production need to focus on decreasing synthetic inputs, sustainably managing disease and weed control, reducing soil erosion, and maintaining soil structure while producing high-quality fruit and profitable yields (Grassbaugh et al. 2004). Although research on the benefit and use of mulches is extensive, little is known about how to optimize their use in organically managed systems (Law et al. 2006).

Weed control

Production losses from weed competition are among the most important crop management concerns for organic growers, and the ability to control weeds is considered a major limiting factor for farmers wishing to transition to organic production systems (Bond and Gandy 2001). Organic vegetable production relies heavily on intensive tillage to reduce weeds and to create a fine seedbed for planting or seeding. This intensive tillage has been shown to be detrimental to long term soil quality, and often leads to contamination of the environment through on-site and offsite losses of organic matter, nutrients and sediments (Magdoff and van Es 2000). It also reduces soil microbial activity, destructs soil structure, while it increase the emission of greenhouse gases, and the potential for nitrate leaching to groundwater (Jackson et al. 2003). Reduced tillage systems are spreading especially on the

[1] This paper is an adapted version of the short communication „Weed supression effect of compost mulch no-tillage systems in organic vegetable production " submitted for publication at the International Conference on Organic Agriculture Sciences (ICOAS) 2015.

American continent, largely as a result of growing concerns about soil quality, costs of tillage operations, fossil fuel and labor use, and environmental resources. On the other hand, decreased intensity of tillage may cause serious problems for growers because of increased weed pressure.

Organic mulches

Application of organic mulches is an alternative method to suppress weeds through blocking light and prevent weed spread without mechanical or manual weeding (Brault et al. 2002) and can be as effective as herbicides in suppressing weeds (Ozores-Hampton 1998). Organic mulches such as straw, wood chips or compost can conserve soil moisture, reduce soil erosion and may also have advantages of low-cost, with no removal requirement compared to black polyethylene mulch, commonly used among organic growers (Ozores-Hampton 1998, Feldman et al. 2000). These mulches have also been shown to improve soil quality and stimulate soil microbial communities due to the addition of organic matter. Possible disadvantages of organic mulches include nutrient tie-up and lowering of soil temperatures to sub-optimum levels (Schonbeck and Evanylo 1998). Also, organic mulch alone is not always sufficient to control perennial weeds, and may even pose a risk of weed infection, especially if its material of origin contained weed propagules, and was not fully hot composted (Merfield 2002). Straw and hay mulches improve soil properties after degradation and are used widely. However, they keep soil cooler which can delay early season growth. Surface-applied yard waste compost (YWC) substantially increases underlying soil nutrient level (Feldman et al. 2010) and also increases yield (Gallaher and McSorley 1994), whereas it does not have a cooling effect on the soil due to its dark color.

Composting is a biological decomposition process in which microorganisms convert organic materials into relatively stable humus like material. During decomposition, microorganisms assimilate complex organic substances and release inorganic nutrients. An adequate composting process should kill pathogens and most weed seeds during the thermophilic phase and stabilize organic carbon before the material is applied as mulch. The end-product of the composting process is optimal as soil amendment and mulch as well. YWC is easily accessible in many regions in Hungary where there are composting operations next to landfills.

Paper mulch

Paper mulches may offer another viable solution for weed control without the problem of disposal of plastic mulches, since they decompose fully after use (Radics and Bognár 2004, Merfield 2002). Paper mulch as soil cover for special agricultural use is even produced and used in commercial scale in some countries and is a permissible product for weed control in organic farming certification systems (Harrington and Bedford 2004). Its main disadvantage is its rapid degradation; it tends to tear from the edges, may be lifted by wind and degrades too quickly, causing high weed population on the field where applied.

No scientific study analyzed an integrated approach where paper mulch and compost mulch is applied at the same time, on the same bed. According to our hypothesis if paper mulch is covered by weed seed free compost and vegetable seedlings are transplanted into this mulch layer, the advantages of both types may be utilized. Paper mulch effectively suppresses weed emergence during the first several weeks after transplanting, and the weed-free compost serves as optimal media for transplants. If drip irrigation applied, the sodden paper mulch will be penetrable for the growing roots of the vegetable plant, so it can reach the soil under the paper mulch ensuring its continuous development.

MATERIAL AND METHODS

Five tillage and organic mulch treatments (Table 1) in four replications are compared in a randomized complete block design in frame of a small scale organic vegetable production system on a clay loam Luvisoil at the MagosVölgy Organic Farm, Terény, Hungary. Treatments are compared regarding their weed control efficacy, effect on soil properties and influence on yields. Yard waste compost (YWC) and paper mulch (PM) were applied by hand. The previous crop was winter wheat in 2014. After the harvest of wheat the entire area with the residues was tilled down by moldboard plough in 2014 November. During spring 2015 the entire area was harrowed and the shape of the 20 plots were measured, shaped and marked. Intensive tillage

TABLE 1: Treatment specification

Treatment	Tillage intensity	Mulch applied	N source (kg/ha)
IT	intensive tillage (IT)	none	none
IT-Cmix	intensive tillage (IT)	none	YWC
IT-C	reduced tillage (RT)	yard waste compost (YWC)	YWC
RT-C	reduced tillage (RT)	yard waste compost (YWC)	YWC
RT-C+P	reduced tillage (RT)	yard waste compost (YWC) + paper mulch (PM)	YWC

Picture 1: Overview of the trials. The 20 plots at the time of transplanting the tomato seedlings.

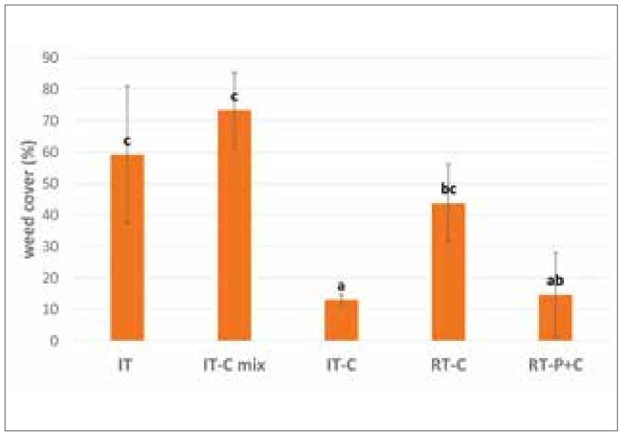

Figure 2: Weed coverage (%) with standard deviation in different tillage/mulch treatments 25 days after planting. Letters above columns indicate significant differences among treatments (Tukey test, p<0,05).

(IT) treatments were rototilled before mulch application and transplanting. In Reduce tillage (RT) treatments the soil was not disturbed after harrowing.

Plots comprise of a 15 m long and 1,2 m wide bed. In early June 2015 each plot was planted with tomato seedlings (cv. Roma), using three rows of plants 40 cm apart and with 40 cm spacing within the rows. Plants were irrigated once after transplanting and then depended on natural rainfall. YWC (1 m^3/bed) and PM (80 gr/m^2) were applied by hand. Intensive tillage (IT) treated plots were rototilled before planting. Compost was mixed with the subsoil in the IT-C mix treatment and left on the surface functioning as a 5 cm thick compost mulch layer in IT-C, RT-C and RT-P+C. In this last treatment the mulch was spread over wrapping paper which entirely covered the bed. The YWC was purchased from the Zöld-Híd Nonprofit Ltd. Company's Nógrádmarcal Facility and was analyzed for dry matter, organic matter, C, N, P, K and pH, and minerals (data not shown) before application using standard procedures in the Laboratory of the Department of Soil and Agricultural Chemistry, Szent Isván University, Gödöllő.

Weed infestation was measured 25 days after transplanting using 1x1 m quadrates in all replications and three times per plot, assessed by soil surface coverage (%) of weed plants. Data was analyzed using SPSS software. One-way ANOVA was performed with the Tukey post-hoc test (p<0,05).

RESULTS

Significant differences were found between the treatments where compost was left on surface as mulch compared with no mulch treatments. Intensive tillage with compost mulch (IT-C) and reduced tillage with compost and paper mulch (CT-P+C) were most effective to reduce early season

Picture 2: Different weed infestation levels in different tillage/mulch treatments: IT-C<RT-C<IT-C mix

weed infestation in organic tomato. The control (IT) and the intensively tilled treatment with compost application (IT-C mix) showed the highest weed cover.

DISCUSSION

We hypothesized compost mulch would decrease weed cover over control (IT) and the treatment in which compost was mixed with the subsoil (IT-Cmix). This was approved while there was statistically significant difference between compost mulch (RT-C, RT-P+C, IT-C) and non-compost mulch (IT, IT-Cmix) treatments.

The compost mulch application combined with intensive tillage (IT-C) and with paper mulch plus reduced tillage (RT-C+P) had the lowest weed coverage. This may be due to the possibly low number of viable weed seeds in the compost layer compared with the natural topsoil. Weed seeds in the natural subsoil covered with mulch needed longer time to germinate, reach the surface and form plants resulting lower weed pressure within the subsequent weeks after transplanting the vegetable seedlings. Also, paper mulch hindered weeds to germinate till the paper has not been decomposed. More research is needed to assess the midterm (later part of the season) and long-term (cumulative use in subsequent years) effect of compost mulch and interactions between soil tillage intensity and compost mulch application. Also, it is not clear why the intensive tillage compost mulch treatment (IT-C) was the least effected by weeds and had significantly lower weed cover compared with the reduced tillage treatment combined with the same compost mulch (RT-C). To answer these questions treatments will be repeated for the next 3 years on the same field within an organic vegetable crop rotation.

CONCLUSIONS

In literature no relevant scientific data has been found on mixed application of paper mulch and compost mulch on small scale, intensively managed organic vegetable production systems. According to the data available, and based on some practical (unstudied) examples of successful vegetable operations in California (USA), it is assumed that a combined system of compost mulch and paper mulch methods may be competitive in terms of weed control compared with conventionally tilled uncovered organic systems. Further research is necessary to meticulously justify this statement and assess the effect of compost mulch methods on vegetable yield, soil chemical and biological properties and long-term weed management effects.

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CHALLENGES OF AGROECOLOGY KNOWLEDGE TRANSFER IN THE HIGHER EDUCATION TRAINING PROGRAMS IN HUNGARY

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ABSTRACT

The agroecology education due to its complexity and its characteristics of transdisciplinarity presents a challenge for educators. Preparing students for a comprehensive understanding of sustainability requires new teaching strategy and approach in education. In SAGITER project, we focus on the promotion of agroecological knowledge transfer, by combining science-based approach with informal knowledge resulting from everyday experiences. Eleven institutions from seven European countries decided to work together in order to create training module and teaching tools for trainers. In Hungary, selecting the best transfer method depends on the basic knowledge of the target group (students), therefore a thorough real user need assessment was carried out. BSc and MSc students studying agriculture and economics participated in the survey in order to explore their opinion and knowledge level about agroecology. The survey focused on three main issues: sustainable agricultural structure, environmental views and ecological farming. Results of the survey proved that there are serious differences in knowledge level related to agroecology by gender, by age and by place of education. Nevertheless the most significant factor that influences students' knowledge is their previous experiences acquired by practice. Therefore the summary of the survey suggests a complex approach based on experimental learning inspired by reflecting experiences on farms that can be also applied at universities. This complex teaching strategy should involve not only environmental, but biophysical, economical, transparency, and even social sensitivity aspects.

keywords: agroecology, sustainability, knowledge transfer, education, ecological farming, transdisciplinarity

INTRODUCTION

Over the past decades, the international literature just as numerous Hungarian authors define the concept of sustainability in various ways. Different definitions originate from one common root, in which everyone agrees: sustainability is a global strategy in order to preserve the world including the conscious use of resources that can satisfy the current generation's needs, in a way that does not diminish the next generation's chances" (Douglass 1984; Harnos 1993; Glickman 1996; Ujj 2006). This definition also implies that in the course of agricultural production, reasonable management of natural resources is needed while balancing the economic sustainability with the environmental one. Furthermore, the preservation of the environmental quality has to be considered while producing healthy foods for the modern, conscious society (Rovira 1995; Fehér 2009). In conclusion, sustainable development stands on three pillars: economy, society and environment, which are inter-related and have mutual impacts on each other (OECD 2008; Lisányi Beke –Fehér 2013a,b).

In general it can be also stated that the primary user and converter of the natural landscape is the agriculture itself, therefore, the protection of nature should be harmonized with agricultural activities (OECD 2008). Conversely it is also true: The success of agricultural activity, especially its efficiency is determined by the natural conditions, the existence and the condition of natural resources (Günal et al. 2015). With this knowledge in mind, it can be stated, that the compliance with the basic objectives of sustainability does not seem to be complicated, even though it is not easy to judge which production systems and methods are 'appropriate'.

Traditional agricultural systems, such as those identified as Globally Important Agricultural Heritage Systems (GIAHS), offer a wealth of knowledge, principles, practises and biodiversity that cannot be replaced by modern science (UNEP 2005; FAO 2003). Several approaches, including integrated pest management, polyculture farming system, conservation agriculture and agroecology combine traditional agriculture practises with modern science (FAO 2003).

As a 'definition', the science of agroecology can be determined as the application of ecological concepts and principles to the design and management of sustainable agroecosystems, providing a framework to assess the complexity of agroecosystems (Altieri 1987). Agroecosystems are communities of plants and animals interacting with their physical and chemical environments that have been modified by human in order to produce food, fibre, fuel and other products for human consumption and processing. Agroecology is the holistic approach of agroecosystems, including not only the environmental but also the human elements. According to Tomich et al. (2011) agroecology is an integrative science that deals with key challenges of mitigating environmental impacts of agriculture while dramatically increasing global food production, improving livelihoods, and thereby reducing chronic hunger and malnutrition. In this spirit, instead of focusing on one particular component of the agroecosystems, agroecology emphasized the interrelatedness of all agrosystem components and the complex dynamics of ecological processes (Vandermeer 1995). But why is this necessary? Dover and Talbot (1978) defines and describes an ecological approach to agriculture that differs from the industrial approach that has dominated agricultural research and development for decades. Francis et al. (2012) also emphasizes that much of education in agriculture has moved from practical, hand-on field activities and internship to focus on theory in formal learning settings (mainly in classrooms). The growing need for a productive and sustainable agriculture calls for a new view of agricultural development that builds upon the risk-reducing, resource conserving aspects of traditional farming, and draws on the advances of modern biology and technology. In the suggested strategy of Dover and Talbot, to attain a sustainable agriculture, the importance of the research and education must be highlighted. In order that the development of ecological agriculture could strike root, scientists need to train a whole new generation. Therefore, multidisciplinary comprehensive ecological-agricultural trainings are needed in agricultural education (secondary schools, universities) that develop a new generation of agroecologist capable of dealing with whole systems and provide agroecological knowledge for future policy makers (SARE 2010; Francis et al. 2013).

On this basis, the SAGITER project (2013-2016 Project title: Agro ecological Knowledge and Ingenuity of terroirs) focuses on the progress toward a sustainable agriculture education that can be achieved by combining both scientific and non-specialised knowledge. Our project aim is to rebalance the asymmetric vision of the world in which the scientific knowledge is regarded as rational and therefore *"right"* and the popular knowledge as irrational therefore *"wrong".* Scientific approach needs to be combined with vernacular knowledge. The question is how the transmission of layman knowledge can operate in a corpus designed for science and which methodologies need to be adapted for the transmission toward the concerned audience. It is also a question how the people who use the agroecological knowledge were able to acquire it and how we can transfer the everyday knowledge through trainings.

In SAGITER project, we participate in the promoting/upgrading process of the agroecological knowledge, and the ingenious systems that are implemented from time to time on the territories with the following project objectives:

- Participation in the evolution toward a productive and sustainable agriculture by creating a training module for trainers. This module will incorporate pedagogical approaches adapted to the consideration, the promotion, the learning and the implementation of agroecological knowledge.
- Exchange on the approaches about the concept of agroecology, the notion of agroecological knowledge, the different pedagogical experiences undertaken by partners.
- Reconsideration of the modes of acquisition and transmission of knowledge by allowing the trainer to move from a posture of transmission of knowledge (teacher) toward a posture of a facilitator/mediator/accompanist/guide.
- Development of a teaching strategy supported by all common observations, a collection of practices and experiments in order to integrate the acquired knowledge into the referential data of initial and continuing training of trainers.
- Development of teaching tools adapted to the transmission methods of this informal knowledge.

As a results of our work the need for a comprehensive approach should be confirmed to the act of production centred around a specific agroecosystem level in which the producer is liable alongside the consumers in a social organization based on solidarity. The correctness, adequacy of quality criteria (organoleptic properties and vitality), should be taken into account when producing and buying. We also hope that the need and usefulness of the implementation or rehabilitation of eco-friendly production practices will come to the fore and the developed agroecological practices will become easily transferable. Furthermore, the integration of this approach in higher technical agricultural education will be visible. In the long run, it will have a direct impact on the farmers by the improvement of their knowledge through trainings offered by project partners.

MATERIAL AND METHODS

In order to gain best project result, eleven institutions (higher educational institute, high school, training centre, organized group, environmental or consumer NGO) from seven countries (France, Germany, Spain, Belgium, Slovenia, Romania and Hungary) are decided to work together during the implementation of the SAGITER project.

Partners selected several methodologies to formalize *"consciousness"* practices from which field data collection and observation represent an important practice in the method of learning. To transform the experience into learning, the project partners support the process of Kolb (Kolb 1984; McLeod 2013). Kolb's experiential learning style theory is typically represented by a four stage learning cycle in which the learner touches all the bases: Alternation of concrete experience phases; Abstract conceptualization; Active experience; Reflexive observation.

This theory helps to highlight the innovative practices that enable the trainer to progress in her/his transmitter's mission of knowledge towards a facilitator's posture in the learning process.

Direct target audience is the trainers, they will benefit from training modules elaborated by project partners. Then trainers will transfer their acquired knowledge to the final recipients (indirect target audience) that are students who will become farmers, processors, traders, agricultural advisers, bureaucrats and educators.

Knowledge transfer is a very complex discipline. There are three approaches that determine the selected knowledge transfer method:

1. Identification of user needs – one can apply this method when an individual, team, or organization has a specific needs in mind.
2. Identification of context and type of knowledge – one can apply this method when an individual, team, or organization has a specific type of knowledge to be transferred.
3. Identification of level of experience – one can apply this methods when the potential receiver of the knowledge has a specific level of experience.

In Hungary several pedagogical methods are used in practice for knowledge transfer (formal, informal knowledge transfer) that provided a starting point of our research work. We needed to apply that approach that identifies firstly the real user needs concerning ecological knowledge. After the identification of user needs by assessing their knowledge related to the subject, we are in the position of preparing practical case studies designed for them, as teaching material.

With these knowledge transfer approaches in mind, in 2014, a quantitative research was carried out to explore students' opinion and knowledge level about agroecological issues. 258 questionnaires were collected, with the participation of 215 students from the Szent István University (Gödöllő) and 43 from the University of Debrecen.

The main target groups were the BSc and MSc students from two faculties, studying agriculture and economics. The questionnaire contained 20 questions. 4 types of question were applied:

1. Simple choice question (with the answer 'yes or 'no')
2. Multiple choice question(one or more possible answers among several options)
3. 5-point rating scale question (in order to rank the importance of the listed items)
4. open-ended question (in order to gain more insight into the respondent's knowledge)

The questionnaire are separated into three parts, accordingly, our result analysis follows this structure. The three main parts are the following:

1. opinion about sustainable agricultural structure
2. environmental views
3. ecological farming

In the 'Results' we refer to concrete questions in order to make the result of the survey even more comprehensive.

In order to demonstrate knowledge gap, we used uni- and multivariable statistical analysis, such as independent sample test and one-way ANOVA.

RESULTS

I. **Opinions about sustainable agricultural structure**

Figure 1 shows that most of the respondents heard about sustainable agricultural production. (Survey question was: Have you ever heard the sustainable agricultural production expression?) On the other hand, students do not know the correct definition of sustainability. (Survey question was: What do you think is the meaning of mentioned expression?) One part of the respondents thinks, it means continues economical improvement/innovation, usage of long lasting materials, long-term financial well-being. The other part says sustainable agricultural production connects to environmental protection. Appearance of environmental thinking is favorable, but not comprehensive. Only a small part of the respondents know the exact definition of sustainability, which includes environmental, economical and social viewpoints, and highlights a long-term thinking.

Figure 2 enforces students' strong environmental orientation in connection with sustainable agricultural production. (Survey question was: According to your opinion, what points play a significant role in the building up a sustainable agricultural structure?) Hence, take into account environmental tasks (77.10%), maintain statue of environment (70.20%) and ensuring conditions of recycling (68.20%) are the most important factors to build up a sustainable agricultural structure. Transparency and documentation system are less important in the viewpoint of sustainable agricultural farming.

Furthermore, there are significant differences in students' opinion in connection with sustainable agriculture factors. We explored that males, females and different classes have different knowledge about sustainable agricultural factors. Most of the time, women are more sensitive about environmental and social issues. In this case, men show a higher responsibility about sustainable agriculture. Results of our analysis demonstrate that the following sustainable agricultural factors are more important for men than for women:

- ensuring employees' well-being (male: 41.4%; female: 28.3),
- waste and pollution management (male: 71.7%; female: 57.2%),

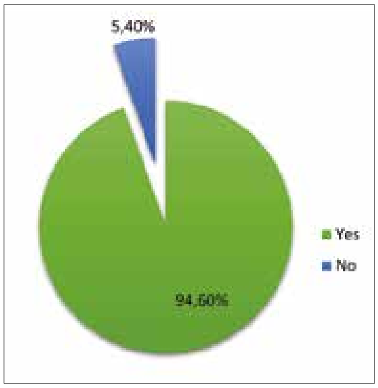

Figure 1: Knowledge about sustainable agricultural production
Source: Own research, N=258, 2014
(Yes: heard the expression; No: have not heard the expression)

- maintaining statue of environment (male: 77.8%; female: 65.4%),
- development of transparent production conditions (male: 26.3%; female: 15.7%),
- integrated farming (male. 46.5%; female: 25.2%),
- maintaining biodiversity (male: 75.8%; female: 62.3%),
- nutrition management, nutrition supplement (male: 46.5%; female: 25.2%),
- precision system (male: 38.4%; 8.2%),
- traditional livestock management (male: 40.4%; female: 26.4%),
- intensive livestock management (male: 22.2%; female: 11.3%) and
- development of documentation (male: 33.3%; female: 18.2%).

Investigating classes, we explored that, essentially first-year class students have lower knowledge about factors of sustainable agriculture. It means that, for first class students integrated farming (8.9%), maintaining biodiversity (48.9%) and traditional livestock management (28.9%) are less important than elder

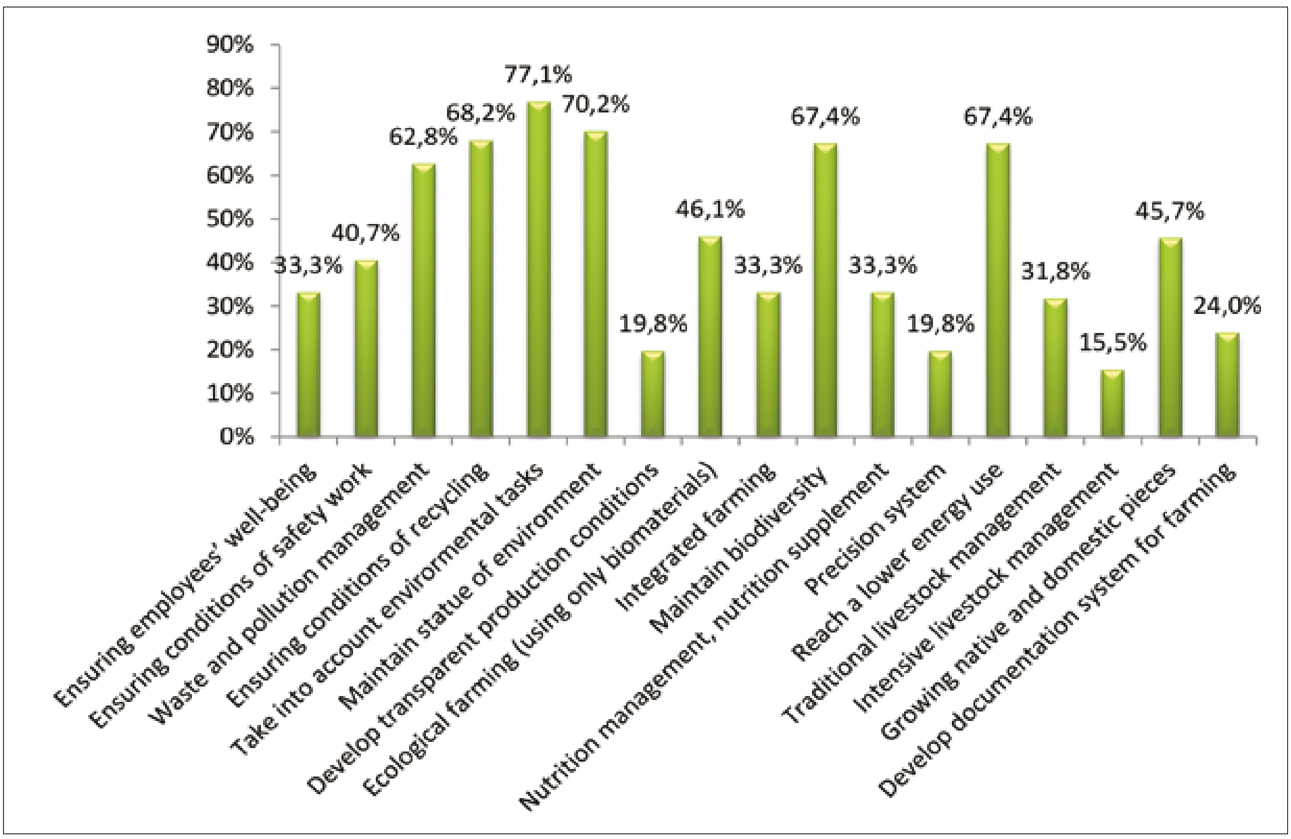

Figure 2: Factors of sustainable agriculture
Source: Own research, N=258, 2014

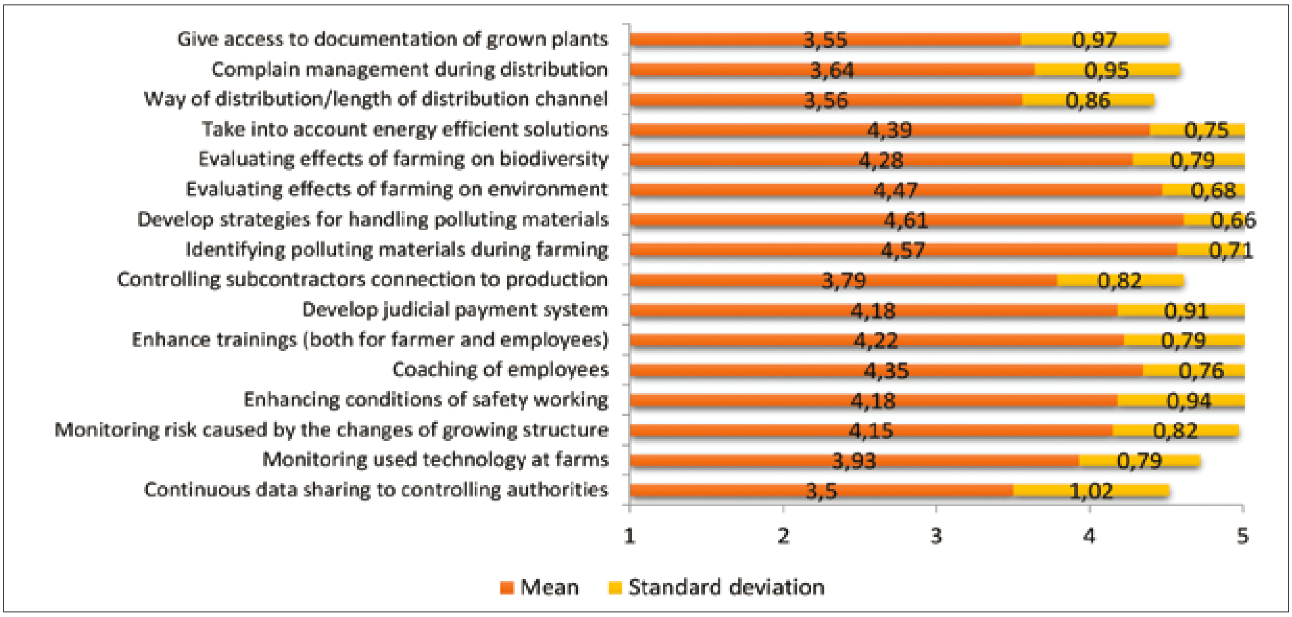

Figure 3: Judgment on factors of sustainable agricultural production
Source: Own research, N=258, 2014

students (they reached 60-80% in connection with the mentioned factors).

In order to get a deeper view about students' judgment on priorities of sustainable agricultural production, we used a 1 to 5 interval scale. In this case, we explored that, besides environmental concerns, social issues are getting a highlighted role (See Figure 3. Survey question was: According to your opinion, how important are factors below in connection with sustainable agricultural production). Both of the mentioned areas are rather important for the subject (means over 4.0). On the other hand, transparency (for instance importance of documentation, data sharing and controlling) still have not the most essential factor in connection with sustainable farming.

In Figure 3, there are eight cases, which have relative high standard deviation. It means that respondents have different opinion about these factors. Therefore, we carried out independent sample tests and One-way ANOVA tests to explore the reason of these dissimilarities. We concentrated on the research focus, therefore we primarily analyzed differences on the basis of gender, faculty, class, age and level of education. In this case, there was only one statement ("Developing judicial payment system"), which was really divisive according to level of education and classes.

On the basis of the categorical means, development of judicial payment system, in the viewpoint of sustainable agricultural production, is more important for Bachelor students (4.31) (first- and second-year class students) than Master student (3.88) (third-year class students and seniors). Moreover, second class students' (4.39) and seniors' (3.67) opinion showed the highest deviation in connection with judicial payment system.

Finally, we investigated students' opinion about how much do people take into account social and environmental issues in Hungary. (Survey question was: According to your opinion, at Hungary how much do people taken into account the factors connected to sustainable agricultural practice, nowadays?) As a result, it can be stated that both of the mentioned areas are relatively important in our country (Figure 4). On the other hand, standard deviations show a really big difference in respondents' views.

According to the research goals, there are two main

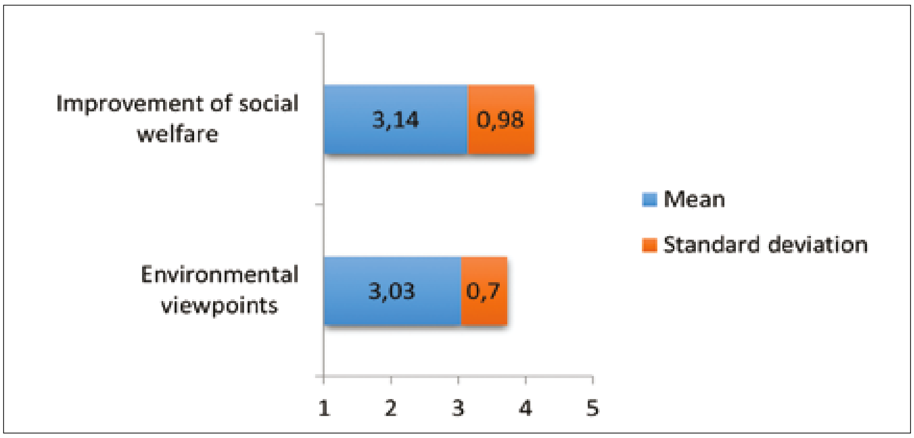

Figure 4: Importance of environmental and social issues in Hungary
Source: Own research, N=258, 2014

categories (gender and level of education), in which opinions about statue of improving social welfare are really divisive in Hungary. Hence, men (mean: 2.91) and Master students (mean: 2.92) are more skeptical about the mentioned issue than women (mean: 3.23) and Bachelor students (mean: 3.24).

In the next two parts in our study, we analyze exact environmental protective behaviors and opinions about ecological farming. These two topics are really essential in connection with agroecology. On the basis of environmental protective behaviors, farmers can improve their farming activities. Moreover, ecological farming is a living example of basic agroecology. Hence, exploring eco-farming failures; principals of agroecological improvement could be defined.

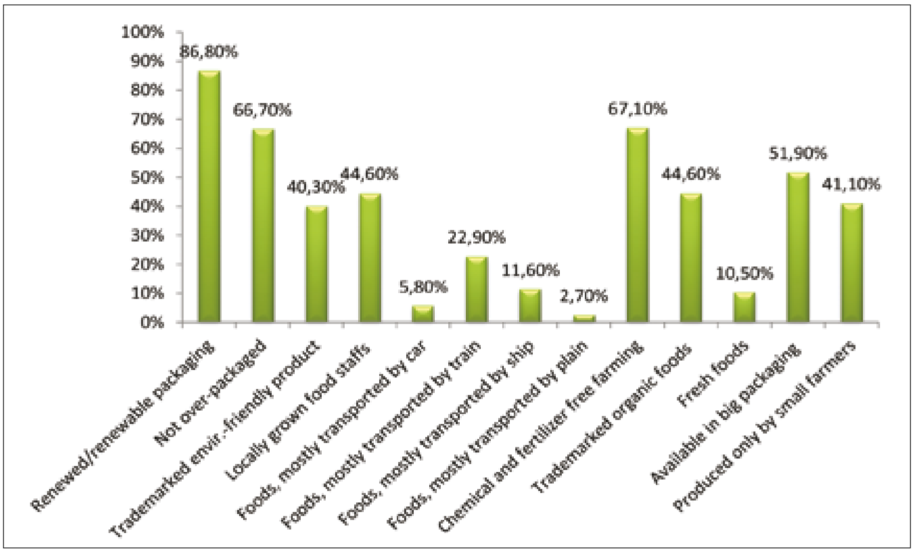

Figure 5: Characters of environmental friendly foods
Source: Own research, N=258, 2014

II. **Students' environmental views**

We investigate food characters connected to environmental protection. We concentrate on exact elements of environmental protection, food information on packaging and food miles.

In Figure 5 shows that respondents of the survey think, the most important food characters, in the viewpoint of environmental protection, are the follows: (1) renewed/ renewable packaging (86.80%), (2) chemical and fertilizer free farming (67.10%) and (3) not over-packaged products (66.70%). It is really essential that, among packaging types (external characters, consumers can check out during food purchasing) farming conditions also appear. It shows that students prefer foods from environmental protective farming. Moreover, method of farming is a confidential food character, since it is really difficult to verify at the time of food purchasing. For this reason, improvement of transparency is a key factor of agroecological development. (Survey question was: According to your opinion, what are the characters of environmental friendly foods?)

If we investigate socio-demographical characters, we can explore that there are two really divisive categories: organic foods (labelled) and chemical and fertilizer free farming. It means that 60.9% of students from University of Debrecen, 58.8% of the second-year class and 50.3% of Bachelor students think that organic foods are environmental friendly agricultural products. While, for women (72.3%), for students at faculty of Economics and Social Sciences (74.8%) and for first-year class students (82.2%) chemical free farming is the most important food character in the viewpoint of environmental protection. Chemical free farming is less crucial for men (58.6%), for students at faculty of Agricultural and Environmental Sciences (60.0%) and for juniors (53.2%). Organic food (trademarked) is less popular character among Master students (32.5%) and seniors (29.5%).

Furthermore, small farmer product is also an essential character for sophomores (56.9%), while renewed/ renewable packaging is important for juniors (4th class) (97.4%). Men prefer not over packaged foods (75.8%), locally grown foods (53.5%) and foods mostly transported by ship (17.2%). Besides organic foods (labelled), small farmers' products are also important for Bachelor students (47.4%).

Students' environmental and social views also appear in connection with information need. Figure 6 demonstrates, during food purchasing, students would like to be informed about the following food characters: Hungarian product (84.9%), avoid animal testing (54.70%), social fair company/farmer (for instance producer does not exploit his/her employees and meet requirements of law). (Survey question was: Which information can influence your decision during food purchasing?)

We also explored, animal tests are primarily influencing women's purchasing decisions. Hence, 61.6% of women prefer products are not tested on animals. Moreover, students from faculty of Agricultural and Environmental Sciences need information about producer activity at social events (23.7%), while students from faculty of Economics and Social Sciences prefer information about farmers' charity activities (41.5%).

Besides information need, participant of the survey think, it is important to reduce food miles to reach sustainable food systems (93.80%) (See: Figure 7. Survey question was: According to your opinion, is it important

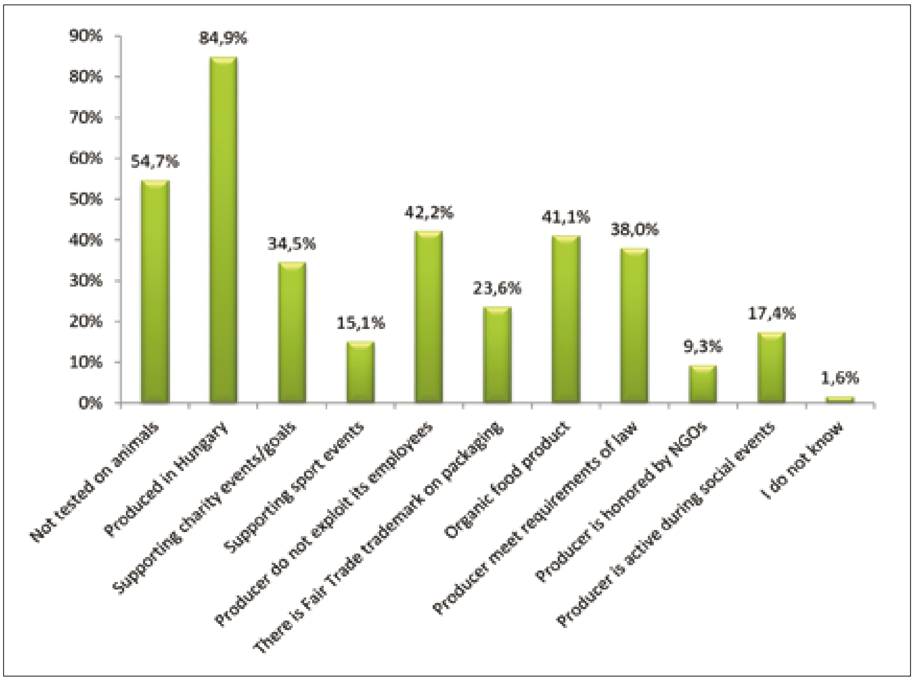

Figure 6: Influencing information during food purchasing
Source: Own research, N=258, 2014

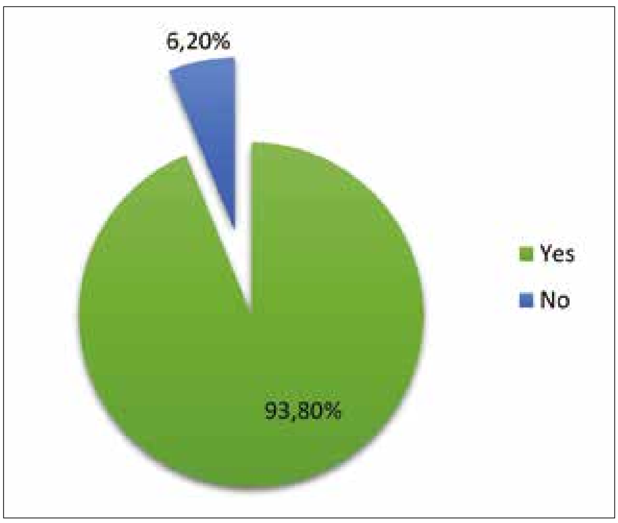

Figure 7: Importance of food miles reduction
Source: Own research, N=258, 2014

to reduce food miles to reach a sustainable food trade?). This result reflects to a more complex view. It means that, students have knowledge about that, agroecological problems have not been solved with a sustainable farming method. According to respondents, it is necessary to optimize food miles, which is an extended ecological management dilemma.

According to the professional literature, farmers' stores, community agriculture and origin labeling are the best ways to reduce food miles, while fair trade, private standards and traditional food chain system significantly increase food miles. Based on the results in Figure 8, most of the time, respondents could identify the most environmental protective food systems. (Survey question was: According to your opinion, which food system can effectively reduce food miles?) However, they have more positive attitude forward traditional food chain systems than origin labeling. Reason of this view can be derived from the method of origin labeling. Regularly, only the name of nation appears on food packaging (for example made in Hungary, made in the EU). So, consumers can not identify the exact region. On the other hand, there is a confidential question. Hungarian consumers are very critical about information connected to food stuffs. That is why origin labeling is less significant in connection with sustainable agroecological system.

It is also explored that men have a more positive attitude forward origin labeling. 19.2% of them think, it is important to reduce food miles, while only 9.4% of women have the same opinion. Moreover, community agriculture is more popular among students from University of Debrecen (66.7%) than respondents in Gödöllő. It refers to that communities have a more significant role in the rural area.

III. **Students' judgment on ecological farming**

As it was mentioned above, ecological farming is a good practical example how to reach a sustainable agroecological system. For this reason, in the last part of our study, we evaluate students' judgment on eco-farming.

At first, we investigated students' opinion about principals of eco-farming (See: Figure 9. Survey question was: According to your opinion, do statements below meet principals of ecological farming?). In this case, a strong environmental orientation (means over 4.0) also appear. On the other hand, exact actions and social issues get a lower importance (e.g. usage of renewable energy sources, growing food high in nutrition and acceptable salary). It refers to that students have environmental orientated attitude, although they do not recognize the concrete farming methods leading to sustainability.

In Figure 9, high standard deviations can be seen, which refer to that students have different opinions about factors of eco-farming. We explored students' views differs according to level of education, faculty and class. Most of the time, Master students join real actions to principals of eco farming. Master students think that maximum use

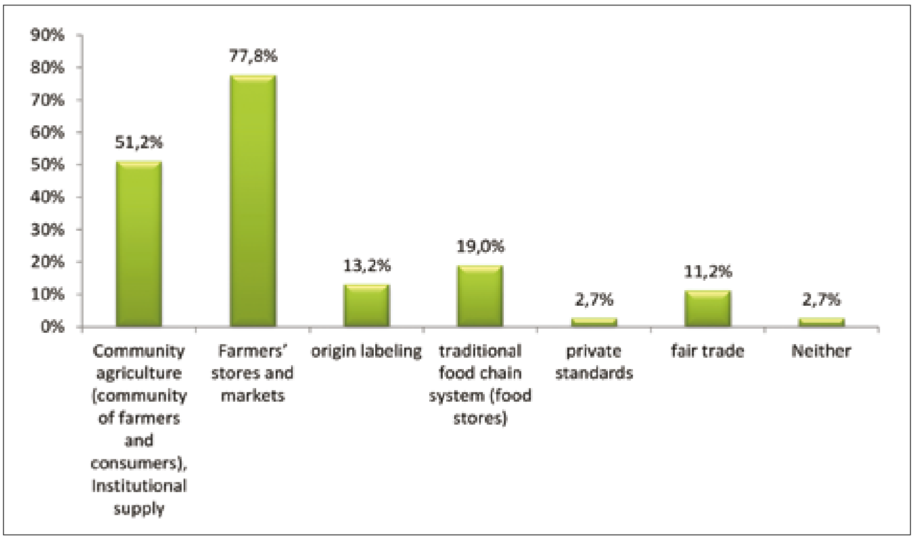

Figure 8: Food miles reducing food systems
Source: Own research, N=258, 2014

class) (4.23) and seniors (4.10) highlight importance of wider social and ecological effects of farming.

Mostly second-year class students agree with that "production of totally depredating organic foods" (3.90) and "maximum work inside the boundaries of closed systems, reckon with organic substances and food ingredients" (4.12) statements are essential principals of eco-farming. In this case, first-year students reached the lowest means (3.32 and 3.63). Besides above, availability of acceptable salary and safe working conditions at farms are more important for students from

of renewable energy sources of local agricultural systems (mean Bachelor: 3.91; mean Master: 4.22), avoiding polluting effect of agricultural machines (mean Bachelor: 4.12; mean Master: 4.40), maintaining agricultural systems and genetic diversity of connecting areas, and conservation of living places of plants and animals (mean Bachelor: 4.06; mean Master: 4.33), and including renewable energy sources into agricultural processes (mean Bachelor: 3.89; mean Master: 4.18) are essential to develop economical farming systems. Moreover, Masters (4.16), juniors (4th

faculty of Agricultural and Environmental Sciences (3.46).

Results show, environmental orientated educational structure plays a strong influencing role in respondents' knowledge. Furthermore, while younger students know some principals of sustainability, elder students can define exact actions to reach a sustainable farming structure.

Figure 10 shows, most of the listed factors are important to develop ecological farming systems. (Survey question was: Please mark those elements, which must be taken into account during formation of ecological farming.) However,

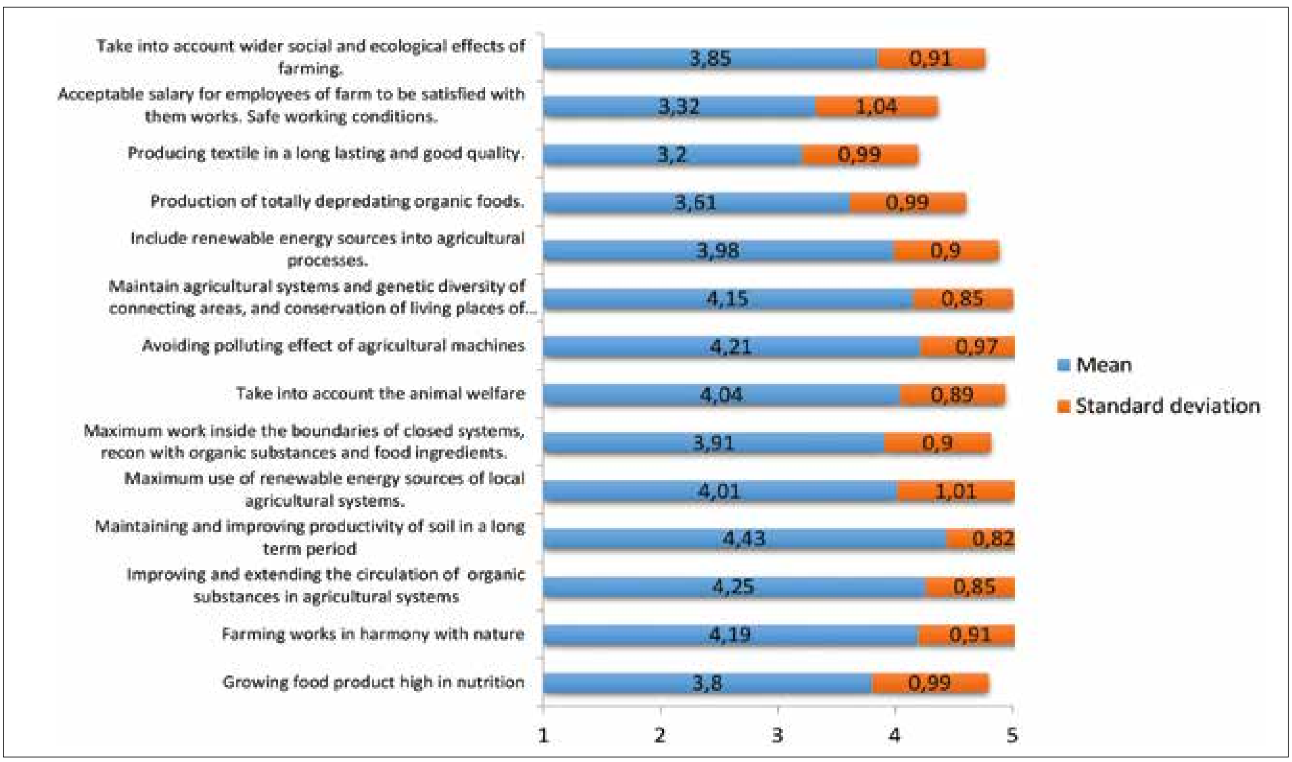

Figure 9: Principals of ecological farming
Source: Own research, N=258, 2014

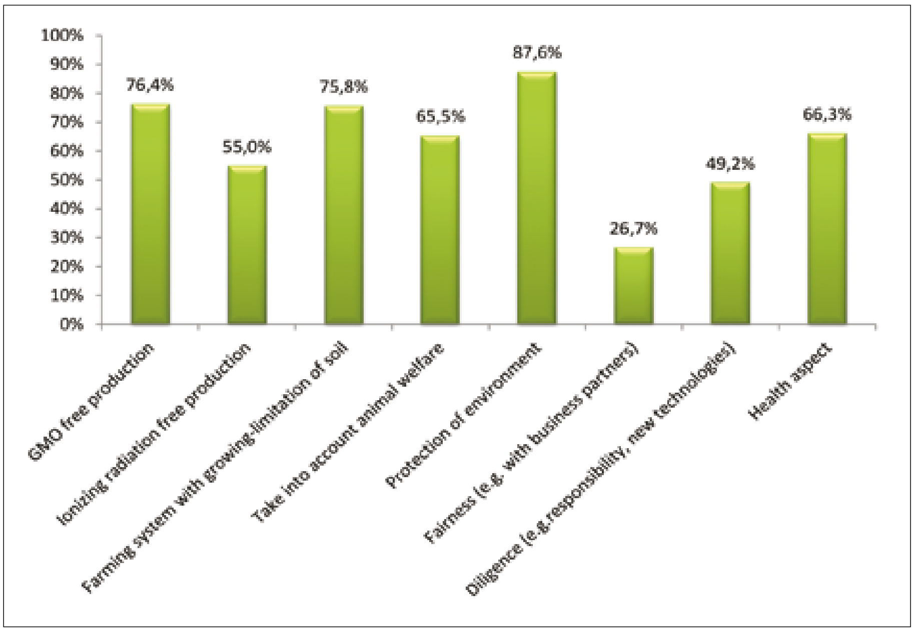

Figure 10: Aiding factors of eco-farming development
Source: Own research, N=258, 2014

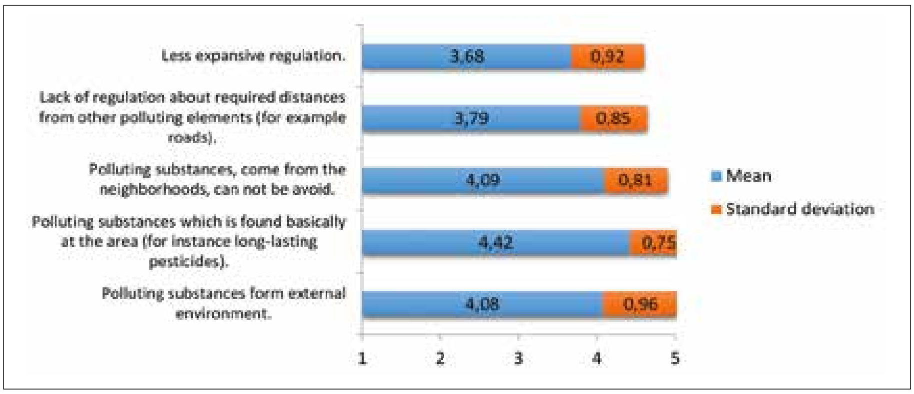

Figure 11: Barriers of eco-farming
Source: Own research, N=258, 2014

In Figure 11 barriers of eco-farming are listed. (Survey question was: According to your opinion, how harmless are factors below in connection with foundation of ecological farms.) According to Biokontroll Hungária Nonprofit Kft. (Biocontrol Hungary Nonprofit Ltd.), most of the time, farmers are very critical about eco-farming in Hungary, because of factors in Figure 11. In reality there are solutions to avoid these problems and develop eco-farm systems. Our results show that students also think that external environmental effects are threats in the viewpoint of eco-farms. On the other hand, improvement of regulation system have secondary importance among barriers of ecological farming.

In this case, there are three barriers with a high standard deviation (polluting substances form external environment, lack of regulation about required distances from other polluting elements, for example roads, and less expanded regulation). Concentrating on research goals, we identified the reason of this dissimilarity. It is found that, there is only one case (polluting substances form external environment), where respondents' opinion differs according to the basic socio-demographical characters. Hence, external polluting substances are considered more risky by women (4.22) than men (3.86).

fairness reached a lower frequency (26.70%). It enforces the weakness of social attitudes. According to the professional literature fairness, diligence and health are the three basic element of ecological farming. Students highlight the importance of health, but the other two factors are less essential to them. It shows a knowledge gap. Hence, complex knowledge has still missing. Respondents could not recognize long term utilities. They focus on visible goals. We also explored that men and women have different opinion about the three mentioned principals. Men are more sensitive about these cases. 39.40% of them say fairness, 60.60% of them say diligence and 73.7% of them say health is a crucial principal of eco-farming. Moreover, GMO free production is preferred by Bachelor students (80.00%), while ionizing radiation free production is highlighted by second-year class students (72.5%). Importance of ionizing radiation free production reached the lowest ratio (41.80%) among juniors (3rd class).

DISCUSSION

According to our result we highlight the following points in connection with judgment of sustainable agricultural structure:

- Students have a strong environmental orientated view.
- Beside environmental protection, social issues also get a higher importance.
- Students concentrate on exact parts of a sustainable agricultural system, but they are not aware of the complexity of agroecology. Hence, it is important to improve their knowledge about the whole ecological

process (for instance they have to learn about transparency, goal of documentation and controlling systems).

• There are differences in students' opinion according to gender, class and faculties. Ordinary the younger ones and women are more optimistic about the statue of agroecological issues. It reflects to that, education give a realistic knowledge about the investigated topic, but a complex understanding of system mechanisms, as we detailed above, has been still missing.

Related to students' environmental views, on the basis of our analysis, the main findings are the follows:

• Parallel with results related to the judgment of sustainable agricultural structure, students have a strong environmental protective attitude. They know that not only external food characters (checkable during purchasing) are important. Confidential food characters also get an essential role in agroecological farming.

• Results show that respondents have a more complex view about environmental protective farming. They think, transportation and social issues are also important in order to develop a sustainable agroecological system.

• On the other hand, most of the time, students' opinion is different. Bachelor students are more optimistic in connection with environmental issues than Master students. Moreover, subject from a rural university (Debrecen) sometimes have a different priority in the viewpoint of factors of agroecological systems (way of farming and food miles reduction). This tendency can be caused by that student at a rural university have more personal experiences about food systems and farming practices. Therefore, direct practice is a must to understand real connections between farming and supply.

Finally, we can highlight the most important results in connection with students' judgment on ecological farming system:

• Evaluating a living example (eco-farms), students show a deeper knowledge. They can identify problems, threats and weaknesses of eco-farming systems. It refers to that it is easier to turn theoretical knowledge into practical actions with the aid of experimental learning. The need of experimental learning is enforced by the knowledge level of students come from a rural university.

• Students' knowledge are not homogenous. Most of the time, Master students with environmental background have more complex views.

• Mostly, respondents have a strong environmental orientation but short term thinking. They cannot identify long term utilities, and extended social and economical goals of agroecological systems.

CONCLUSIONS

The examination of the results reveals the key factors that can improve educational system and knowledge transfer in Hungary and suggest further acts for the SAGITER international project team. The key factors are the following:

Complexity – besides environmental orientation, social and economical goals should be better highlighted. Agroecological knowledge has to be extended to the whole food chain.

In the case of BSc students, knowledge on social issues and necessity of documentation systems should be improved, while during the knowledge transfer toward to MSc students, the necessity of the whole food chain management should be more detailed.

Transparency – besides complexity, students have to understand the necessity of transparency. Managing the whole food chain, it is essential to develop correct documentation and controlling system.

Between BSc and MSc students, knowledge gap on importance of documentation and controlling systems can be detected, therefore they have to be taught the wider effect of agricultural farming.

Social sensitivity – students need to understand that fair working conditions also play an important role in agroecological improvement.

As a future task for the teachers, it is important to demonstrate for BSc students that farming plays a strategically role in social welfare. Therefore, it is crucial to take into account working conditions at farms and presenting practical case studies.

Dissimilarities in knowledge – economical education has to be extended with ecological studies. Women' agricultural integration is also a crucial factor of education development. Bachelor students have to get a more practice-oriented education, whilst students from the Faculty of Economics and Social Sciences should complement their studies with environmental issues. They primarily concentrate on economical development. They should understand the importance of environmental protection and social fairness, and they should also understand the long term outcomes of economical decisions.

In general, our results show, that men have a wider knowledge on agricultural issues. Women should be better integrated into agricultural activities. Women have to get a complex knowledge on farming systems, strength and weaknesses of agricultural farming and ecological knowledge transfer and development.

Experimental learning – visualization and experiments are the best methods to provide students with practical knowledge. Besides theoretical classes, living examples have to get a higher importance in educational structure.

For BSc students that would be advisable to have a more practical education. It is necessary to visit farms and meet with farmers during their studies. Our results show that living examples (field visits, case studies) are the best indicators of understanding the complexity of agroecological problems.

In the case of the metropolitan students, the individual experiences are also key factors in order to give a deeper knowledge on agroecological issues. Students, come from rural area, have direct experience with farming problems. On the other hand, it is difficult to identify agroecological actions for metropolitans. These underline the necessity to use relevant knowledge transfer methods and practical case studies during their studies, thus theory can grow from experience.

One single project cannot result a complete change in knowledge transfer method applied at universities in Hungary, but the practical method collection related to knowledge transfer designed for educators elaborated by SAGITER project team will surely support them during teaching. This collection will also reinforce the better understanding of the complexity of the sustainable agriculture by providing a better view of the whole picture. The main expected outcome of the project is still the awareness of the importance of those knowledges that cannot be acquired by university text books and the educational foundation of future responsible actions.

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THE IMPACT OF DIFFERENT DURATIONS AND MAGNITUDES OF MANURE HEAT ON THE GERMINATION OF YELLOW BRISTLE GRASS SEEDS (*SETARIA PUMILA [POIR.] ROEM ET SCHULT*.)

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ABSTRACT

During an experiment spanning several years (2007, 2012 and 2013), we studied the impact of high temperatures developing during manure treatment on the germination of weed seeds inserted into a total of six experimental manure windrows. For our test plant, we chose yellow bristle grass (*Setaria pumila [Poir.] Roem et Schult.*) and used seeds collected in different time periods (2006, 2007, and 2011) for the experiment. Following heat treatment, the weed seeds were germinated in culture dishes in a random block arrangement, in four repetitions, in some cases over a period of several years. After a full 22-week heat treatment (during which the seeds were in direct contact with the manure), the yellow bristle grass seeds failed to germinate. We also applied heat treatment of various durations at an average temperature of 50-60°C, in periods lasting between 4 and 42 days, during which the seeds had no contact with manure. At a temperature above 60°C for a duration of at least 28 hours, 4 days were sufficient for the yellow bristle grass seeds to lose germinability. An average temperature of 50-55°C had to be maintained for at least 21 days to produce a significant decline in the germinability of the examined weed seeds. However, at an average temperature of 55°C or higher, a shorter period may be sufficient for weed seeds to lose germinability.

keywords: manure treatment, yellow bristle grass, manure sterilization

INTRODUCTION

It has long been known that livestock manure promotes weed infestation (Wagner 1908; Grábner et al. 1918; Czérer 1922). The incorrect treatment or lack of treatment of manure not only contributes to the spread of weed, but weed seeds may also retain germinability (Zucker 1928; Újvárosi 1951; Dastgheib 1989; Mt. Pleasant and Schlather 1994).

The high temperatures developing during manure treatment play an important role in reducing the germinability of weed seeds within the manure. 1-2 days of treatment at 55-65°C may result in the sterilization of a few seeds, but generally, weed seeds do not lose their germinability from such treatment. The heat-resistance of different weed seeds varies greatly, primarily due to differences in the structure of seed pericarps (Gyárfás 1933). Consequently, the magnitude and duration of temperatures able to sterilize weed seeds may vary from species to species.

In the experiments conducted by Shiralipour and McConnell (1991), the seeds of 9 weed species were treated for one hour at an average compost temperature of 66°C, which caused all weed seeds to lose germinability, while a heat treatment at 60°C for three hours resulted in the germination of only one weed species. Similarly, Nishida et al. (1998) examined the seeds of 15 weed species and found that once the maximum compost temperature reached 46°C, there was a rapid decline in the germinability percentages of the different species, and all seeds lost germinability once temperature reached a height of 57°C.

The tolerance of weed seeds to heat and moisture varies from species to species. For instance, Egley (1990)

TABLE 1: Parameters of the full-duration experimental heat treatment

Windrow	Experimental Site	Manure Windrow	Year of Collecting Yellow Bristle Grass Seeds	Heat Treatment Period	Germination Period
1.	Jászdózsa	cattle manure base area: 3×6 m height: 1.5 m	2006	May 15 to November 17, 2007	May 13-27, 2008
2.	Jászdózsa		2006	November 10, 2007 to April 9, 2008	May 13-27, 2008
			2007		June 4-27, 2008
3.	Gödöllő	horse manure base area: 3×3 m height: 2 m	2006	October 29, 2007 to May 7, 2008	May 13-27, 2008
			2007		June 4-27, 2008
4.	Gödöllő	horse manure + water base area: 3×3 m height: 2 m	2006	November 14, 2007 to May 7, 2008	May 13-27, 2008
			2007		June 4-27, 2008

subjected the seeds of 8 weed species to a 7-day treatment at different temperatures in both dry and moist soil. In dry conditions, seeds were tolerant to heat and barely lost germinability below 70°C, though at higher temperatures, germinability declined significantly from the second day of treatment. However, even in such conditions, there was no considerable loss of germinability in certain species of weed. On the other hand, in moist soil, lower temperatures and shorter treatments were enough for certain weed species to lose germinability. Nevertheless, heat treatments actually promoted germination in certain weed species, possibly due to the fact that physical dormancy is broken at high temperatures.

The results of the analysis conducted by Thompson et al. (1997) show that the maximum temperature at which sterilization occurs is not only species-dependent, but more significant as a factor than the duration of the heat treatment. According to Larney and Blackshaw (2003), however, the role of temperature in the loss of germinability is only 17-29%, because other factors may also promote the sterilization of weed seeds during composting. Based on their studies, Shiralipour and McConnel (1991) concluded that aside from high temperatures, phytotoxins also play an integral role in reducing the germinability of weed seeds.

The object of the present study was to determine the impact of manure heat on the germination of yellow bristle grass seeds (*Setaria pumila [Poir.] Roem et Schult.*) at different durations and magnitudes of temperature by analyzing the research results of several years of experiments.

MATERIAL AND METHODS

We examined the impact of manure heat on the germination of yellow bristle grass seeds (***Setaria pumila [Poir.] Roem et Schult.***) by applying heat treatments of different durations. During full-duration treatment, weed seeds remained inside the windrow for the entire duration of manure treatment and were in direct contact with the manure. During heat treatments of different durations, we were able to continuously insert and remove weed seeds in the windrow during composting, thereby ensuring exposure to different magnitudes of heat for varying durations of time.

In the first experimental cycle, we constructed four manure windrows at two experimental sites for the application of full-duration heat treatment. The yellow bristle grass (*Setaria pumila [Poir.] Roem et Schult.*) seeds subjected to heat treatment were collected in the fall of 2006 and 2007. Heat treatment was applied in two periods, from spring till fall of 2007, and from fall of 2007 till spring of 2008 (Table 1). Two of the manure windrows were made from cattle manure (without any moisturizing agents), and two were made from horse manure (one of which was moisturized with water during construction). Before heat treatment was applied, we prepared 4×4 cm cloche foil packets of 400 seeds each, which were inserted into the windrows at a depth of 100 cm. The temperature of the windrows around the seeds were regularly measured with the aid of an Ebro TFN 520 manual digital thermometer and a 1000 mm long SMP measuring probe.

In the second experimental cycle, we constructed two manure windrows at the Organic Gardening Experimental Farm of Babatvölgy operated by GAK Kft. to study the impact of different durations of heat treatment under the professional supervision of the Institute of Environmental and Landscape Management of Szent István University. In April 2012 and April 2013, we constructed two horse manure windrows of identical size (3 × 3 × 3 m = 27 m^3) (Figure 1) with each layer moisturized during construction. The yellow bristle grass seeds used in the experiment were collected in fall of 2011 and placed into 3 × 3 cm packets made of cloche foil containing 200 seeds each. The packets were inserted into the windrow at a depth of 1 m in a way that enabled us to freely remove and reinsert the seeds to achieve different durations and magnitudes of temperature. The seeds had no direct contact with the manure. Temperature was measured directly next to the seeds at 15 minute intervals using an EBI-2T-312 data recording thermometer. Data processing was completed using the software EBI WINLOG 2000. The seeds were

Figure 1: Experimental windrow (2012)

removed from the windrow after 4, 7, 14, 21, 28, 35, and 42 days. In one experiment, the seeds used were germinated over the course of four years (2012–2015), while in the other experiment, the seeds used were stored at room temperature for two years and only germinated in 2015.

In each experimental cycle, the heat-treated weed seeds were germinated in plastic culture dishes in four repetitions. In 2008, each repetition used 100 seeds respectively, but after 2012, all germination experiments used 50 seeds respectively. The seeds were inserted into 0 to 1 mm grain size quartz sand (washed twice) at a depth of 1 cm for germination. Culture dishes were placed in a random block arrangement in an outdoor area protected from precipitation. The quartz sand was irrigated to ensure constant moisture for the entire 14-day period of germination. In the case of experiments where seeds were germination over several years, culture dishes were kept in a dry, cool, and dark cellar between germination periods. The control seeds were kept at room temperature and not subjected to heat treatment. At the end of the germination period, we determined the number of germinated seeds, then analyzed the results using variance analysis.

RESULTS

Regarding the temperature dynamics of manure windrows receiving full-duration heat treatment, we observed that within 7 days of constructing the windrows, the temperature of the manure increased above 50°C. The maximum temperature was above 70°C in Windrows 1 and 4, 64°C in Windrow 2, and a mere 54°C in Windrow 3. The windrows managed to maintain a temperature above 50°C for several weeks: Windrow 1 for 13 weeks, Windrow 4 for 16 weeks, and Windrows 2 and 3 for 6 weeks (Figure 2).

Concerning the development of high temperatures, Windrow 3 proved the least efficient and produced the lowest maximum temperature, which only increased above 50°C for a short period of time and then rapidly decreased. Due to the fact that this horse manure windrow was not watered during construction, the lack of moisture resulted in a slow decomposing process that produced less heat. In contrast, Windrow 4, another horse manure windrow, was constructed next to Windrow 3, but watered during construction. Due to a sufficient supply of moisture, this window produced the most favorable temperature dynamics of all windrows, despite the fact that similarly to Windrow 3, it was constructed in November and maintained until May the following year.

Despite the development of different temperatures in

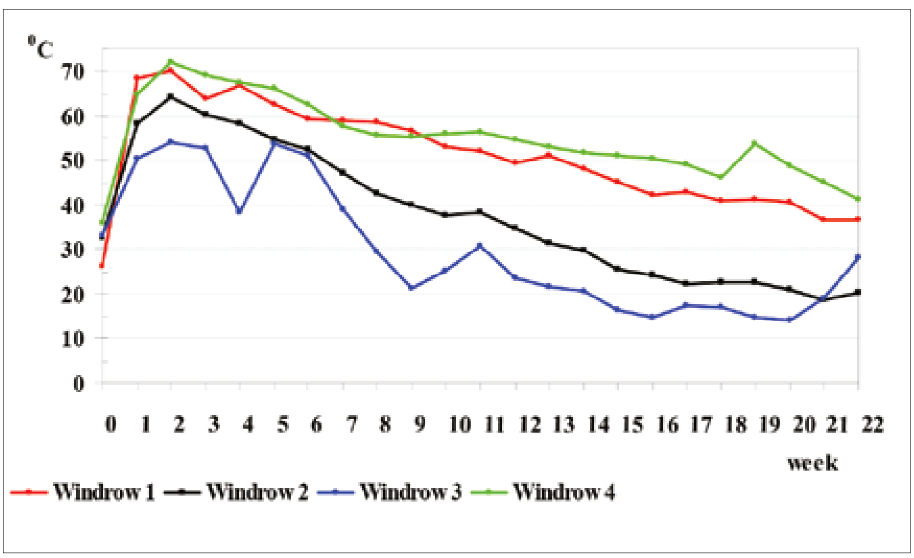

Figure 2: The weekly average temperature of experimental windrows between May 2007 and May 2008

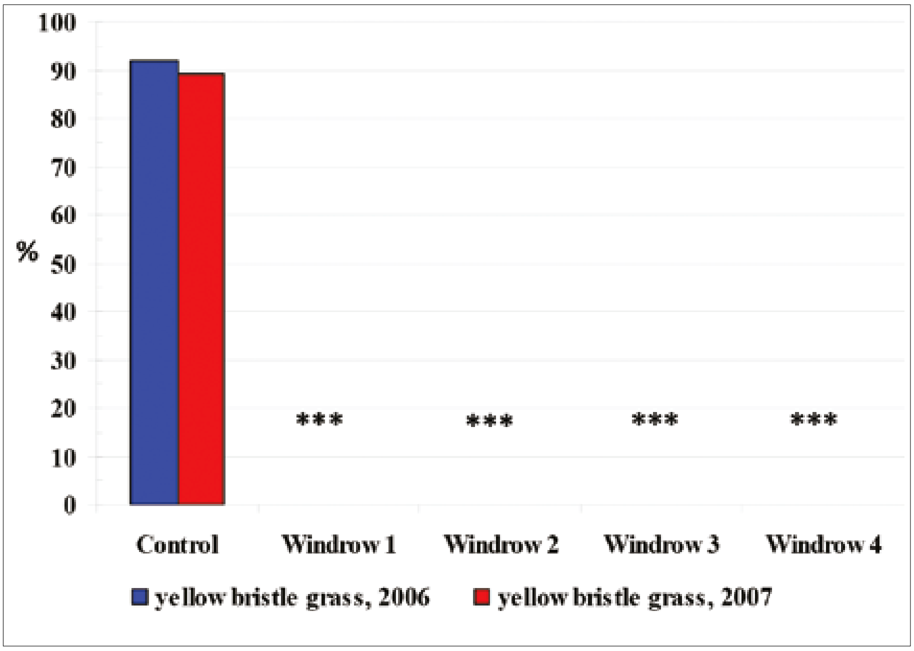

Figure 3: Germination percentages of yellow bristle grass seeds after the full-duration heat treatment. The difference compared to the control experiment is significant at ***P0.1%; $SD_{0.1\%}$ 7.44 for 2006 and ***P0.1%; $SD_{0.1\%}$ 7.17 for 2007.

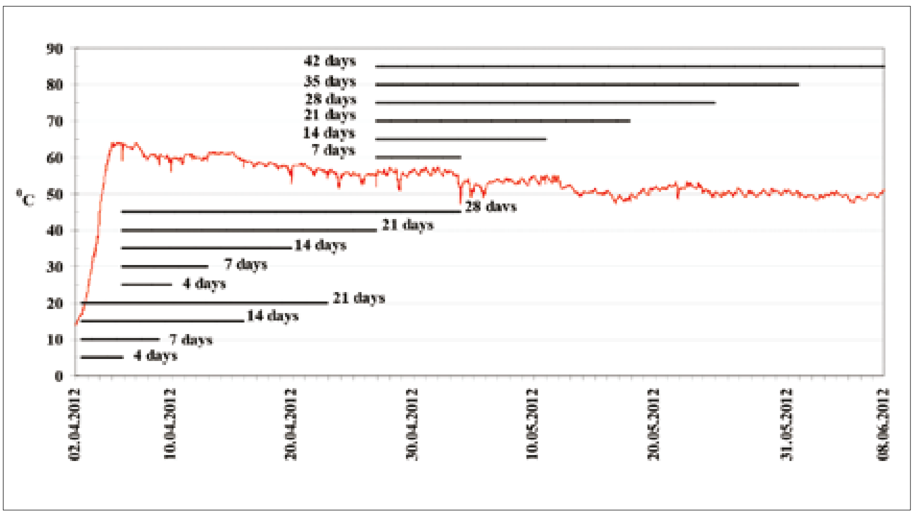

Figure 4: Windrow temperature and the heat treatment periods of yellow bristle grass seeds during heat treatments of varying durations (2012)

the manure windrows, the 22-week heat treatment proved successful in the case of yellow bristle grass, as none of the heat-treated seeds germinated during culture dish germination (Figure 3). At the same time, the germination percentage of yellow bristle grass seeds collected in 2006 and not subjected to heat treatment was 92% during the 14-day germination experiment, while the germination percentage of the seeds collected in 2007 was 89%.

In 2012, we conducted heat treatment of varying durations, during which the temperature of the constructed windrow increased within 2 days from 13°C to 50°C. The maximum windrow temperature was 64.1°C, reached on Day 3. The windrow maintained a temperature above 50°C for 44 days, and temperature never dropped above 48°C even by the end of the 60-day examination period.

Packets containing yellow bristle grass seeds were inserted into the window at three different dates. The first packets were inserted immediately after the construction of the windrow, the second group of packets were inserted 4 days later, at a time when windrow temperature was rising, and the third group of packets were inserted 21 days later, when windrow temperature had reached 55°C (Figure 4). Packets were usually removed at weekly intervals.

Yellow bristle grass seeds inserted into the windrows immediately after construction or 4 days after construction did not germinate during the 4-year germination period (Figure 5). Weed seeds inserted immediately after the construction were exposed to temperatures above 50°C for 5 to 18 days, during which temperature increased above 60°C for a period of 1 to 5 days. Weed seeds inserted 4 days after the construction of the windrow were exposed to temperatures averaging between 57.8°C and 61.3°C.

In both cases described above, a heat treatment of 4 days was sufficient for yellow bristle grass seeds to lose germinability. In the first 4-day period, weed seeds were exposed to temperatures above 60°C (ranging from 60°C to 64.1°C) for 29 hours, in which case germinability may have been affected by the relatively short exposure to high temperatures as well as the rapid increase of temperature. In the second 4-day period, manure temperature fluctuated between 57.7°C and 63.9°C (average: 61.3°C), but temperature only remained below 60°C for 16 hours.

Weed seeds inserted into the windrow 21 days after construction were exposed to temperatures averaging between 51.7°C and 55.6°C regardless of the duration of heat treatment. However, even after a heat treatment

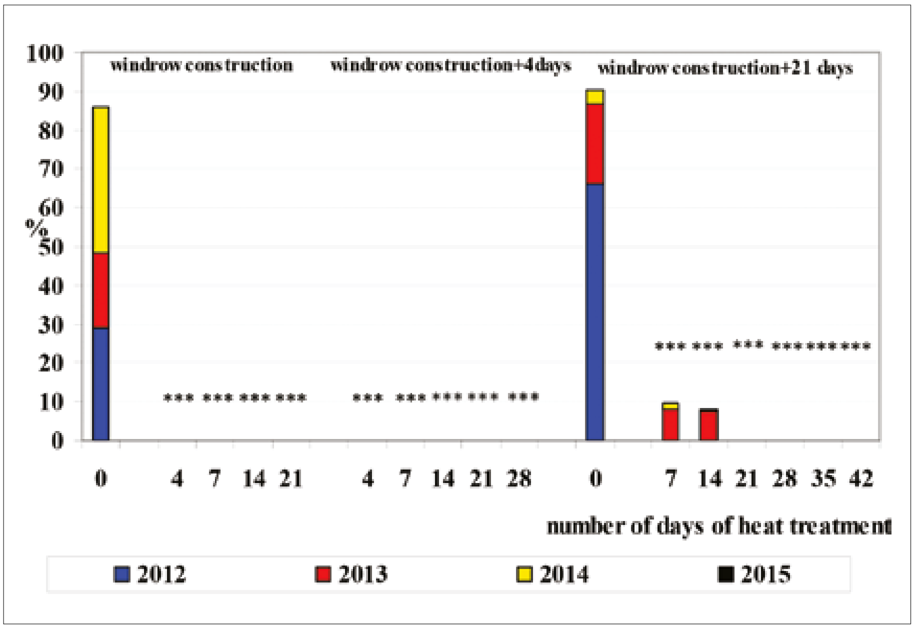

Figure 5: Germination percentages of yellow bristle grass seeds after heat treatment of varying durations (2012–2015). The difference compared to the control experiment is significant at ***P0.1%; $SD_{0.1\%}$ 6.46 for Control Group 1 and ***P0.1%; $SD_{0.1\%}$ 9. 71 for Control Group 2.

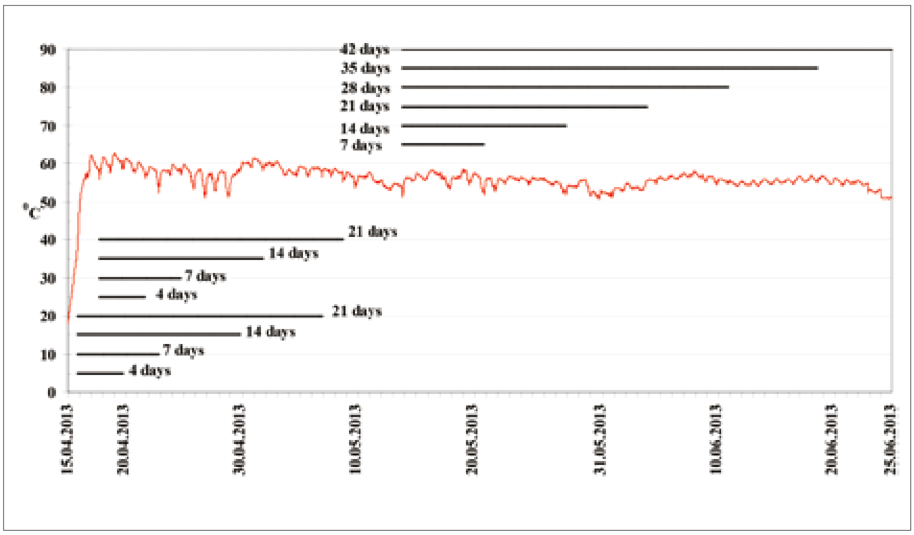

Figure 6: Windrow temperature and the heat treatment periods of yellow bristle grass seeds during heat treatment of varying durations (2013)

of 7 and 14 days, respectively, 10% of the weed seeds still germinated, predominantly in the second year of germination (2013), with a post-germination rate of 1-2% in the third year (2014).

Since the germination of heat-treated weed seeds occurred in two consecutive spring turns, both experiments used untreated control seeds. However, even among the control seeds, germination rates varied, with one control group showing a 30% germination rate in the first year while the other group showed a germination rate of 66%. In the second year, we observed a 20% rate of post-germination in both control groups. In the third year, the first group had a significant germination rate of 38%, while the second group showed a rate of 4%. In 2015, neither group showed any signs of germination. By the end of the fourth year, 86-91% of the untreated seeds managed to germinate.

The temperature dynamics of heat treatments of varying durations applied in 2013 developed similarly to the experiments conducted in 2012. Within 45 hours of constructing the windrow, temperature increased from 20°C to 60°C. The maximum windrow temperature was 62.7°C, and temperature did not decrease below 50°C even by the end of the 60-day examination period. Similarly to the previous experiment, yellow bristle grass seeds were inserted into the windrow at three different dates (Figure 6).

Heat-treated seeds were first germinated in spring of 2015, 2 years following treatment, and we found that none of the heat-treated seeds germinated. At the same time, 70% of the untreated control seeds collected in 2011 and stored at room temperature germinated.

Similarly to the experiment in 2012, 4 days of heat treatment proved sufficient for yellow bristle grass seeds to lose germinability. In the first 4-day heat treatment period (where the seeds were inserted immediately after the construction of the windrow), the seeds were exposed to temperatures above 60°C (ranging from 60°C to 62.7°C) for 45 hours. During the second 4-day period (where the seeds were inserted 4 days after the construction of the windrow), manure temperature fluctuated between 56°C and 62.7°C (averaging at 60.1°C), but only stayed below 60°C for 40 hours, and the difference was only a few tenths in degree.

Seeds inserted 28 days after the construction of the windrow were subjected to temperatures averaging between 55.1°C and 56.4°C. Average temperatures were a few degrees higher (above 55°C in every treatment period) than in the year 2012 (when temperatures averaged between 51.7°C and 55.6°C). We found that compared to the heat treatments of 2012, in the current sample, seeds receiving 7 or 14 days of heat treatment did not germinate. In 2013, heat treatments lasting 7 or 14 days developed temperatures ranging between 51.4°C and 58.6°C (the average temperature during the 7-day treatment was 56.4°C, and 55.9°C during the 14-day treatment). In 2012, values were lower, with temperatures ranging between 47.3°C and 57.3°C during the 7-day and 14-day treatment (with an average temperature of 55.6°C during the 7-day treatment and 54.3°C during the 14-day treatment).

We also calculated the accumulated temperature totals for the 7-day and 14-day treatments. To calculate the totals, we subtracted 40°C from all temperatures measured at 15-minute intervals, then totalized the resulting temperature values. We chose 40°C as the critical temperature value due to the fact that during the drying of crop seeds, temperatures above 40°C are considered unfavorable to retaining germinability. In 2013, the temperature total was 486°C higher for the 7-day treatment and 2090°C higher for the 14-day treatment than in 2012, which may have contributed to the loss of germinability in seeds that were germinated in that year (approximately 10% of the total number of seeds).

CONCLUSIONS

During the storage of livestock manure, manure withdrawn from storage should be constructed into a manure windrow as soon as possible in order for manure temperature to increase as fast as possible and remain above 55°C for longer periods of time. In the event that manure temperature rises above 60°C within 1-2 days and retains this temperature for at least 28 hours, even a 4-day treatment could prove sufficient in sterilizing any yellow bristle grass seeds inside the manure. Yellow bristle grass seeds could also lose germinability at temperatures between 50°C and 55°C, but these temperatures have to be maintained for at least 21 days for treatment to be effective. The magnitude of temperature and the short but intense rise of temperature both contribute to the loss of germinability in weed seeds. Based on the full-duration heat treatments applied in the first experimental cycle, where the development of temperatures was not always favorable, but weed seeds were in direct contact with the manure, we concluded that beyond the magnitude of temperature, other factors not discussed in this paper may have also played an integral role in the loss of germinability of weed seeds.

ACKNOWLEDGEMENTS

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ECONewFARMERs
BUILDING A FUTURE FOR NEW FARMERS IN ECOLOGICAL FARMING THROUGH VOCATIONAL TRAINING

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ABSTRACT

In 2013 6 institutions from 6 countries started a common innovation transfer program with the support of Leonardo da Vinci 2013-1-PT1-LEO05-15535. Within this paper we outline the outcome of the questionnaires filled by stakeholders and – based on the results - the training material developed.

The m-learning course curriculum (or syllabus) includes a set of information with great emphasis on the learners needs and characteristics, including the course goals, course objectives, length of the course, target audience, course prerequisites, course components (e.g., classroom instruction, farm practice) and evaluation methods. Based on existing innovative learning practices and on partners' expertise and training experience, a course curriculum was developed. The contents description and materials are under development.

The m-learning course curriculum will provide the structure for the learning process for the specific target group based on m-learning methodologies. They will work as a framework structure for the learning contents of the Platform.

The m-training modules for the ecological farming m-learning curriculum were selected available ecological farming material. The adaptation of the selected packages for vocational training considering the needs of the target group (young unemployed people without any knowledge in agriculture or with an academic degree in other scientific area) and national conditions is going on. Revised, updated and adapted learning material will be included to the training platform.

The course is divided into modules, with a previews presentation of the course objectives and a final review, organized in sections. These sections contain the information related to the subject. The possibility of using voice-over is being analysed.

keywords: m-learning, curriculum, vocational training, ecological farming, international questionnaire

INTRODUCTION

Organic agriculture is increasingly becoming important as a preferred avenue of production of farm produce to meet a globally growing market demand. The relevance of organic agriculture is more so due to the need and demand for more organically produced farm products, which are free of chemicals and are ecologically sound and healthier. At present, organic agriculture results in value added products but these production systems require specialized approaches. There is a gap of expertise to address the challenges and requirements of organic farming.

Furthermore, an increasing number of people with higher levels of education are changing their activity to agriculture without any knowledge in this technical area, mainly in countries with economic difficulties, such as Portugal. According to the Ministry of Agriculture, there are 200 new farmers by month and most of them did not have any education or training in agriculture.

Before we had been start with our work, we carried out a training need analysis in the form of international survey with questionnaire. The main goal was to explore the organic farmers need.

There is therefore a need to build capacity in skilled people in this field, in order to improve their agricultural skills and to facilitate their performance and innovation capacity, so they might contribute to the European (EC) rural development strategy.

This course is designed to produce such skilled farmers. The overall objective of this course shall be to produce new farmers with knowledge and skills required for development of the organic agriculture value chain.

The specific objectives will be:

i) To provide training in various aspects of organic agriculture and related fields such as natural resources management (soil, water, plants, environment) and rural development (conservation, family and organic farming, multifunctionality).

ii) To facilitate the effective exchange of knowledge and expertise in organic agriculture, rural development and environment.

iii) To offer technical support and knowledge in ecological farming on a permanent mobile context.

This course will also contribute to preserve European languages and cultures, in order to improve communication among the different stakeholders and target groups.

This course includes organic farming principles and techniques, based on the triangle plant-soil-environment and on the relations between animal production and the environment. Food preparation and labelling, marketing and conversion are also demonstrated. The presented principles and techniques are explained based on practical rules and guidelines (standards), with a logistic approach that will ensure the system balance and integrity. The course also presents the national and European regulations and standards that are mandatory for the organic farmers.

MATERIAL AND METHODS

Questionnaire, a means to guide the training offer in all partner countries

The project ECONewFARMERS aims to contribute for the training of new farmers who want to devote themselves to organic farming, and who already have at least secondary education but no formal knowledge in agriculture in general or organic farming in particular.

The aim of this questionnaire was to know the experiences of previous training in this area, or similar, with the view of defining a set of guidelines (rules for training and evaluation, forms, themes) for the preparation of new contexts of training in biological agriculture, in particular in the form of m-learning (mobile-learning).

This questionnaire, as a means to guide the training offer, was presented and worked as base for a debate on the contents, formats and evaluation for training in ecological farming. It will contribute to define the course goals and objectives and contents, and to ensure that the course will meet the needs of the learners as well as training formats and preferences (duration, training place, evaluation, among others).

The questionnaire was structured in order to address the respondent's characterization, its past experiences in ecological farming training, its use of technologies and m-learning tools, and preferences on the type of training to offer. The questionnaire also tried to identify eventual gaps in training in ecological farming.

The questionnaire was firstly prepared in English and Portuguese and applied to the participants of the launch conference of the ECONewFARMERS projects – the Conference Innovative learning systems in ecological farming, that was held in the Polytechnic Institute of Viseu, in 2014 February 7th. Later it was translated into all the languages of the participating countries and applied to potential interested people in each of the countries of the ECONewFARMERS partners (Portugal, Spain, Slovakia, Hungary, United Kingdom, Italy and Turkey). The questionnaire was produced using the tools provided by Google Drive, as it provides an easy way of sharing and altering the language among all partners participating in the project.

Questionnaire structure

The questionnaire was structured in five sessions that aimed to assess respondents' characterization, past experience in actions for agricultural training, use technologies and m-learning tool, preferences towards the type of training to offer and gaps in training in ecological farming.

Respondents' characteristics that were addressed include age, education level, experience in agriculture (form learner to farmer) and place of professional activity.

The experience in agricultural training included questions related to the role in which they have participated in those actions (from learner to coordinator) and type of training used (classroom, e-learning, b-learning, m-learning, other). A short description about the organization of such actions was asked.

The practices related to the use of technologies and m-learning tools included a reference to the equipment commonly used (laptop, mobile phone, blackberry, tablet/i-pad, i-pod, i-phone, other), the reasons for its use (professional purposes or other), periodicity and which kind of research tools are used.

The preferences for different type of training included formats such as Classroom, e-learning, b-learning, m-learning or other. Respondents were asked if they consider the organization of classroom sessions in the context of m-learning training essential, with what frequency and why (Sporadically in 1 or ½ day modules, once a month, when asked, in the beginning or in the end of the training or both). The types of support materials and evaluation for m-learning were asked.

Finally, an open question was presented so that respondents might present their opinions on which training topics/modules they considered useful and that constitute gaps in training in ecological farming.

RESULTS

The course consists of 7 modules, and has a previews presentation of the course and its objectives and a final review to help the learner to understand its achievements.

Each module is made up of between 3 and 8 sections. Each section contains the information related to the subject, presented in a set of pages with short notes and images (pictures, graphics, and schemes), animated and synchronised. The possibility of using voice-over is being analysed.

Course Contents
Module 1 - Introduction to organic farming
Section 1 –The Organic Philosophy
Section 2 – History of organic farming
Section 3 – Food quality
Section 4 – Organic farming and conservation
Section 5 – Organic farming for family farms
Section 6 – Multifunctionality in organic farming
Section 7 – Marketing organic produce
Assignment
Module 2 – Soil and Nutrient Cycling
Section 1 – Soils and soil fertility
Section 2 – The plant/soil system
Section 3 – Nutrients in organic farming
Section 4 – Manures and supplementary nutrients
Section 5 – Composting
Assignment
Module 3 – Plants and technical itineraries
Section 1 – Knowing plants and crops
Section 2 – Crop rotation
Section 3 – Machinery and equipment
Section 4 – Soil preparation and crop establishment
Section 5 – Irrigation
Module 4 - Livestock husbandry
Section 1 – The role of livestock on the organic farm
Section 2 – Origin and conversion of livestock

Course Contents
Section 3 – Livestock health
Section 4 – Grass and forage management
Section 5 – Feeding organic livestock
Section 6 – Housing and accommodation
Assignment 1 and 2
Module 5 – Conversion planning and farm profitability
Section 1 – Organic farming – Tell your history
Section 2 – Gathering information
Section 3 – Planning the conversion
Assignment – Case study information, Part 1 and 2
Module 6 - Conservation and transformation of organic products
Section 1 – Food alterations
Session 2 – Importance of water in food conservation
Session 3 – Conservation and transformation processes
Session 4 – Effects of processing and conservation on the nutritional value of foods
Session 5 – Packaging technologies
Assignment
Module 7 - Certification, standards and procedures
Section 1 – Organic regulations
Section 2 – Procedures at farm level
Section 3 – Summary of European and national Standards
Assignment
Course Review and Personal Action Plan
Glossary

Short descrition of each module:

The course starts with a brief outline presenting the objectives and structure of the course.

Module 1 - Introduction to organic farming
Introduce the history and philosophy and environmental benefits of organic farming including how it is regulated. It also describes the food quality issues that come with organic farming and the marketing channels that are most usual with specific reference to their advantages and disadvantages. The close relations between organic farming and conservation, as well as the interest of organic farming and a production option for family farms are presented. The advantages and possibilities of multifunctionality in organic farming are introduced.

Module 2 – Soil and Nutrient Cycling
Outlines the soil structure and characteristics, and its central role in organic farming. Introduced principles for nutrients management on organic farming and for soil fertility conservation and improvement. Composting techniques are explained.

Module 3 – Plants and technical itineraries
Knowing plants and crops is essential to choose appropriate

crop species and varieties to meet particular farm situations and market requirements. The module includes a detailed description of farming practices required for successful organic farming. These practices will be discussed in the context of the organic farming principles. Technical itineraries are presented, as a set of steps from crop rotation to integrated plant protection. Advantages and disadvantages of the different techniques are presented

Module 4 - Livestock husbandry
How to produce livestock in organic farms and the ways and rules to livestock health maintenance and housing are presented. Includes the techniques to enhance grass production and the most required species for pastures and forages in organic farming. It also covers grassland management to enhance animal nutrition and health.

Module 5 – Conversion planning and farm profitability
Successful organic examples are introduced as a basis to start a new project in organic farming. Requisites for farm conversion and start planning an organic farm, based on farm and soil management plans, as a way to ensure sustainability. Determination of the potential profitability of organic farms are detailed. Crop rotation and crop management strategies are presented as a means to facilitate the transition process.

Module 6 - Conservation and transformation of organic products
The advantages associated to the consuming of organic produced foods are also strictly related to the preservation of their quality from the moment they are produced up to the moment when they are consumed. Hence the aspects related to conservation and transformation of organic products are important as a means to guarantee quality throughout the whole food chain. The principals of food alterations and conservation are addressed, as well as the effects of processing on the safety and quality of foods and their nutritional value. Finally, and because most of these products are commercialized with some kind of package, the packaging materials and technologies are also briefly discussed.

Module 7 - Certification, standards and procedures
Explains how organic farming is regulated in Europe. Describes how to become a certified organic producer, based in different national Standards.

Course Review and Personal Action Plan
A course review and the Development of a Personal Action Plan as a process of expanding, shaping and improving skills, knowledge and interests is proposed. This will help learners to move ahead to the next stage in their professional career.

Each module will include proper assignments at its end. Each assignment is based on information given in the module itself, delivered in specified texts and on information obtained by the learner. These assignments will test the learners' understanding of the modules, and try to encourage them to look for information elsewhere. Assignment responses can be one or two words, written explanations or descriptions, or numerical answers with calculations. The time expected for completing each assignment is between ½ to 3 hours, depending on their familiarity with the subject.

The proposal of developing a Personal Action Plan as a process of expanding, shaping and improving skills, knowledge and interests will help learners to move ahead to the next stage in their professional career. Learners will be asked to define what they want to achieve and to set their own goal(s). Each learner will write a personal development plan (PDP) to outline the actions they should undertake to achieve their goal(s) in organic farming and also to evaluate how close they are to the goal. Based on, a final reflexion might be done on what further actions are needed.

DISCUSSION

In our questionnaire-based survey the respondents identified a set of useful training modules, that constitute gaps in training in organic farming and that could be interesting in the context of m-learning training. These include very diverse areas, such as those listed.

- animal production
- bee keeping
- certification
- conservation and transformation
- conversion
- crop protection
- food safety
- management
- markets and marketing
- multifunctionality
- organic farming principles
- organic fertilization
- qualification
- technical itineraries
- tourism

The majority of the respondents were from Hungary, Spain, Slovakia and Portugal representing almost three thirds of the sample (80%). The participants from Turkey, United Kingdom and Italy represented 20% of the overall sample.

Most respondents had a higher level degree (68%). From those who have a higher education, about 27% was in Agricultural Sciences. Other areas of higher education were in nearby subjects, such as Environmental Sciences, Biology or Landscape architecture, but also in very distinct ones, as Law, Economy, Civil Engineering, History, Social Sciences, Nursing, Arts or Sports.

An expressive number of farmers with no training, education and experience in agriculture (52%), are already involved and aiming for training in this areas. From the respondents, 86% currently have, or are thinking of starting, some agricultural activity, and the average farm size (either current or planned) was 25 ha, but with a majority of farms (58%) with less than 5 ha. As to the crops they presently have or consider exploiting in the future, the greatest production goes for fruit crops (47%), vegetable crops (36%), followed by field crops (20%). Regarding the farming system, 70% have already adopted ecological (organic) farming or wish to adopt it in the future, revealing the interest for this farming system. However, when it comes to certification, it seems as not being an option for the majority of farmers (52%). The local market appears as the first choice for selling the goods produced (40%) followed by specialized shops (32%) and door to door baskets (25%) or via internet (23%).

Most of the enquired that practice some kind of agricultural activity do it because they like this area (51%). Some respondents, however, come from other areas of knowledge (70%), and some others were even unemployed (15%). Among those who practise agriculture, 28% obtained their farm though family and 40% already had experience in organic farming.

From the respondents, 58% had already participated in training activities related to agriculture. The teaching, training and learning experience was generally in classroom (65%), with only a few presenting experience in e-learning, b-learning and m-learning training.

All respondents use IT technologies regularly, with preference for laptops (79%) and mobile phone (74%), including for their professional activity. The use of this kind of devices is in a daily base, by the majority. An important number of respondents use these devices to search for information related to their professional activity.

The solution for the training offer that was indicated for a larger number of respondents was classroom and m-learning, with a significant number preferring that some classroom sessions were included in the training (29%). The reasons for this opinion were to allow to clarify doubts, exchange thoughts and discussion of topics and to facilitate the assimilation of knowledge. These sessions should occur when asked by trainees (29%) or periodically once a month (23%). Also training sessions on a farm were identified as a useful tool for complementing the training (83%). The preferred training materials were manuals (22%), electronic books (e-books) (21%) but other materials were also recognized appropriate (specific software, manuals, interactive platforms, technical leaflets). Regarding the assessment of the learning performance, the tests for response on-line were preferred (32%), followed by practical activities in the classroom (25%).

Some gaps of training in ecological farming were pointed out, partly related to technical aspects and knowledge (such as crop protection, organic farming, technical itineraries, conversion, conservation and transformation, certification, food safety, multifunctionality, markets and marketing) as well as to social and economic issues (like consumer education, certification, commercialization, legislation or marketing).

The results of the questionnaire allowed characterizing the target group and identifying its training needs and preferences towards m-learning formats, giving valuable tools to design the training offer. The curriculum has been based on the discovered gaps.

CONCLUSIONS

Training in organic farming will constitute as a tool for building knowledge and understanding the requirements of organic farming. Whether the new farmers are planning to convert their land or make an application to certify their products, or already are certified in organic farming, the organic farming course can help them to understand the organic regulations and standards.

Training can cover any and all requirements from farming methods and permitted inputs, to product composition, labelling and record-keeping. This training course is designed to give confidence to manage organic integrity, especially to those people that are or intend to be new farmers, mainly ecological farmers, and which don't have experience and knowledge in agriculture.

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INTERCROPPING EXPERIMENTS IN HUNGARIAN VINEYARDS[1]

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ABSTRACT

Intensive mechanical soil cultivation and herbicide treatment was often the preferred technology in vineyards in the second half of the 20th century. In the last decades we increasingly experienced the disadvantages of these suboptimal technologies: soil degradation, erosion and deflation damages. Alternative cultivation methods were sought for in research and practice, especially in organic viticulture. The use of well-adapted cover-crop mixtures in the vine inter-rows poses a possible solution for weed control, soil conservation and biodiversity development. The technology has a special importance on steep slopes: it helps to prevent erosion damages and provides easier cultivation circumstances. In 2012 the Hungarian Research Institute of Organic Agriculture in collaboration with other experts and growers began to study three different species-rich cover crop mixtures (Biocont-Ecovin, Legume mixture, Grass-herb mixture) in Hungarian vineyards. Each mixture was sown in three neighbouring inter-rows at each experimental site. After sowing (March 2012) we studied vegetation composition (June 2012, 2013 and 2014), pruning weight and diameter of the second bearing spur of the stocks, yield quality and quantity. Most of the sown species established successfully and in 2012 we found that Biocont-Ecovin and the mixture of Legumes were the most effective in weed suppression. For 2013 we detected lower weed coverage in the inter-rows sown with the Grass-herb and Legume mixtures, while in control and Biocont-Ecovin inter-rows we detected increasing weed coverage. In the third year (2014) we found in case of every plot that the grass-herb mixture-covered inter-rows were the least weedy. The most successful species in the inter-rows are: *Coronilla varia, Lotus corniculatus, Medicago lupulina, Onobrychis viciifolia, Plantago lanceolata, Trifolium repens, Trifolium pratense.* Viticultural measurements (2014) show a 10-13% decrease of yield in case of covered inter-rows, and a 26 and 21% reduction in pruning weight (Gróf Degenfeld and Tokaj-Hétszőlő). In case of the Gróf Degenfeld Estate we found significant differences among the measured indices. For Hungarian conditions it is therefore recommended to implement this technology in every second inter-row where erosion control is not required.

keywords: grapevine, cover crops, erosion, biodiversity, species rich mixtures

INTRODUCTION

Mechanical cultivation is one of the most frequently applied inter-row management technique in Hungarian vineyards. However, mechanical cultivation can cause several negative effects, such as soil desiccation due to higher evaporation, decayed soil structure, erosion and nutrient losses (Aljibury and Christensen 1972; Bauer et al. 2004; Dijck and Asch 2002) (Figure 1.).

Sustainable, alternative technologies, e.g. mulching or intercropping, can positively affect the water content of the soil (Rinaldi et al. 2000; Varga and Májer 2004). But suboptimal intercropping systems can also have negative effects on the soil moisture and on vine growth, due to e.g. water concurrence with the vine. So it was a challenge to develop the best practice to each wine production site. The use of cover crops has a special importance, especially on steep slopes and in hill-valley planted vineyards, to provide conditions for environmental friendly soil management.

[1] The paper is an adapted version of the short communication "INTERCROPPING EXPERIMENTS IN HUNGARIAN VINEYARDS" submitted to the International Conference on Organic Agriculture Sciences (ICOAS), 2015.

Species rich cover crop mixtures from local provenance may help to prevent erosion and to create easier cultivation circumstances. Furthermore they have also a positive effect on soil structure, soil fertility and ecosystem functions (Hoffmann et al. 2008). By using legumes, atmospheric nitrogen can be fixed in the soil, providing an additional benefit for the vineyard (King and Berry 2005; Wheaton et al. 2008). Previous vineyard cover crop experiments from Hungary (e.g. Varga et al. 2007; Göblyös et al. 2011) used mixtures with mainly foreign provenance. However, research results show that species and even ecotypes of local provenance can establish better under local environmental conditions (Mijnsbrugge et al. 2010). Therefore in case of this research, started in 2012, our aim was to develop well-adapted species-rich cover crop mixtures for Hungarian vineyards by using native species of Hungarian provenance whenever possible.

MATERIAL AND METHODS

Between 2012 - 2014 we compared three seed mixtures: Biocont-Ecovin (12 species), grass-herb mixture 16 species) and mixture of legumes (9 species). Biocont-Ecovin is a commercial seed mixture, which was developed during the Ecowin project (Vér and Takács, 2013), whereas the mixture of legumes and grass-herb mixture were developed by us for this research. During the experiment we cooperated with local vine growers and seed mixture experts. The experimental sites were in the Tokaj and Szekszárd wine regions. Five vineyards were involved in the study: Gróf Degenfeld, Oremus Budaházi and Szentvér vineyards (Tokaj wine region), Illyés Kúria, and Tringa Borpince (Szekszárd wine region). Each seed mixture was sown in the spring (March) of 2012 in three adjacent inter-rows. The coverage of vascular plant species was recorded in the central sown and control inter-rows in five 1×1 meter permanent plots in June, 2014. The yield was measured by picking ten-ten

Figure 1: Soil erosion in the vineyard

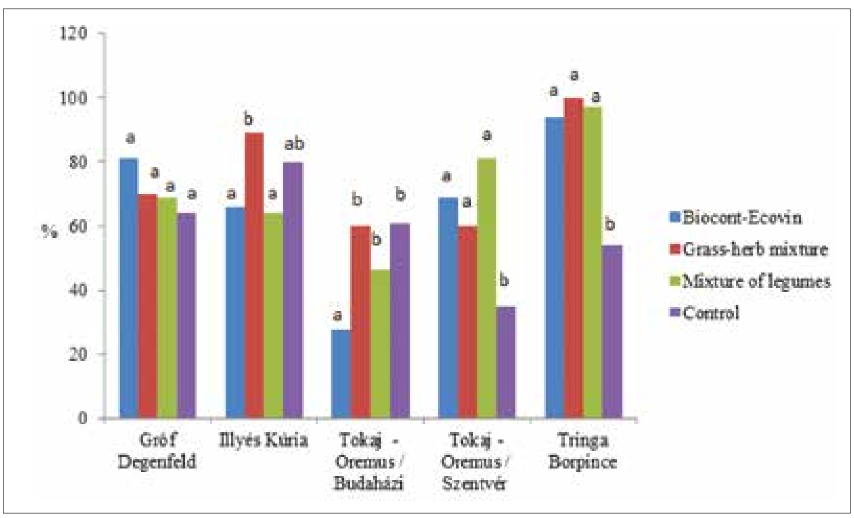

Figure 2: Total plant coverage of the third year (2014) after sowing (2012)

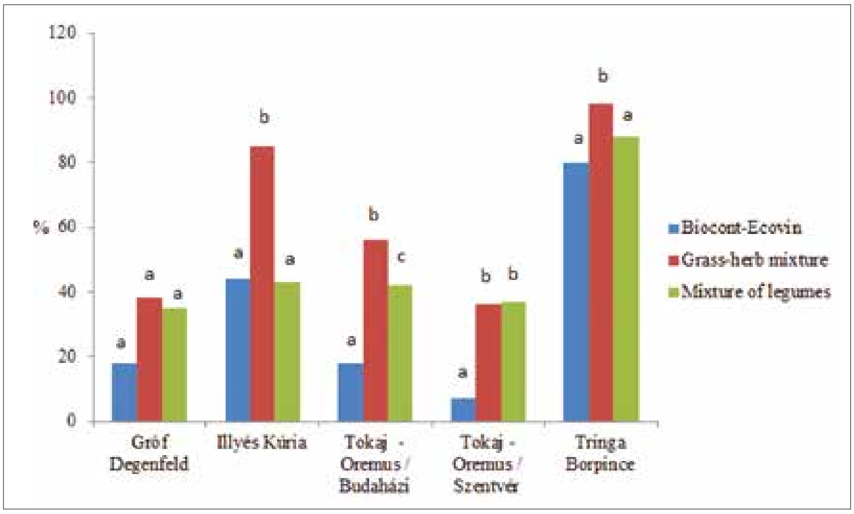

Figure 3: Average coverage of the sown species in percentage of the total coverage in the third year (2014) of the experiment

zigzag chosen vines in each block. Sugar content (MM°) and titrable acidity (g/l) of the must were measured in the laboratory of the Research Institute of Oenology and Viticulture, Tokaj wine region. As control, the weed flora of the mechanically cultivated area and the inter-row mowing were recorded. We considered all unsown plants as weeds. Data was anyalyses using SPSS sofware. One-way ANOVA was performed with the Tukey post-hoc test (p<0,05).

RESULTS

Botanical results

In 2012 we found that Biocont-Ecovin mixture and mixture of Legumes were the most effective in weed suppression. In 2013 we detected lower weed coverage in inter-rows sown with the grass-herb mixture and the mixture of legumes, while in unsown control inter-rows and in the area with the Biocont-Ecovin mixture we detected increasing weed coverage.

Botanical results show that to the third year (2014) on most sown sites the highest total coverage was detected in the inter-rows sown with the grass-herb mixture and mixture of legumes, but these differences were significant only at two sites (Figure 2). The percentage of sown species-coverage compared to whole coverage (sown+weed) was also highest in the grass-herb treatment at most sites (Figure 3), and in case of four out of five sites there were significant differences.

According to the experiences of the three years, most successful species in the inter-rows are: Coronilla varia, Lotus corniculatus, Medicago lupulina, Onobrychis viciifolia, Plantago lanceolata, Trifolium repens, Trifolium pratense (Miglécz et al. 2015).

Viticultural results

Viticultural measurements show a tendency of decreasing yield in case of inter-rows with cover crops, but the difference was significant only at one site (Table 1). This reduction was measured also in case of the pruning weight. The indices of the must quality were not significantly affected by the applied cover crops. There were no differences in the diameter of the internodes among treatments.

DISCUSSION

Our results show that seed mixtures can be used successfully in Hungarian vineyards, but the farmers have to be careful

TABLE 1: Yield and pruning weight of the stocks (2014)

Pruning weight, yield (g/stock), diameter of internodes (mm)	Biocont-Ecovin			Grass-herb mixture			Mixture of legumes			Control		
	pruning weight (g/stock)	mm/in-ter-node	yield (g/stock)	pruning weight (g/stock)	mm/in-ter-node	yield (g/stock)	pruning weight (g/stock)	mm/in-ternode	yield (g/stock)	pruning weight (g/stock)	mm/in-ternode	yield (g/stock)
Gróf Degenfeld	359 ab	9,53 a	930 a	300 a	9,07 a	820 a	333 a	9,44 a	850 a	449 b *	9,1 a	1030 b *
Tokaj-Hétszőlő	532 a	8,51 a	1390 a	587 ab	8,25 a	1180 a	570 b *	8,71 a	1100 a	596 a	8,93 a	1440 a
Tokaj - Oremus / Budaházi	n.d.**	9,56 a	1190 a	n.d	9,47 a	1390 a	n.d	9,46 a	1140 a	n.d	9,41 a	1370 a
Tokaj - Oremus / Szentvér	n.d	8,94 a	2240 a	n.d	9,55 a	2120 a	n.d	9,29 a	1740 a	n.d	8,85 a	2080 a

* significant difference (P<0,05)

** no data

under Hungarian edaphical and climatical conditons in context of the chosen mixture(s), technology of the soil management, age of the vineyards, etc. From the practical point of view it is important to choose species with similar seed size and shape to enable easy sowing by machinery. A carefully designed high diversity cover crop seed mixture should contain both annual and perennial species. Sown annual species with fast establishment can suppress weeds already in the first year, and sown perennial plants provide improved weed suppression in the later years. In case of the yield, we found that in Hungary the every second covered inter-rows are more optimal, where the control of the erosion is not required provided by the cover crop. Hungarian growers show high interest to apply alternatives to mechanical tillage in vineyards. Our results help them to create optimal cover crop floor management systems, taking into account the age of the grapevines, the local edaphic and the climatic conditions.

CONCLUSIONS

Our findings show that Ecovin-type mixtures that often contain cheaper seeds of anual plants (e.g. *Camelina sativa, Fagopyron esculetnum, Phaecelia tanacetifolia, Sinapis alba*) can help to avoid damages of erosion in the year of seeding. However, in the second and third years these species mostly disappear from the inter-rows. In case of suboptimal climatic conditions (e.g. extreme dry periods) weeds can better occupy the open inter-rows. In Hungarian climate, where dry periods are frequent in summer, our results show that it is more advisable to create cover-crop mixtures from perennial species, with low percentage of annuals.

Most examined indices of grapevines were not significantly affected by the applied cover crop, however, our results show that in our climate, every second inter-row sowing may be more preferable for vine-growth and yield, where erosion control is not required. Differences in must quality were not found.

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