Co-funded by the Erasmus+ Programme of the European Union

SAgri Sustainable Agriculture

Project Title

Skills Alliance for Sustainable Agriculture

Project Acronym

SAGRI

Deliverable 2.1: Analysis of skills needs for agricultural workers for a "Sustainable Agriculture"

Prepared by: University of Évora

Luis L. Silva

Fátima Baptista

Vasco F. da Cruz

Évora, 30/04/2017

Funding details:

Education, Audiovisual and Culture Executive Agency

Erasmus+: Schools, Vocational Training Adult Education, Platforms

KA2: Cooperation for innovation and the exchange of good practices – Sector Skills Alliances

Agreement Number: 2016 – 2987 / 001 - 001

Project Number: 575898-EPP-1-2016-1-EL-EPPKA2-SSA

Support:

Co-funded by the Erasmus+ programme of the European Union

Deliverable details:

Due date of Deliverable: 30 - 04 - 2017

Actual submission date: 06 - 04 - 2007

1st Revision date: 30 - 04 - 2017

Start date of project: 1 - 11 - 2016 Duration: 3 years

Organisation name of lead contractor for this deliverable: UEVORA

Revision []

Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Disclaimer:

Contents

Co-funded by the Erasmus+ Programme of the European Union

1. Introduction

In the EU almost 50% of the territory is covered by farmland (both arable and permanent grassland), which means that agriculture plays a key role in land management and has a huge responsibility in the preservation of natural resources. The desired relationship between agriculture and the environment can be captured by the term "sustainable agriculture". 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.

To do so, farmers must be educated in agreement with the "sustainable agriculture" concept. A critical issue in the 21st century are the changes and adaptations required in agricultural education in order to make it more effectively, contributing to the improvement of sustainable agricultural production and rural development (Van Crowder et al., 1998). Recent developments in science and technology, that could be an added value for farmers' crop and land management, are still unutilized in many situations because farmers have not been introduced to them or have not been trained to use them.

The main goal of the SAGRI project is to allow agricultural workers or farmers to acquire skills, knowledge and ability to understand and analyse agro-environmental systems as natural ecosystems modified by human activity, with an emphasis on environmental technologies that can be applied to achieve crop sustainable production by means of improved systems' management.

Thus, this document tries to identify the skills needs in the field of agricultural technology (agri-tech), required for a farmer to be able to practice a "sustainable agriculture", with a particular focus on "green skills" and "digital skills". Skilled agricultural workers are generally defined as those responsible for growing, managing and harvesting crops; rearing livestock and managing forests (Cedefop, 2016). According to Cedefop's European skills and jobs survey (ESJS), the key 5 skills for skilled agricultural, forestry and fishery workers are teamwork, problem solving, learning, planning and job-specific skills (Cefedop, 2016). This document will focus mainly in the analysis of job-specific skills.

According to the EU Skills Panorama (2014), changes in technology, work organisation and available tools have and are changing the skills requirements of agricultural workers, concerning:

a) Green skills. Skilled agricultural workers increasingly need to have a holistic awareness of sustainability. This may relate to understanding Climate changing, the need for carbon emission reduction, renewable energy, biofuels, water resources and ecosystems management, and to be updated with new regulations and legislation linked to the sustainability agenda.

b) Digital or technological skills. Skilled agricultural workers 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.

Of course, not all agricultural workers or farmers have sufficient knowledge to understand all the new developments in agriculture applied research, since some of them require a minimum education level. Therefore, prior to identifying the skills it is mandatory to define the agricultural worker profile to whom they are destined. In the SAGRI project we decided to analyse the skills needs of an agricultural worker or farmer considering that he or she would have a minimum education level of high school and a basic knowledge and experience in agriculture, at a practical level. Seven major areas were identified, where significant technological developments occurred and that can help farmers for a more sustainable agriculture: 1) Precision technology; 2) Remote sensing to assess land capability; 3) Integrated pest management in plant protection; 4) Agricultural reuse of organic residuals; 5) Drip irrigation and water-conserving technologies; 6) Renewable energy and its application as green agricultural energy source and 7) Bioenergy and energy crops.

These skills will be the basis for the developing of new innovative curricula integrating the latest advancements of the "agri-tech" sector, and training courses for agricultural workers according to the EQF/ECVET framework.

Co-funded by the Erasmus+ Programme of the European Union

2. Transversal skills

Although this report is mainly about the job-specific skills for agricultural workers, there are some generic and transversal skills that agricultural workers need to have in order to adapt to changing production processes, and to other sector-specific changes and challenges (Cedefop, 2016).

- Information and Communication Technology (ICT) skills. Nowadays the information available in the World Wide Web about agriculture (production systems, technology, results from research, new machinery, equipment and products for agriculture) is enormous. For the farmer to benefit from this information he (or she) has to know how to find it in the internet. Free agricultural software or on-line platforms that can interact with the farmer and give him specific information and e-tools useful for its activity are also available for those that can use a computer, a smartphone or a tablet. Communication technology gives farmers greater control over their access and exposure to information. It enables them to take initiative as information seekers, rather than adopting a passive role as information recipients (Meera et al., 2004). Text messaging is one of the most widely used mobile data service worldwide, and many services or equipment can use this tool to interact with the farmer providing him with real time information. This can be very useful for farm management.

- Desktop software skills. The use of common word processors and spreadsheets is essential for data management and are becoming an important skill in farming practice, allowing workers to process information collected from different sensors and mapping systems (European Commission, 2014). Software can also store digital evidence to be presented to national and EU agricultural regulators on the fulfilment of subsidy conditions.

- An up-to-date understanding of evolving EU and national regulations for the agricultural sector and awareness of sustainable practices are requirements to improve the efficient use of resources (European Commission, 2014).

- Climate change awareness. Climate change and environmental degradation increase farmers' responsibilities on conservation and environmental management. Farmers need to maintain the productivity of their land while facing extreme weather events, potential water shortages etc. There is a growing need for skilled agricultural workers to understand how environmental sustainability is integral and applicable to their everyday practice (i.e. managing pesticide and other chemical use, reducing carbon dioxide emissions, using renewable energy, and managing water resources) (European Commission, 2015).

3. Specific skills

The following presented skills are those that have been identified in the framework of the SAGRI project for each of the proposed training modules. They are job-specific skills with a highlight in the awareness for all agricultural sustainability aspects and in the introduction to major technological developments in the specific areas.

3.1. Precision technology

Precision Agriculture (PA) is "a holistic and environmentally friendly strategy in which farmers can vary input use and cultivation methods – including application of seeds, fertilizers, pesticides, and water, variety selection, planting, tillage, harvesting – to match varying soil and crop conditions across a field" (Srinivasan, 2006). The adoption of PA may be represented as a five-step cyclical process including data collection, diagnostics, data analysis, precision field operations and evaluation. It uses information technology, satellite positioning (GNSS) data, remote sensing and proximal data gathering (European Commission, 2014).

The implementation of PA has become possible thanks to the development of sensor technologies combined with procedures to link mapped variables to appropriate farming practices such as tillage, seeding, fertilization, herbicide and pesticide application, harvesting and animal husbandry (European Commission, 2014). With PA technologies the farmer can increase yields and/or profitability in a sustainable and environmentally friendly way. Several studies have demonstrated the economic and ecological benefits of PA tools over conventional techniques (e.g. Stafford,

Co-funded by the Erasmus+ Programme of the European Union

2006; Silva et al., 2007; Takacs-Gyorgy, 2008). It is a complex process requiring different types of knowledge and expertises, usually available through consulting, advisory and training services. Nevertheless, the farmer or agricultural worker is a key factor for the implementation of PA. He must be aware of the benefits of PA, and must have some skills regarding the use of Precision technology. According to Pierpaolia et al. (2013) one of the main reasons for farmers not to adopt PA technologies are insufficient skills and competences to manage PA tools.

The agricultural workers required skills in Precision technology are:

a) Notions on the concept and principles of Precision Agriculture and the potential benefits from its use. The implementation of PA schemes enables farmers to: i) be more economically competitive; ii) improve farm sustainability; iii) improve crop quality and yield; iv) to attain more homogeneous products; v) secure traceability of products; and vi) be better adapted to comply with regulations regarding the use of nutrients and chemicals (Bakhtiari and Hematian, 2013).

b) Notions on the criteria for PA adoption and implementation. It is important for the farmer to be aware that the implementation of PA requires clear evidence of significant spatial and temporal variability in soil and crops conditions within a field or within fields in a region. The fields with the greatest opportunities for PA are those which reveal a high degree of yield variation. A high degree of variation will mean higher variable rate application of inputs and, therefore, greater economic and environmental benefits in comparison with uniform management. It is also important to analyse aspects as farm size, expected reduction in costs, higher revenues to provide a suitable cost/benefit ratio, the total income, land tenure, the farmer's level of computing skills, access to information and location, which are also important factors influencing the adoption of PA (Pierpaolia et al., 2013).

c) Notions on the better techniques and technologies to evaluate field variability. The farmer may not be able to use these techniques, due to the required expertize to operate different sensors and equipment, but he must be aware of the best techniques that can be used to evaluate soil and crop variability in order to be able to acquire the correct consulting services for his own situation. Over the last few decades, many new technologies have been developed for, or adopted to, agricultural use, such as: yield monitors, sensors developed to quantify the physiological status of crops (e.g. Nitrogen sensors, crop vegetation index sensors), geophysical sensors to measure soil properties, such as apparent electrical conductivity (ECa) sensors, and low-cost remote sensing techniques.

d) Skills for implementation and/or use of precision technologies. Precision technologies can be used in several agricultural activities: i) Controlled Traffic Farming (CTF) and auto-guiding systems are the most successful applications on arable land showing clear benefits in many cases; ii) Variable Rate Application (VRA) methods, for fertilizer or pesticide application, for irrigation, etc, can be used with different success depending to the specific factors of the application. Its use allows precise seeding, optimization on planting density and improved application rate efficiency of herbicides, pesticides and nutrients, resulting in cost reduction and reducing environmental impact. There is some evidence from research which shows that environmental degradation is reduced when PA methods are applied, including increased fuel use efficiency resulting in lowering carbon footprints. PA has been identified as a way to meet EU directives in Member States to reduce agro-chemicals (Zhang et al., 2002); iii) Precision Livestock Farming (PLF) that relies on automatic monitoring of individual animals and it is used for meat, milk and egg production and for monitoring animal behaviour, welfare and productivity and also their physical environment (European Commission, 2014). There are a lot of monitoring equipment that the farmer can use to collect data after a proper training; iv) Precision irrigation. In high-value crops, precise irrigation methods are developing rapidly in order to save water while improving yields and fruit quality. A simple division of a field in different individual controlled irrigation sectors, can allow to apply different irrigation depths according to specific field and crop variations.

The farmer must be aware of the main available precision technologies, including different sensors required to collect field data for crop status evaluation, and what is necessary to use them.

3.2. Remote sensing to assess land capability

Co-funded by the Erasmus+ Programme of the European Union

Land Capability was defined by FAO (1976), as the ‘‘quality’’ of land to produce common cultivated crops and pasture plants without deterioration over a long period of time. The term "land capability" is used in a number of land classification systems, namely the one of the Soil Conservation Service of the U.S. Department of Agriculture. In the USDA system, soil mapping units are grouped primarily on the basis of their capability to produce common cultivated crops and pasture plants without deterioration over a long period of time. Instead of “land capability” the FAO (1976) framework for land evaluation uses the term “land suitability”. According to this framework, “capability is viewed by some as the inherent capacity of land to perform at a given level for a general use, and suitability as a statement of the adaptability of a given area for a specific kind of land use; others see capability as a classification of land primarily in relation to degradation hazards, whilst some regard the terms "suitability" and "capability" as interchangeable”.

The aims of land evaluation as given in the original FAO framework refer to the identification of adverse effects and benefits of land uses, and although they remain wholly valid, the FAO (2007) framework revision introduces a greater emphasis on environmental consequences and on wider benefits and environmental and ecosystem services.

Land capability or suitability analysis requires the use of different kinds of spatial and non-spatial data (soil, climate, land use, topography, etc.). These data can be incorporated in Geographical Information Systems (GIS) to attain diverse thematic information to be used in land assessment procedures. The use of remote sensing techniques, due to its capacity for covering large areas within a reasonable time and reliable accuracy, has become increasingly important to collect large amounts of field data, facilitating the evaluation of land use possibilities.

The required skills for agricultural workers regarding the use of remote sensing for land capability assessment are:

a) To understand the concepts of land capability and land suitability.

b) Notions on land evaluation objectives, principles and land classification. Land suitability should be assessed and classified with respect to specified kinds of land use and services. This includes the comparison of benefits obtained and the inputs needed on different types of land to assess the productive potential, environmental services and sustainable livelihood and, the comparison of more than one kind of use or service, taking into account the biophysical, economic, social and political context as well as the environmental concerns (FAO, 2007).

c) Notions on land evaluation procedures and required data. Land capability or suitability analysis requires the use of different kinds of spatial and non-spatial data (soil, climate, land use, topography, etc.). The agricultural worker or farmer must know what the necessary data is and how to obtain it.

d) To know the definition of remote sensing, its principles and major techniques for land capability assessment. The data required for land evaluation can be easily attained using remote sensing techniques. Topographic, crop and soil data can be attained from aerial photographs, photographs from unmanned aerial vehicles (UAV), satellite images and proximity sensors. These data can then be incorporated in Geographical Information Systems to attain diverse thematic maps, such as elevation maps, soil electric conductivity maps, pH maps, yield maps, vegetation index maps and others, which can be used for land capability and suitability assessment. Notions about the characteristics and accuracy of the referred data sources, such as, spatial resolution, frame size and equivalent ground area, are also important to identify the best data source according to the goals of the intended land capability or suitability assessment.

3.3. Integrated pest management in plant protection

“Integrated pest management means careful consideration of all available plant protection methods and subsequent integration of appropriate measures that discourage the development of populations of harmful organisms and keep the use of plant protection products and other forms of intervention to levels that are economically and ecologically justified and reduce or minimise risks to human health and the environment. ‘Integrated pest management’ emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms” (European Parliament and Council Directive 2009/128/EC).

Co-funded by the Erasmus+ Programme of the European Union

For a farmer to adopt an integrated pest management strategy he must have the following skills:

a) Notions on general goals and principles of integrated pest management (Directive 2009/128/EC Annex III);

b) To know relevant national legislation and regulations for the adoption of integrated pest management.

c) Notions on integrated pest management strategies and techniques, including:

i. Notions on risk assessment, economic threshold levels and pest control methods (agronomic, biological, genetic, biotechnical and chemical);

ii. Information on the general principles and crop or sector-specific guidelines for integrated pest management;

iii. Harmful organisms monitoring methods. Harmful organisms must be monitored by adequate methods and tools, where available. Such adequate tools should include observations in the field as well as scientifically sound warning, forecasting and early diagnosis systems, where feasible, as well as the use of advice from professionally qualified advisors.

d) Decision making. Based on the results of the monitoring the professional user has to decide whether and when to apply plant protection measures. For harmful organisms, threshold levels defined for the region, specific areas, crops and particular climatic conditions must be taken into account before treatments, where feasible. Sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control (Directive 2009/128/EC Annex III).

e) Notions on the standards for a sustainable use of plant protection products, including:

i. Definition, classification, toxicity and eco-toxicity, and authorized plant protection products in integrated pest management strategies.

ii. Application methods of plant protection products, including equipment characteristics, selection and maintenance needs.

iii. Procedures for preparing pesticide application equipment for work, including its calibration, and for its operation with minimum risks to the user, other humans, non-target animal and plant species, biodiversity and the environment, including water resources.

iv. Measures to minimise risks to humans, non-target organisms and the environment: safe working practices for storing, handling and mixing pesticides, and decontamination and disposal of empty packaging, other contaminated materials and surplus pesticides (including tank mixes), whether in concentrate or dilute form; recommended ways to control operator exposure (personal protection equipment).

3.4. Agricultural reuse of organic residuals

The term "organic residuals" includes several different waste categories. Among them are the organic fraction of municipal solid waste, animal wastes or effluents, agro-industrial co-products, by-products and effluents, biosolids (organic solids or sludge remaining after sewage treatment) and forestry and agricultural crops by-products and wastes. There is considerable potential for beneficial use of organic residuals through land applications. These beneficial uses can contribute to sustainable agricultural production and support a triple bottom line with positive economic, social and environmental outcomes. However, land application of organic residuals has some risks and costs, and these must be carefully evaluated and managed (King et al., 2011).

In order to reuse organic residues in agriculture in a sustainable way, farmers must have the following skills:

a) Notions on available organic residuals and their potential uses. Types, characteristics, availability and agricultural potential uses of major organic residuals.

b) To know the legislation regarding the use of organic residuals. National regulations, limits for contaminants level, pre-treatment regulations, pathogen regulations, limits on direct discharge into water bodies, etc.

Co-funded by the Erasmus+ Programme of the European Union

c) Notions on environmental and economic aspects of using organic residuals. Crop residues, manure or compost can be used in agriculture reducing the use of fertilizers, offsetting the environmental impacts of its use (the energy consumption for its production, or gas emissions and leaching), the use of pesticides or irrigation water (European Commission, 2010). This may also bring economic benefits for farmers. However, there can be some biological and chemical risks (from direct exposure or from contamination of food and water), depending on the source of the organic residuals or its previous treatment. Treating material to reduce or eliminate pathogens, for example, will affect costs associated with beneficial uses. To optimize economic benefits, the viability of all end use options must be factored into decision making processes. Land application of organic residuals may only be feasible if certain economic incentives are instituted. These incentives may evolve as a result of a fuller understanding of the benefits of reusing organic residuals (King et al., 2011).

d) Notions on transport, storage and treatment requirements for different organic residuals. Previous to its use, organic residues may have to be transported to the application site, and in some cases stored or transformed prior to its application. In many cases there are specific rules (best management practices) and regulations that must be followed.

e) Notions on organic residuals management and treatment techniques that could be performed in the agricultural farm. There are several treatment techniques that the farmer can apply in the management of organic residuals. Composting is one of the most ecological technologies for the management of the bio-waste, allowing its material valorisation (Scotti et al., 2016). On-farm composting could be an efficient, cost-effective and environmentally safe biological process for the recycling of residual agricultural biomasses (Maniadakis et al., 2004). Application of organic amendments, such as compost, has been successfully proposed in many cases to improve soil structure and fertility, as well as to suppress soil-borne pathogens (Scotti et al., 2016).

3.5. Drip irrigation and water-conserving technologies

Co-funded by the Erasmus+ Programme of the European Union

Climate changing and the increase of the competition for water use from other activity sectors is increasing water scarceness for agriculture. Therefore it is very important to provide agricultural workers with skills to improve the use of available water, increasing water use efficiency and farmers profitability. Drip irrigation has the potential to achieve the highest uniformity and efficiency values of all irrigation methods. Yet, it is possible to observe drip irrigation systems with poor uniformity and application efficiency resulting from various causes, such as inadequate maintenance, low inlet pressure or pressure fluctuations, emitter clogging and inadequate system design (Hsiao et al., 2007). A correct use of these systems is very important not only to preserve water or the environment, but also because water efficiency will be an increasingly important factor for competitiveness (CEC, 2008).

The agricultural worker required skills for a better use of drip irrigation systems are:

a) Manage irrigation following an irrigation scheduling. Irrigation scheduling is the farmers' decision process related to `when' to irrigate and `how much' water to apply to a crop (Pereira, 1999). It requires knowledge on crop water requirements and yield responses to water, the constraints of the irrigation system ("how" can the system apply the desired irrigation water), the availability of the water that supplies the irrigation system, and the knowledge of soil properties, such as soil water holding capacity, field capacity, wilting point, etc, that can affect irrigation scheduling. The agricultural worker must be aware of the importance to manage irrigation according to an established irrigation scheduling, either based on crop water evapotranspiration and/or soil water availability. He also must understand the effect of meteorological parameters (air temperature, wind, solar radiation, etc) over the crop evapotranspiration to choose the right time to irrigate. For example, scheduling irrigation during night will allow a reduction in evapotranspiration, thus improving irrigation efficiency and saving water. The reduction of applied irrigation water, due to the improvement of irrigation efficiency, will also allow an energy saving due to less pumping hours. It is recognised that the adoption of appropriate irrigation scheduling practices could lead to increased yields and greater profit for farmers, significant water savings, reduced environmental impacts of irrigation and improved sustainability of irrigated agriculture (Smith et al., 1996).

Co-funded by the Erasmus+ Programme of the European Union

b) Definition of different irrigation goals. Although the primary irrigation goal is to satisfy full crop water requirements, to achieve maximum yield, there can be other objectives associated with crop quality, the scarceness of water resources, economic return, etc. The agricultural worker must understand the concepts of full irrigation, supplemental irrigation, deficit irrigation (including regulated deficit irrigation (RDI) and partial root drying (PRD)), water use efficiency (WUE) or water productivity (WP), and be able to adapt the irrigation scheduling to different irrigation goals. Different irrigation strategies have been proven to successfully increase WUE reducing water use. For example, the successful use of RDI in fruit trees and vines demonstrated not only increases in water productivity, but also in farmers' profits (Fereres and Soriano, 2007).

c) Irrigation system evaluation. The agricultural worker must know all the irrigation system components, from the pump to the dripper, to be able to evaluate, at any time, their operating status and to perform changes in its operating mode that can improve its performance. For this reason, it is essential that the farmer knows and is able to use the equipment required to measure the major operating parameters, such as manometers to measure the system operating pressure, flowmeters or other flow measuring techniques to ensure a proper dripper discharge, etc.

d) Maintenance of irrigation systems. The irrigation system maintenance is also another very important issue. The agricultural worker must know how to maintain the irrigation system to ensure his lifespan. Drip irrigation systems, more than other irrigation systems, require a good maintenance, including annual operations to clean filters, pipes and drippers. Only with a good maintenance it is possible to guarantee its proper operation, which is essential to enhance water use efficiency.

e) Irrigation evaluation and monitoring. The agricultural worker must understand the concepts of irrigation efficiency and uniformity, and know how to perform a field irrigation evaluation determining its efficiency and uniformity. Only based on this information will he/she be able to improve the irrigation performance, saving water and increasing water use efficiency or water productivity. Excessive irrigation stimulates run-off, leach-outs of fertilisers and pesticides and soil erosion. The determination of performance indicators requires specific equipment, including soil

Co-funded by the Erasmus+ Programme of the European Union

moisture sensors, which he must know how to operate. Soil moisture sensors are also essential for irrigation monitoring. Irrigation performance and actual meteorological data can produce variations in soil water availability different from those expected, demanding real time corrections on the irrigation scheduling. Therefore, a continuous monitoring of soil water content to improve water use efficiency is essential.

f) Notions on the use of low quality irrigation water. There are many examples of soil salinization and yield reductions due to the use of irrigation waters with high salinity content. The farmer must be aware of the effects of using low quality irrigation water on soils and crops. Irrigation scheduling may need to be adapt (irrigation frequency, irrigation depths) when the farmer uses low quality irrigation waters. Additional irrigation, using good quality water, may also be needed to promote salts leaching. Excessive and inappropriate fertilizers used in fertigation systems can also contribute for soil salinization. It is important to know how to select fertilizers in order to minimize their salinization effect.

3.6. Renewable energy and its application as green agricultural energy source

Climate change and the global agenda to reduce CO2 emissions are among the most pressing international challenges of the present day. Together they form the single most significant factor driving a preference for renewable energy over energy from fossil fuels (ILO, 2011). The renewable energy sector has the potential to deliver substantial reductions in energy related emissions of greenhouse gases and other pollutants. Renewable energies offer the full range of energy services – heat, light, electricity and mechanical energy (IPCC, 2011). The main renewable energy technologies are wind, solar, geothermal, hydropower and bioenergy. Some of them can be more easily used in a farm, like solar or geothermal energy. Solar energy, for example, can be used to produce electricity and heat. Photovoltaic panels can be used to power different farm operations, pumping water, lighting and electric fences. Solar heat collectors can be used for house, livestock buildings and greenhouses heating, in drying systems and to provide hot water for dairy operations, cleaning and sanitary uses. Geothermal energy can be used to generate heat

Co-funded by the Erasmus+ Programme of the European Union

for farm buildings heating. Bioenergy due to its importance will be addressed in more detail in another training module.

The Agricultural workers' required skills regarding renewable energy are:

a) Environmental awareness. Farmers must be aware of the environmental advantages of using renewable energies.

b) Notions on all possible renewable energy sources. It is important for farmers to know what types of renewable energy sources and technologies they can use and the environmental, social and economic benefits of using them. The farmer should be able to identify renewable energy sources that are most appropriate for their own situation, from a technical and economical aspect. Off-grid renewable energy solutions (meaning in areas not connected to a central grid) can often make economic sense even without subsidies or policy support (ILO, 2011).

c) To know national legislation and regulations promoting the use of renewable energies. Many governments have favoured the connection of smaller renewable energy capacity generating facilities to electricity grids. This can be a business opportunity for farmers, allowing to increase profit and farm sustainability. Many governments have also promoted the use of renewable energies from subsidizing the installation of wood chip fired heating systems to subsidizing bioethanol or biodiesel. A good knowledge of national subsidy policies regarding the use of renewable energy can be an incentive to its use.

d) Notions on safety measures for using different renewable energy equipment. All equipment has specific rules for its installation and safe use that must be known and complied with. Its compliance will allow better performance of the equipment, increasing its lifespan, and the decrease of potential risks to people interacting with them.

3.7. Bioenergy and energy crops

The term bioenergy refers to energy derived from any organic matter that is available on a renewable basis. It may use any of a wide range of inputs, including forest and mill residues,

Co-funded by the Erasmus+ Programme of the European Union

agricultural crops residues, as well as processing residues, wood and wood waste, animal production wastes, aquatic plants, fast-growing trees and herbaceous crops, municipal and industrial wastes, among other sources (ILO, 2011).

Bioenergy outputs can include electricity, fuels such as bioethanol and biodiesel, and heat, with more than one of these sometimes coming from the same process. They can also include chemicals and other materials with potential for further processing.

Bioenergy uses a number of different types of process (ILO, 2011). The biomass may be burned directly to produce heat and/or for the generation of electricity. Other possibilities are: i) a process to produce a liquid fuel such as biodiesel or bioethanol; ii) gasification process to produce gases which can be stored and used to produce electricity, or iii) a process of anaerobic digestion to produce methane, which may then be used to generate electricity or thermal energy.

Biomass production requires substantial numbers of agricultural or forestry workers to plant, manage and harvest biomass crops for as long as the bioenergy facility is in operation. Efficient production also relies on skills in agricultural science.

For the purpose of this report we will define agricultural worker skills in the bioenergy sector considering mainly, the subsectors of: i) anaerobic digestion; ii) dry agricultural residues (poultry litter, straw and spent mushroom compost); iii) energy crops; iv) liquid biofuels and v) wood. Although, some of these subsectors will also be included in the "agricultural reuse of organic residues" module.

The agricultural workers' required skills regarding bioenergy and energy crops include:

a) <u>Environmental awareness</u>. Farmers must be aware of the environmental benefits and impacts of bioenergy.

b) <u>Notions on the range of bioenergy resources, conversion technologies and markets</u>. It is important for farmers to know what types of bioenergy resources and technologies they can use and the environmental, social and economic benefits of using them. They must be introduced to the technical, business, environmental, policy and legal aspects of: i) anaerobic digestion; ii) Dry

Co-funded by the Erasmus+ Programme of the European Union

agricultural residues (poultry litter, straw and spent mushroom compost); iii) Energy crops; iv) Liquid biofuels and v) Wood.

c) Notions on handling, transport and storage of biomass, bioenergy products and by-products. To a proper use and production of bioenergy resources the farmer must have a basic knowledge on how to handle, transport and storage biomass, bioenergy products and by-products.

d) To identify which bioenergy solutions are most appropriate for their own situation, technically and financially.

e) Notions on how to evaluate energy crops as a farm business opportunity. Characteristics (including yields) and requirements of energy crops. Comparison of different energy crops, including financial evaluation. Agricultural practices for establishment and production of energy crops. Cutting cycles and harvesting options, including baling, bundling or chipping as appropriate. Logistics of supply following harvesting, including immediate use or drying and storage. Possibilities for transport and preliminary processing of biomass.

4. Conclusions

The above mention skills are those that have been identified as the necessary and possible to transmit to agricultural workers in the frame of the SAGRI project. Main skills will be focused in:

i) Gaining awareness about principles and objectives of different agricultural practices that are friendly to the environment and at the same time economically viable;

ii) Gaining awareness of different legislation and regulations regarding the adoption and use of these different agricultural practices;

iii) Be able to identify the data, equipment and techniques to acquire field data, that the farmer must have or hire in order to adopt the above mentioned agricultural practices; and,

iv) Be able to recognize the benefits and to evaluate the technical and economic feasibility to adopt any of these agricultural practices.

In some modules it may also be possible to give to the agricultural workers (farmers) the information and/or training that can enable them to use some of the equipment required for implementation of the proposed agricultural practices. It will be also desirable to present to farmers actual examples of the application of different technologies explaining its benefits and constrains. If possible this can be complemented with field demonstrations.

It is our belief that the acquisition of these skills is an important step to achieve a more technologically advanced and social, economic and environmentally sustainable agriculture.

5. References

Bakhtiari, A.A., Hematian, A., 2013. Precision Farming Technology, Opportunities and Difficulty. International Journal for Science and Emerging Technologies with Latest Trends: 5(1), 1-14.

Commission of the European Communities (CEC), 2008. Follow up Communication on Water Scarcity and Droughts in the European Union COM (2007) 414 final, [SEC(2008) 3069], Brussels.

Cedefop, 2016. Analytical Highligts. Skilled agricultural, forestry and fishery workers: skills opportunities and challenges. (http://skillspanorama.cedefop.europa.eu/en/analytical_highligths/skilled-agricultural-forestry-and-fishery-workers-skills-opportunities-and) accessed in January, 2017.

European Commission, 2010. Accompanying the Communication from the Commission On future steps in bio-waste management in the European Union. Assessment of the management of bio-waste. Commission staff working document. Brussels, SEC(2010) 577 final.

European Commission, 2014. Precision agriculture: an opportunity for EU farmers: potential support with the CAP 2014-2020. Study.

European Commission, 2015. Towards a long-term strategy for European agricultural research and innovation by 2020 and beyond. Background paper, EU pavilion at Expo Milan.

European Parliament and Council, 2009. Directive 2009/128/EC. Establishing a framework for Community action to achieve the sustainable use of pesticides. Official Journal of the European Union. L 309/71-86.

EU Skills Panorama, 2014. Skilled agricultural workers analytical highlight (http://skillspanorama.cedefop.europa.eu/en/analytical_highlights/prospects-skilled-agricultural-workers).

FAO, 1976. A framework for land evaluation. Soils Bulletin 32. Food and Agriculture Organization of the United Nation, Rome, Italy.

FAO, 2007. Land evaluation. Towards a revised framework. Land and water discussion paper 6, Food and agriculture organization of the United Nations. Rome, Italy.

Fereres, E., Soriano, A., 2007. Deficit irrigation for reducing agricultural water use, Journal of Experimental Botany, 58 (2): 147–159.

Hsiao, T.C., Steduto, P., Fereres, E., 2007. A systematic and quantitative approach to improve water use efficiency in agriculture. Irrigation Science, 25, 209–231.

ILO, 2011. Study of occupational and skill needs in renewable energy: final report / International labour office, ILO skills and employability Department (EMP/SKILLS), European Commission. Geneva.

International panel on climate change (IPCC), 2011. Special report on renewable energy sources and climate change mitigation, prepared by the Working Group III of the Intergovernmental panel on climate change. Geneva.

King, G.M., Brooks, J.P., Brown, S., Gerba, C., O´Connor, G.A., Pepper, I.L., 2011. Land application of organic residuals: Public health threat or environmental benefit?. American Society for Microbiology. (https://www.asm.org/index.php/education?id=7489:biorep8-2011).

Co-funded by the Erasmus+ Programme of the European Union

Maniadakis, K., Lasaridi, K., Manios, Y., Kyriacou, M., Manios, T., 2004. Integrated waste management through producers and consumers education: composting of vegetable crop residues for reuse in cultivation. Journal of Environmental Science Health B 39, 169–183.

Meera, S., Jhamtani, A., Rao, D., 2004. Information and Communication Technology in Agricultural Development: A Comparative Analysis of Three Projects from India. Agricultural Research and Extension Network Paper No. 135. Washington DC: World Bank.

Pereira, L.S., 1999. Higher performance through combined improvements in irrigation methods and scheduling: a discussion. Agricultural Water Management, 40, 153-169.

Pierpaolia E., Carlia G., Pignattia E., Canavari, M., 2013. Drivers of Precision Agriculture Technologies Adoption: A Literature Review, Procedia Technology 8, 61 – 69.

Scotti, R., Pane, C., Spaccini, R., Palese, A.M., Piccolo, A., Celano, G., Zaccardelli, M., 2016. On-farm compost: a useful tool to improve soil quality under intensive farming systems. Applied Soil Ecology, 107: 13–23.

Silva, C.B., Do Vale, S.M.L.R., Pinto, F.A.C., Muller, C.A.S., Moura, A.D., 2007. The economic feasibility of precision agriculture in Mato Grosso do Sul State, Brazil: A case study. Precision Agriculture, 8(6), 255-265.

Smith, M., Pereira, L.S. Beregena, J., Itier, B., Goussard, J., Ragab, R., Tollefson, L., Van Hoffwegen, P. (Eds.), 1996. Irrigation Scheduling: From Theory to Practice. FAO Water Report 8, ICID and FAO, Rome.

Srinivasan, A. (Ed.), 2006. Handbook of Precision Agriculture. Principles and Applications. Food Products Press. The Haworth Press, Inc. NY.

Stafford, J.V., 2006. The role of technology in the emergence and current status of precision agriculture, in Srinivasan, A. (Ed.), Handbook of Precision Agriculture. Principles and Applications. Food Products Press, The Haworth Press, Inc. NY., Chapter 2, 19-56.

Takacs-Gyorgy, K. 2008. Economic aspects of chemical reduction on farming: role of precision farming—Will the production structure change?. Cereal Research Communications, 36: 19-22.

Van Crowder, L., Lindley, W.I., Bruening, Th.H., Doron, N., 1998. Agricultural education for sustainable rural development: Challenges for developing countries in the 21st century. The Journal of Agricultural Education and Extension, 5(2): 71-84.

Zhang, N., Wang, M., Wang, N., 2002. Precision agriculture—a worldwide overview, Computers and Electronics in Agriculture, 36: 113-132.