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Sustainable farming best practices for MSc programmes

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Abstract: The sustainable agriculture concept emerges from the necessity to ensure food production to feed the human growing population, while the natural resources, water and soil quality, ecosystems and others are preserved. One way to implement the know-how and techniques in sustainable agriculture is through educational courses in the universities, such as MSc programme, by promoting communication between academics, researchers, agricultural workers and other experts. This paper examines the best practices to serve as a guide to develop a MSc programme in sustainable farming. A questionnaire was prepared and distributed to academics' expert in agrarian sciences in Greece, Italy and Portugal. The questionnaires were developed in order to define the fundamental competences/expertise, to identify the sustainable agricultural practices and the methods of training/learning that should be taken in consideration in a MSc programme in sustainable farming. The results allowed to identify the relevant best practices, the fundamental competences/expertise, the most important sustainable farming practices adequate forms of training/learning and the more efficient training methods that should be taken into account when developing the MSc programme.

Keywords: Questionnaires; High education; Sustainable agricultural practices.

1. Introduction

Nowadays, world faces huge challenges such as reducing poverty and ensuring food security. Therefore, the approximately one million people living in hunger today, by 2050 there will be 2 million more people who need to be fed. In addition, it is necessary to consider the climate changes that are negatively affecting the availability of fertile soil and water for agriculture production [1]. The sustainable agriculture concept emerges on growth in sustainable productivity to ensure the continued existence of our production base to feed a growing population, also thanks to innovation, while enhancing rural livelihoods [1]. The important role played by sustainable agriculture is to increase the productivity without affecting the quality of soil and water, preserve the ecosystems, safeguard animal welfare, generate income for farms

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and improve quality of life in rural areas, support territorial development and contribute to economy [2].

Consequently, issues related with economic, social and environment aspects are key factors for a sustainable agriculture, as a practice of farming using principles which respect ecology and save natural resources. Currently, there is a conscious need to relate agriculture, food and environmental policies and issues from a perspective that takes account of the diversity of sustainable agriculture and the complexity of their interdependencies [3]. In a brochure untitled "Sustainable agriculture for the future we want" [1] some success stories are presented, such as organic farming, on-farm biogas production, extensive grazing practices, renewable energy, precision farming and agro-forestry systems.

In order to practice a sustainable agriculture, farmers responsible for the management of farmland must adopt correct and environmental friendly practices, using appropriate technology and complying with EU regulations for a sustainable agriculture. Hence, farmers will need know-how and techniques to implement the changes, as well as, a smart governance system, fully set up, linking research, support services, farmers and their organizations and markets. The communication gap between academics, researchers and agricultural workers should be promoted. Also, the introduction of the know-how in sustainable agriculture it will be better implemented through MSc programme, since the public is more aware of environmental problems and the offer of educational courses in the universities is increasing in this area [4].

Thus, this study aims to identify the best practices to serve as a guide to develop a MSc programme in Sustainable Farming through a questionnaire prepared and distributed to academics' expert in agrarian sciences in Greece, Italy and Portugal. The questionnaires were developed in order to define the fundamental competences/expertise, to identify the sustainable agricultural practices and the methods of training/learning that should be taken in consideration in a MSc programme in sustainable farming. A long-term impact in securing the sufficient, safe, as well as environmentally, socially and economically sustainable production of agricultural products is expected to be developed.

2. Materials and Methods

In order to identify the best practices to serve as a guide to develop a MSc programme in Sustainable Farming, a questionnaire was prepared by the University of Evora (UEVORA) with the contribution of Agricultural University of Athens (AUA) and University of Basilicata (UNIBAS). This questionnaire was distributed to academics' expert in agrarian sciences in Greece, Italy and Portugal (Deliverable 1.2 – Similar Curricula in Europe of SFARM project). The main objective of the questionnaire was to identify the best practices based on other similar questionnaires and ideas expressed in EISA [5], such as:

- Which are the fundamental expertise in an MSc programme on sustainable farming?
- Which are the most important sustainable agriculture practices?
- Which forms of training/learning are adequate? Theoretical, practical classes? Presential, e-learning, b-learning?

The questionnaire is divided in three parts: 1) Present and future of sustainable farming; 2) Training needs on sustainable farming and 3) Personal data.

The questionnaire results were analyzed by country and were presented in percentages to allow the comparison of the results between the countries. Table 1 shows the methodology defined for the analysis of the currently existent practices, current level of farmers' expertise, future trends for practices, training needs, skills with future training needs, forms of learning/training, and training methods more efficient for the respondents of each country.

Table 1. Methodology defined for the analysis of the best practices of sustainable farming in Greece, Italy and Portugal, based on the percentage of the respondents.

Best practices	Percentage of the respondents	Results
Currently existing practices	> 60 %	Present in farms
	< 30 %	With low expression in farms
Current level of farmers' expertise	Sum of medium, high and very high > 80 %	High level
	Sum of medium, high and very high > 40 % and < 80 %	Medium level
	Sum of none and small > 50 %	Very low level
Future trends for practices	> 60 %	Main futures
	< 30 %	No future
Training needs	Value 5 > 60 %	Extremely important expertise
	Sum of values 4 and 5 > 80 %	Very important expertise
	Sum of values 1 and 2 > 10 %	Not important expertise
Future training needs	Sum of strongly agree and agree > 80 %	Strongly agree
	Sum of neither agree nor disagree, disagree and strongly disagree > 20 %	Not required
Forms of learning/training	Sum of values 4 and 5 > 75 %	Very applicable/important
	Sum of values 1, 2 and don't know > 10 %	Not very applicable/not important
Training methods efficiency	Sum of values 4 and 5 > 75 %	Extremely efficient
	Sum of values 1, 2, 3 and don't know > 60 %	Not efficient

3. Results and discussion

3.1. Personal data

A total of 72 questionnaires were answered by academics' expert in agrarian sciences: 22 in Greece, 30 in Italy and 36 in Portugal. In the three countries, most of the respondents were male (70.8 %) and the average age vary between 35.5 and 56.7 years old.

3.2. Best practices

There is a strong need to relate agriculture and environment into the term sustainable farming, because agriculture is one of the major user and polluter of water, a driver of deforestation and of loss of biodiversity. Farming systems, from intensive conventional farming to organic farming, have the potential to be locally sustainable. Whether they are in practice depends on farmers adopting the appropriate technology in the specific agro-ecological environment.

3.2.1. Current situation

More than half of the Greek, Italian and Portuguese academics said that there is a widespread concern in their region regarding the practice in sustainable agriculture (Figure 1).

Despite, they affirm that some farmers don't have the "know-how" of these practices and that farmers are interested in the economic profit.

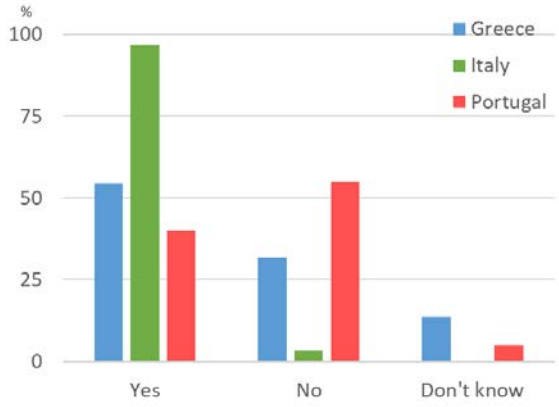

Figure 1. Present widespread concern of European expert academics regarding sustainable agriculture.

The sustainable agriculture practice concern was mainly related to subjects: i) climate change; ii) soil quality and resources; iii) water resources and management; iv) sustainable production; v) conservation agriculture; vi) farmers' income. The identified subjects are those that are causing a degree of concern and optimism in farmers that significantly varies according to the stakeholder's political views, production region, and agricultural occupation group [6].

Less than half of the respondents of each country agreed that exist some concern regarding the practice of sustainable agriculture. In Greece, the majority of respondents said that farmers do not have enough knowledge in sustainable agriculture issues and most of the stakeholders' focus on short-term profit, without taking into account the environmental impact and the sustainability of the farming systems. In Italy, the only questionnaire with negative answer said that there is not a widespread concern regarding the practice of sustainable agriculture, because their productions - organic agriculture and integrated agriculture - are regulated by the law. In Portugal, the majority of respondents said that many farmers are more interested in the economic sustainability. In sum, the differences in the elaboration of the "Yes" and "No" answers can be accounted based on the demographic characteristics of farmers in different countries.

From the analysis of the existent sustainable farming practices, we found that sustainable crop rotation plan, crop protection management and soil management were considered as practices already present in farms in the three European countries (Table 2). However, crop nutrient management and organic based fertilizers, integrated pest management and reuse of agricultural residues could almost be considered as practices present in European farms. Reduction of methane emissions from livestock and reduction of CO_2 emissions from machinery and fuel use were considered to be practices with low expression in Europe. Precision agriculture (PA) is a sustainable farming practice existent in Portugal and with low presence in Greece and in Italy. The low expression practices, identified among the respondents, have been considered to be the main drivers of climate change. According to Climate Change Position Statement Working Group (2011) and IPCC (2007), agriculture contribute with an estimation of 10 % - 15 %, to global anthropogenic greenhouse gases (GHG) emissions including nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2). Climate change and environmental degradation increase farmers' responsibilities on conservation and environmental management.

Table 2. Existent sustainable farming practices in Greece, Italy and Portugal.

Existing practices	Greece (%)	Italy (%)	Portugal (%)
Whole farm management plan	45	50	45
Farming cooperation	82	53	55
Sustainable crop rotation plan	73	87	75
Soil management	68	60	85
Crop nutrient management and organic based fertilisers	59	67	65
Crop protection management	91	77	85
Management plan for efficient energy use	32	37	25
Farm waste management	18	40	35
Use of renewable energy	36	43	45
Energy production from biomass and liquid manure	41	43	30
Water conservation and management	41	43	85
Irrigation evaluation and monitoring	36	50	75
Reduction of CO_2 emissions from machinery and fuel use	14	10	30
Reduction of methane emissions from livestock	18	23	10
Maintenance and calibration of spraying equipment	68	30	85
Use of catch crops	41	60	30
Integrated pest management	59	90	75
Reuse of agricultural residues	55	77	60
Precision agriculture	41	23	70

3.2.2. Current level of farmer's expertise

In Greece, Italy and Portugal, most of the respondents consider the farmers to have medium level of experience in the topics presented in Table 3. The highest level of knowledge of farmers' expertise was in crop nutrition, health and protection. However, the farmers have a considerable level of knowledge in animal husbandry, health and welfare, soil management and organization and planning. The lowest level of knowledge of farmers' expertise was in climate change and air quality, and waste management and pollution control. These results revealed that the farmers are experts in every phases of crop and animal production but not in farming waste and pollutants.

Table 3. Level grade of farmer's expertise in Greece, Italy and Portugal.

Subject	Greece						Italy						Portugal					
	None	Small	Medium	High	Very high	Don't know	None	Small	Medium	High	Very high	Don't know	None	Small	Medium	High	Very high	Don't know
Energy efficiency	5	55	36	0	5	0	3	50	47	0	0	0	10	45	45	0	0	0
Water use and conservation	0	50	32	14	0	5	3	47	43	7	0	0	0	25	55	20	0	0
Climate change and air quality	27	45	18	9	0	0	20	50	30	0	0	0	10	70	10	5	0	5
Landscape and nature conservation	0	41	50	5	0	5	3	23	50	23	0	0	5	50	25	20	0	0
Animal husbandry, health and welfare	0	32	27	27	9	5	0	7	50	33	10	0	0	15	45	25	5	15
Waste management and pollution control	23	36	23	5	9	5	7	47	37	10	0	0	20	40	25	10	5	0
Soil management	5	27	55	9	5	0	0	30	43	27	0	0	0	35	40	20	5	0
Organization and planning	0	23	50	14	9	5	0	30	47	23	0	0	0	35	45	20	0	0
Human and social capital	0	18	64	9	0	9	0	37	37	20	3	3	10	25	30	20	0	10
Crop nutrition	0	5	32	50	14	0	3	7	43	40	7	0	0	0	45	45	0	10
Crop health and protection	0	0	32	55	14	0	3	13	37	40	7	0	0	0	60	30	5	10

3.2.3. Future trends

The main future trends of sustainable farming practices in Greece, Italy and Portugal were management plan for efficient energy use, farm waste management, and energy production from biomass and liquid manure (Table 4). Although, the use of renewable energy, reduction of methane emissions from livestock, and precision agriculture may be also considered important future trend practices in European farms. Whilst, water conservation and management were considered the sustainable/farming practice with lowest future trend. This can be due to the fact that water is already a concern for farmers, especially in the opinion of Italian and Portuguese academics.

Table 4. Future trends in sustainable farming practices in Greece, Italy and Portugal.

Future trends practices	Greece (%)	Italy (%)	Portugal (%)
Whole farm management plan	55	50	45
Farming cooperation	23	47	40
Sustainable crop rotation plan	23	13	35
Soil management	32	40	20
Crop nutrient management and organic based fertilizers	41	33	40
Crop protection management	55	57	20
Management plan for efficient energy use	73	63	60
Farm waste management	86	60	65
Use of renewable energy	73	57	50
Energy production from biomass and liquid manure	91	90	60
Water conservation and management	14	23	15
Irrigation evaluation and monitoring	50	10	30
Reduction of CO_2 emissions from machinery and fuel use	59	57	60
Reduction of methane emissions from livestock	86	77	55
Maintenance and calibration of spraying equipment	32	70	25
Use of catch crops	55	40	35
Integrated pest management	68	50	30
Reuse of agricultural residues	45	23	45
Precision agriculture	77	77	40

3.2.4. Training needs on sustainable farming

The Greek, Italian and Portuguese academics considered very important expertise the majority of the technological, legislative, management and business, local community leadership and marketing (Figure 2). The technological was the most important expertise, while the legislative was the least important expertise. To train properly the farmers in sustainable agriculture, it is important to provide critical knowledge and skills to enhance the agricultural productivity and become economically self-reliant through gainful-employment [7].

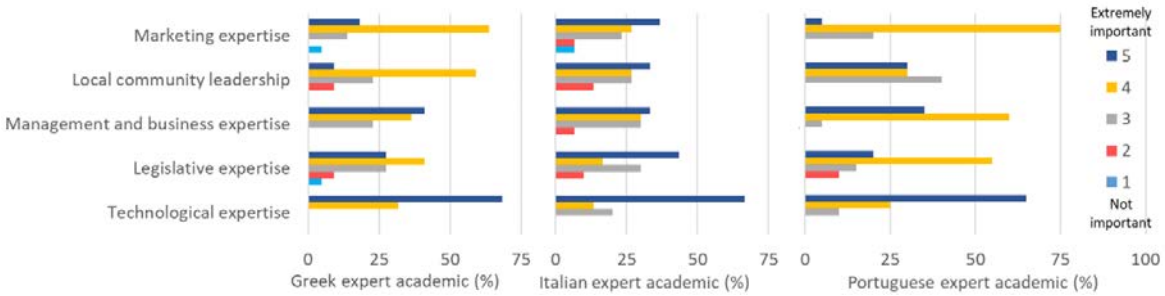

Figure 2. Expertise important rate for the future of sustainable agriculture in Greece, Italy and Portugal.

When the academics of the three countries were asked, about subjects in sustainable agriculture/farming, which do they think to be important to be taught in a Master Level, they agree in 9 important subjects: 1) agricultural waste management; 2) animal husbandry; 3) pest management; 4) precision agriculture; 5) remote sensing and GIS; 6) resources use efficiency (water, energy, nutrients, etc.); 7) soil management and conservation; 8) technological, economic, social and environment applied to sustainable agriculture; and 9) water management and conservation. These subjects are being used as the basis for the new curricula integrating the latest advancements of the "agri-tech" sector, and training courses for agricultural workers. Six of these

areas, where significant technological developments occurred to help farmers for a more sustainable agriculture, were identified in the ongoing project SAGRI – Sustainable Agriculture (http://www.sagriproject.eu/), and are being applied in the ongoing project SFARM – Sustainable Farming.

3.2.5. Training methods

The analysis of future training methods allows us to identify that Greek, Italian and Portuguese academics strongly agree with the require learning of new agronomical and environment (Figure 3). However, Greeks and Portuguese respondents strongly agree that management, and information and communication technology (ICT) skills are future training needs, while Italians respondents consider that these skills do not require future training. Skilled farmers will need to be able to understand and apply new technologies related to primary production for both food and non-food uses, soil science, crop and livestock genetics, agri-chemicals and general-purpose technologies such as remote sensors, satellites and robotics.

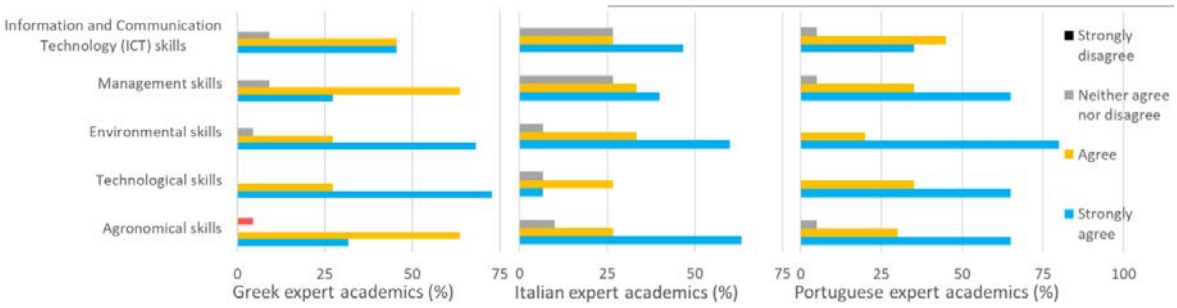

Figure 3. Overall future training needs in Sustainable farming.

Furthermore, we found that traditional face-to-face learning, experienced farmers as mentors and knowledge sharing mechanisms were rated as very applicable/important by the academics of Greece, Italy and Portugal (Table 5). On the other hand, massive open online courses and apps for learning via a smartphone was considered not very applicable/not important forms for learning/training in sustainable farming.

Table 5. Rate forms of learning/training in Sustainable farming by Greek, Italian and Portuguese expert academics (1 - not very applicable/ not important; 5 – very applicable/important).

Forms of learning/training	Greece (%)						Italy (%)						Portugal (%)					
	1	2	3	4	5	Don't know	1	2	3	4	5	Don't know	1	2	3	4	5	Don't know
Traditional face-to-face learning	0	0	14	41	41	0	0	7	10	30	53	0	5	0	10	45	40	0
Virtual and blended learning	0	0	36	27	32	0	3	10	37	37	10	3	0	5	25	40	30	0
Massive Open Online Courses	9	14	27	27	14	5	3	30	13	37	10	7	0	30	60	10	0	5
Peer-to peer learning	0	0	41	45	9	0	7	23	10	43	13	3	0	5	25	40	30	0
Experienced farmers as mentors	0	5	9	27	55	0	0	0	17	30	53	0	0	0	15	45	40	0
Knowledge sharing mechanisms	0	0	9	50	32	5	0	0	20	40	37	3	0	0	10	45	30	15
Apps for learning via a smartphone	5	9	32	32	18	0	0	13	50	23	13	0	5	5	40	20	10	20

The training methods educational excursions/visits, field demonstrations, short-term seminars, practical courses/exercises and agriculturalist's visits in farms were extremely efficient by the academics of the three European countries (Table 6). On the other hand, these academics considered not efficient the training methods broadcasts on radio, information in the form of forms-brochures, television broadcasts and articles in newspaper. Some agricultural universities and colleges still teach unsustainable conventional agricultural practices and technologies linked to crop and livestock production, such as crop monoculture and heavy use of chemical inputs.

Table 6. Training methods believed to be more efficient for the respondents (1 – not at all efficient; 5 – extremely efficient).

Training methods	Greece						Italy						Portugal					
	1	2	3	4	5	Don't know	1	2	3	4	5	Don't know	1	2	3	4	5	Don't know
Classroom sessions	0	0	36	50	14	0	0	7	17	40	37	0	0	5	35	25	35	0
Educational excursions/visits	0	0	14	36	50	0	0	0	13	30	57	0	0	0	20	45	35	0
Field demonstrations	0	0	0	36	64	0	0	0	3	27	70	0	0	5	10	25	60	0
Short-term seminars	0	0	18	73	9	0	0	3	10	57	30	0	0	0	25	40	35	0
Practical courses/exercises	0	0	5	36	59	0	0	0	7	23	70	0	0	0	10	35	55	0
On-line courses (e-learning)	0	14	50	27	9	0	0	10	57	23	7	3	0	10	45	40	5	0
Education at the individual level/ individual contact	0	5	18	50	27	0	3	10	40	30	10	7	0	0	15	50	30	10
Agriculturalist's visit in farms	0	0	0	41	59	0	0	0	20	13	67	0	0	0	15	40	45	0
On-line communication with agriculturalist (real time)	0	9	36	45	9	0	0	17	57	7	13	7	5	0	45	25	20	5
Lectures at physical meetings	0	0	27	64	9	0	0	13	50	20	13	3	0	15	45	30	10	0
Farmers visits to agriculturalist's office	5	5	45	32	9	0	0	0	37	43	20	0	0	20	20	35	15	5
Creating newsgroups	0	27	41	27	5	0	0	17	50	20	7	7	0	15	35	45	0	0
Broadcasts on radio	14	32	45	5	0	5	0	40	40	10	7	3	10	15	60	15	0	0
Information in the form of forms-brochures	5	18	64	9	0	5	0	17	53	20	7	3	10	20	30	30	5	0
Television broadcasts	0	32	41	18	5	5	0	23	43	20	10	3	0	20	35	35	5	5
Articles in newspapers	0	36	36	27	0	0	0	17	57	20	7	0	0	15	50	30	5	0
Agricultural journals	0	9	50	32	5	5	0	13	57	23	7	0	0	10	45	45	5	0
Helpline instructions	9	5	32	32	14	9	0	27	37	23	7	7	0	5	40	15	15	15

4. Conclusions

Relevant best practices in sustainable farming and agro-environmental technologies in Europe can be taken into account when developing a MSc programme were identified based on questionnaires. The questionnaires were developed in order to define the fundamental competences/expertise, to identify the sustainable agriculture practices and the methods of training/ learning that should be taken in consideration in a MSc programme in sustainable farming. The questionnaires were answered by Greek, Italian and Portuguese academics experts in agrarian sciences. The results allowed to identify the relevant best practices that should be taken into account when developing a MSc programme in sustainable farming.

In summary, the fundamental competences/expertise to be present in a MSc programme on sustainable farming should be:

1) Agricultural waste management
2) Animal husbandry
3) Pest management
4) Precision agriculture
5) Remote sensing and GIS
6) Resources use efficiency (water, energy, nutrients, etc.)
7) Soil management and conservation
8) Technological, economic, social and environment applied to sustainable agriculture
9) Water management and conservation

The most important sustainable agriculture/farming practices identified were:

a) Sustainable crop rotation plan
b) Crop protection management
c) Soil management

The more adequate forms of training/learning considered were:

1) Traditional face-to-face learning
2) Experience farmers as mentors
3) Knowledge sharing mechanisms

The more efficient training methods considered were:

a) Educational study visits
b) Field demonstration
c) Short-term seminars
d) Practical courses/exercises
e) Agriculturalist's visits in farms.

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