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FAtIMA

FArming Tools for external nutrient Inputs and water MAnagement

D4.1.3: Guidelines for on farm Water-Energy- Food audit, including training material

WP4.1 – Water-Energy-Food nexus

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Executive summary

The objective of WP 4.1 Water-Energy-Food (WEF) nexus is to develop and implement a theoretical and practical framework for energy-water-food assessment in pilot areas and farms and integrate it into the central MDSS (Modelling and Decision Support System) hub and the FATIMA prototypes. This includes energy audits of farms and rural areas.

Consumption of food, water and energy — directly or indirectly — impacts ecosystems and natural resources that society depends on for its survival. Recent events like droughts, oil spills and increasing food prices tell us that we can no longer view food, water and energy systems in isolation. Instead,it is necessary to understand how and where these three systems intersect - the nexus. The use and management of one of these resources can impact the others, so it is necessary to take a nexus approach to all three. This means gaining a better understanding of how these three systems interconnect, then acting to ensure food, water and energy security in a whole sustainability perspective.

Our essential novel approach holds two keys for quantum leaps in sustainable crop production: firstly, the integration of the energy-water-food nexus into the current “water-only” management practice and secondly the first-ever complete treatment of all energy sources and forms (electricity, fuel, indirect energy consumption in fertilizer/pesticide production) in this context. It also introduces a novel rigorous definition of virtual energy and the energy footprint.

For those reasons audits on farms seems to be the proper tool investigate WEF nexus. Guidelines are needed to allow people entrusted to do energy and water audit.

Some preliminary remarks concerning audit technique will be done, to focus the attention on energy, water and food issues and for finding technical indicators to express the nexus.

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1 Introduction

This report constitutes Deliverable 4.1.3 of the FATIMA project that aims to define guidelines for on-farm Water-Energy-Food audit to evaluate current level in management of water and energy (related to food production of the farm) and to identify potential solutions to improve farm's efficiency.

In D 4.1.1 concerning the WEF nexus framework, our analysis was built proposing a downscaling approach starting from regional dimension and passing through pilot area till farm level [Figure 1].

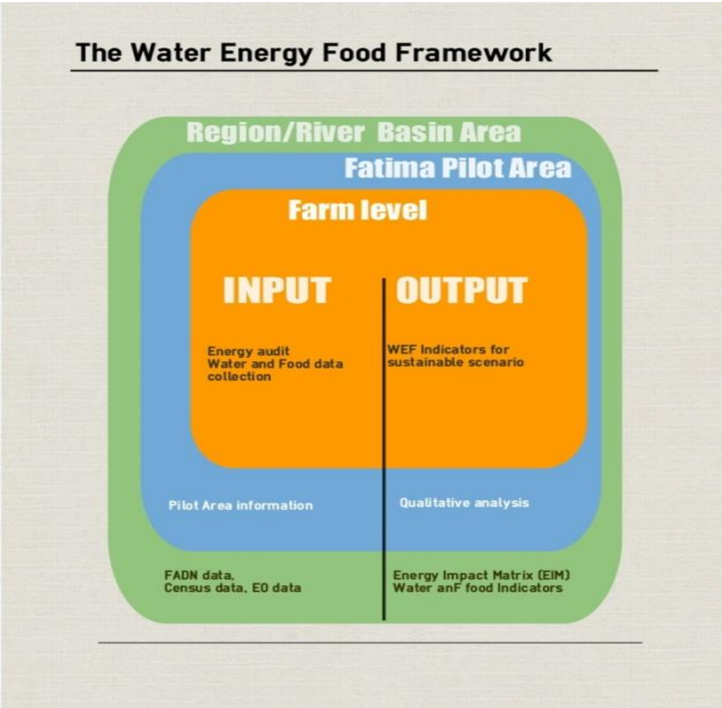

Figure 1- WEF level of analysis

In this document we will focus on farm level, proposing the methodology and tools to be implemented in selected farms for each pilot area.

The analysis in farms will regard energy, water and food production. The approach we propose will be based on the audit technique, capable to collect data concerning farm's input (use and management), energy and water to obtain a certain quantity of yield (food). For each input specific data will be collected as discussed in the following paragraphs.

2 The audit technique

The audit technique is referred to the traditional procedures adopted for quality and/or environmental management systems derived from ISO 19011:2003 "Guidelines for quality and/or environmental management systems auditing".

The general audit procedure, is based on the Deming Cycle or Plan-Do-Check-Act, which represent a systematic series of steps for gaining valuable learning and knowledge for the continual improvement of a product or process (Figure 2)

The cycle begins with the Plan step. This involves identifying a goal or purpose, formulating a theory, defining success metrics and putting a plan into action. These activities are followed by the Do step, in which the components of the plan are implemented, such as making a product. Next comes the Check step, where outcomes are monitored to test the validity of the plan for signs of progress and success, or problems and areas for improvement. The Act step closes the cycle, integrating the learning generated by the entire process, which can be used to adjust the goal, change methods or even reformulate a theory altogether. These four steps are repeated over and over as part of a never-ending cycle of continual improvement

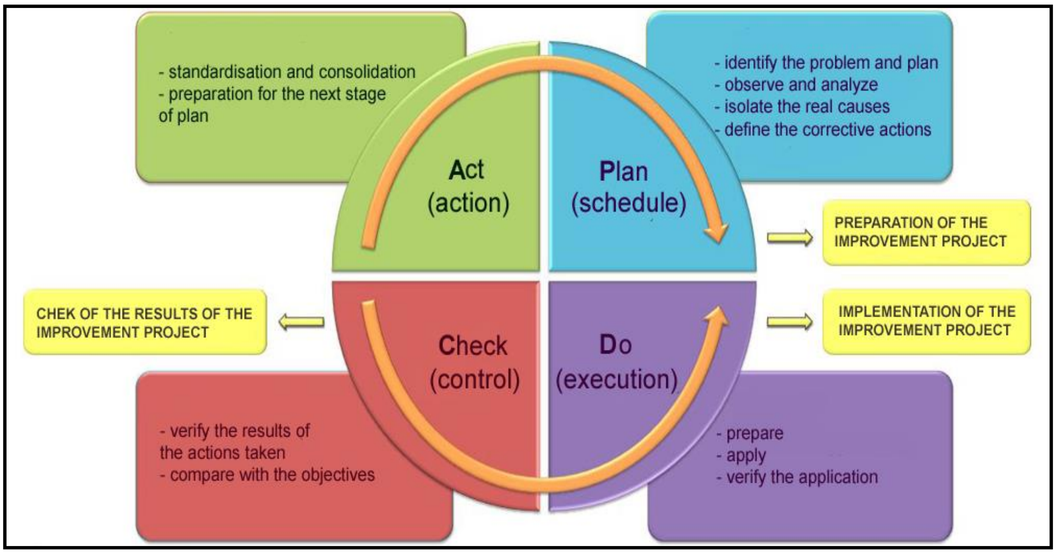

Figure 2 - Deming Cycle *(Source: http://www.iwolm.com)*

2.1 ENERGY

Acknowledgements of regulatory framework on energy efficiency and technical approaches in use, such as ISO 50001 certifications systems (adoption of EMS – Energy Management System) allow us to consider Energy Audit as the right tools to evaluate farm's energy consumption. The total energy consumed at farm level related to quantitative (Yield) or physical (hectare) dimensions, gives also a proxy of energy productivity (EP index). An energy audit is realized following the steps proposed in Table 1.

Step	Activity	Description
Step 1	Energy bill analysis	Data on electric utilities, heating, cooling, water pumping (power, demand/ consumption per hour, working hours, etc.) may be collected through inspections.
Step 2	Detailed energy analysis and feasability studies	Critical analysis of the use of energy and comparison with average parameters of consumption. Identification of improvements to reduce consumption and costs and preliminary evaluation of technical and economic feasibility (the measures proposed should have a payback rather low, 3-5 years).
Step 3	Definition of actions	Measures can be of different nature: change of energy supply contracts, better management of plant and equipment, purchase of new plant and equipment, interventions on building, etc.
Step 4	Maintaining	Periodic review of plant and equipment to maintain their performance levels over time
Step 5	Monitoring	Consumption monitoring to verify the savings achieved

Table 1- Energy audit procedure

The proposed steps of an energy audit can be performed a different level of detail. The *American Society of Heating, Refrigerating and Air-conditioning Engineers - ASHARE* divides the audits into three levels, from 1 to 3, depending on the objectives to be achieved (ASHARE, 2004).

- Level 1 - A Level 1 audit involves the assessment of energy costs by analyzing energy bills, followed by and a brief inspection. This form of audit helps to identify possible savings in the immediate (i.e. without structural measures) and provides an economic basis for any interventions. The result is a list of potential management measures that deserve consideration and further analysis, with a first assessment of what will be the investment cost and the associated savings. The survey provides an initial assessment of the potential savings and also helps to optimize the resources available allowing to identify the areas with the best potential for reducing consumption, and where, therefore, must be conducted further studies.
- Level 2 - The second level audits include targeted inspections and more detailed energy analysis. All of the actions that can be realized and the energy savings that can be achieved have to be evaluated by providing a complete list of potential improvements that require more data and / or analysis, with an initial assessment of the costs and potential savings. The audits of second level generally do not include data monitoring, but can be made of random measurements of parameters such as power electric motors, temperature, relative humidity, etc. Beside the definition of areas that can bring the biggest savings, also specific solutions of intervention are identified.

  For instance some of the analysis that must be addressed during an audit of the second level are:

  - Analysis of energy bills: consumption data for the period of at least one year must be identified to obtain different seasonal patterns of energy consumption (consumption profiles);
  - Models of final consumption: understand where and when energy is consumed is an important first step in understanding how it can be rationalized. The final model of use, which provides an insight into the overall energy consumption of each system component, helps define how to achieve better economic results by investing in energy efficiency. These models are mainly dependent on the structure of the system and its features and functions (i.e refrigeration unit, thermal power, lighting, pumping, and other consumer services). The consumption of each subsystem can be estimated using the single consumption expressed in kW multiplied by the hours of operation per year. Each estimate of the consumption of the individual components of the entire plant is gradually added, to form the overall consumption; this value must then be compared with the consumption values provided by energy bills. If the two are not equal, this indicates that not all uses have been considered during the analysis or the individual consumption have not been properly estimated. If this occurs, further testing is required to ensure that all components have been counted.
  - Comparison with reference values: the estimated values of consumption in kWh and demand in kW can be used to assess how efficient systems, comparing them with reference values.
- Level 3 - The third level of audit focus on the possibilities of economic investment. They are based on analyses carried out by providing more specific data and engineering analysis more complete. They also provide more detailed economic analysis and possibilities of energy saving with a high confidence level, suitable for most economic investment decisions.

Performing an energy audit in a given structure means to do an objective analysis of energy management. The data collected are evaluated to find areas of optimization and identify specific solutions with practical suggestions for implementation (for example: quantification actions, costs, financing channels). All the recommendation for increasing energy efficiency are thus reported in a final document of the audit process.

After the analytical phase of audit it is necessary to move on to the implementation of a control system able to highlight specific energy savings, monitoring the actual performance of facilities and the savings made. Finally, once the implementation of the monitoring system is done, the maintenance of savings achieved must be ensured through periodic repetition of energy audits.

Summing up the whole procedure of audit, it consists in one/year (or more if needed) visit of the farm, gathering of data through questionnaires, data analysis with dedicated tool, and a final report followed by a business plan.

Technically the audit must be realized in two different moment:

1. Defining farm's base line scenario on energy consumption;
   - quantification of direct energy consumption
   - quantification of indirect energy consumption, including all inputs, fertilizers, seeds, pesticides, feed, etc.
   - distribution of energy consumption per production. This enables to calculate ratios of energy per unit of output.
2. Building an action plan highlighting the best solution in terms of energy effienency looking at:
   - reducing consumption, both direct and indirect, by identifying, for each farm potential improvements, either by investments or better management
   - increasing the use of alternative energy in agriculture (solar, mini-hydro, wind, biogas, etc.), according to the specific characteristics of the area and the different incentives systems;
   - establish guidelines for access funding oriented to promote consulting and training (i.e Rural Development Regulation UE n° 1305/2013, art. 15)

GHG (GreenHouse Gas) reduction can be estimated according to production processes. The tool to be used for energy audits in farms is the *Sustainability Indicators Calculator Tool - SICT* presented in D4.1.1, which is meant to:

- quantify energy use, both direct and indirect
- assign it to the various productions in the farm
- quantify output
- quantify GHG emissions

Energy audits can also be included in a training package with stakeholders, which enables to share experiences at a local level between farms.

The audit is therefore an essential tool for achieving the objectives of reducing consumption and therefore energy costs and can be done properly only by personnel with appropriate skills, independent and objective, can ensure transparent and results comparable. Regarding water and food assessment audit technique will be implemented with differently and in close cooperation with WP 1.2.

2.2 WATER

For a farmer or an irrigation managing authority, a basic objective is to use the available water resources in a way that will assist the plants do what they are expected to (i.e. produce a lot of good quality products or create a pleasant landscape and at the same time) with costs as low as possible. This approach must consider once again that various levels have probably different priorities and concerns (Figure 3) usually in European countries. In developing countries such as Turkey, environmental concern is mainly the issue of locals as the regional managers and governments are more focused on investments hazarding environment but creating high economic impact.

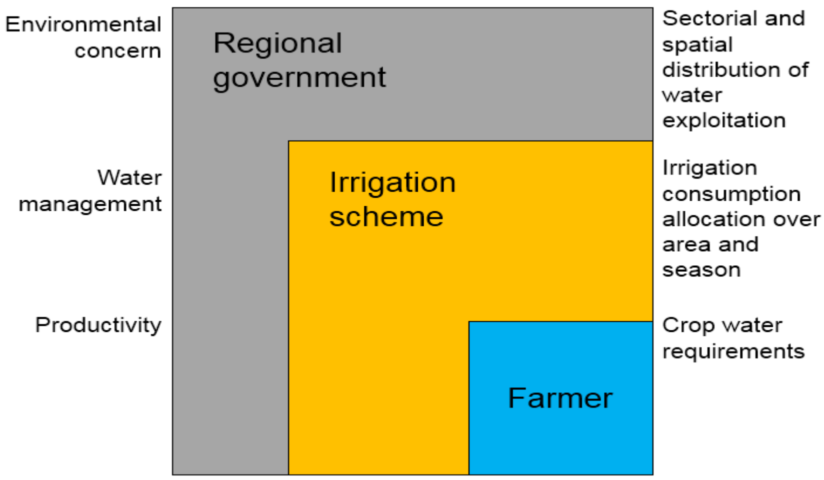

Figure 3 - Irrigation management priorities

Achieving this goal is not easy and success is much more important when we have to irrigate under water scarcity conditions, which is a typical case for countries around the Mediterranean Sea, which means high irrigation cost for farmers. A fair management of (scarce) water is a key element for farm global sustainability.

The "water cycle" in irrigation at farm level can be clarified by the following scheme, that represent the different processes which can affect water use efficiency: grey boxes are the processes leading to the crop yield; white boxes are those leading to water wastes and losses (Pereira et al., 2012)

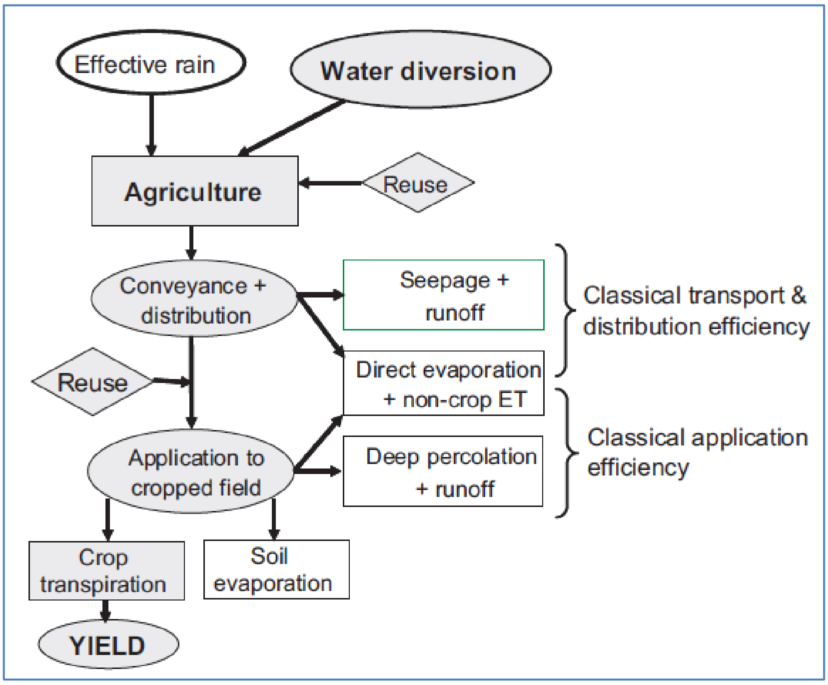

Figure 4 - Processes influencing irrigation efficiency off- and on-farm

To better understand the process of optimization of water use, a distinction beetween the concept of *Efficiency* and *Productivity* needs to be done. The term "Water Use Efficiency" (WUE) should only be used to measure the water performance of plants and crops, irrigated or non-irrigated, to produce assimilates, biomass and/or harvestable yield. The term "Water Productivity" (WP) should be adopted to express the quantity of product or service produced by a given amount of water used, i.e., consumptive and non-consumptive uses, both in irrigation and non-irrigation water uses.

As water resources are not unlimited and this is more intensively understood in arid climates or during droughts a third parameter of great value is *water savings*. To achieve water savings, there is a need to first set the limit of water allocation to various crops and users and then use measures to increase "Irrigation efficiency" (IE) and WP through the adoption of a solid water accounting framework (Steduto, 2015). Knowing and monitoring quantities of water applied in farm is thus a crucial element. Irrigation audit seem to be the right tool to achieve this pourpose.

Irrigation efficiency is measured in terms of: 1) irrigation system performance, 2) uniformity of the water application and 3) response of the crop to irrigation. Irrigation efficiency affects also the economics of irrigation, the amount of water needed to irrigate a specific land area, the crop development and its yield, the amount of water that can return to surface sources for downstream uses.

Under technical point of view, Bos (1983 and 1990) says that the irrigation efficiency of each network can be measured in each one of its levels:

- conveyance,
- distribution,
- field application.

It is also affected by several external factors. According to Irrigation New Zealand (2010) some of those are:

- climatic parameters (effective rainfalls, evapotranspiration etc.),
- soil and terrain characteristics (texture, depth, slope etc),
- design and materials of irrigation systems,

- central management control of systems (entities organisation and applied management),
- maintenance of central systems,
- method and management of water application at farm level,
- expertise level and training of managers and end-users.

So in the water auditng activity the attention must be focused on irrigation systems and on the way of application from the farmer.

Irrigation efficiency depends basically on design, installation and management (which involved both scheduling and maintenance). Any type of irrigation system can be designed to provide good irrigation uniformity, but it is management’s responsibility to sustain the irrigation uniformity over the life of the irrigation system through proper maintenance.

In many cases (such as in Italy) efficiency assessment is directly influenced by the fact if irrigation is considered public or private. In the first case the farm is part of Water Users Association (WUA or Irrigation Consortium), and it provide all the services of catchment, delivery and distribution for which the farmers pays a rate (irrigation tariff), while in the other case, he provide himself to have available water in his farm, for instance with drillings or other proper irrigation systems.

Concerning application, it involves directly farm management of water: Irrigation Application Efficiency (IAE) is a measure of the quantity of water that is available for crops. Irrigation application efficiency is the ratio of water delivered at the irrigation system start point to the amount stored in the active root zone and is available for use by the crops.

$IAE=100*W_u/W_d$

where IAE is the Irrigation Application Efficiency, W_u the volume of water that is actually used from the crop and W_d the volume of water that is delivered to the irrigated area. This index will be calculated in presence of water meters in the field or will be estimated using expert evaluation based on informations about crop type, irrigation system type and irrigation scheme typology.

So the audit should be performed both in application phase, and irrigation scheme level.

Irrigation system’s audits can assist to improve and maintain their efficiency.

An additional typical information that can be retrieved by measurements during an audit at end-user level is linked to distribution uniformity (how evenly) and precipitation rate (how intensively) water is applied in the various zones of the system. Regarding uniformity the basic concept is that all irrigated areas within an irrigated field must receive the same amount of water. Areas of the field that are under-irrigated or over-irrigated will be under-irrigated or over-irrigated for all applications, multiplying the error (Kelley, 2004). Distribution cannot be considered identical to efficiency, but it provides a sense of the system efficiency level under the condition that adequate management is applied. Regarding precipitation rate - which is mainly an issue for sprinkler systems - it has to be much less than the infiltration rate of the soil in order that a reasonable duration of irrigation events would be allowed and the danger of surface run-off would be limited. Problems arising from poor irrigation uniformity occur at diverse locations in the field and often gradually appear over the growing season. Problems arising from poor irrigation scheduling are often much more noticeable because they occur on a larger scale over a short period of time.

2.3 FOOD

Using collected data about water and energy (and nutrients) use, a qualitative and/or quantitative analysis at farm level will show how to reduce input without a decrease in yield production and farm's income.

For example Water Productivity (WP) can also refer the net benefits from an agricultural system (which is not necessarily limited only to crop production) to the amount of water used. For instance it could be yield per unit of water used by a crop or profit per unit of water used by a crop or jobs per water used by a crop (all of them generally estimated by Evapotranspiration). Thus, this parameter has dimensions, as kg/m^3, €/m^3 or hour/m^3 respectively.

Some examples[1]:

The Water Use Efficiency, Y is the yield (expressed in dry matter per unit of area, kg/m^2) and IRv is the applied water (mm)

$WUE = Y/Ir_v$

The Economic Productive Efficiency of Irrigation water use (€/m^3) can be compared with the price paid by farmers for water (€/m^3) to test the profitability of irrigation water use.

A relevant index according to Kitta et al. (2014), is called Economic Productivity Indicator (Kitta et al., 2014).

$EPI = PV/IRv$

where EPI is the Economic Productivity Indicator, PV is the economic value of the yield (€) and IRv is the applied water (m^3)

[1] Bos et al. (2005) provide a special appendix (II) which contains an extensive list of irrigation performance assessment indices. More recent lists of indices can be found in Pereira et al. (2012) and Seide et al. (2015).

3 Identification and training of "auditors"

Considering the aim of the audit, to measure the energy efficiency (both direct and indirect energy) as well as the water (irrigation) efficiency and productivity related to the yield and to identify possible actions to improve it, only audits realized by skilled and trained persons can be taken into account. So the definition and training of "auditors" is an essential process aimed at guarantee that they have fulfilled minimum requirements (diploma and competencies) regarding energy use and water management in agriculture.

In a long term perspective of adoption of WEF audit in national efficiency (environmental and economic) plan for farmers, the auditor can also be considered a new professional "green" figure.

The approach to be adopted to prepare auditors will be based on:

1. the definition of the training module (days, topics, material, etc.),
2. the training, for selected auditors (WP leaders o regional managers) on concept regardin energy and water use in agriculture, mainly focusing on:
    - reference scenario, EU and Turkish political framework (Climate/energy policies, energy efficiency, energy market, Water Framework Directive, CAP, etc.),
    - Irrigation management, crop water requirements, water governance, etc.;
    - energy uses and sources (fossil energy, renewable energy, etc.);
    - fertilization;
    - measuring energy and energy efficiency;
3. template for data collection;
4. use of analysis tools (Energy calculator, others..)
5. final report.

4 Conclusions

Data needed to evaluate WEF nexus at farm level will be collect and harmonized using questionnaries presented Annex 1. The final goal is to define a set of indicators able to show the nexus, proposed in the following tabel:

	WATER (Irrigation)	ENERGY	FOOD/LAND
WATER (Irrigation)	IE– Irrigation Efficiency: Total water withheld from the plant/total water applied (0-n) WP - Water Productivity: Total annual production value/Total annual water consumed (€/m^3)	EW: Energy (kWh)/Water consumed (m^3)	
ENERGY		EUE – Energy Use Efficiency index: Output energy (MJ/ha)/Input energy (MJ/ha)	LEP: Land (ha)/Energy Production (Mj)
FOOD/LAND	WDeL: Water Delivered (m^3)/ Land irrigated (ha) WDeY: Water Delivered (m^3)/ Yield (kg)	EP*: Energy Productivity (Mj)/Yeld	LP: Land Productivity: Total Yeld/hectare

* Both direct and indirect energy

Table 2 - Indicators to express WEF nexus

	INDICATOR	UNIT	DESCRIPTION
WATER based	IE	adimensional	Range (0 – n) Irrigation Water Requirement (IWR)/Irrigation applied
	WP	(€/m^3)	Economic value of a unit (m^3) of water used for irrigation
	WDeL	m^3/ha	Is the ammount of water used in the field for unit of land. It depends from the type of yeld and form irrgation technique use and irrigation system available.
	WDeY	m^3/t	Is the ammount of water used in the field for unit of yeld.
ENERGY based	EW	kWh/m^3	Ammount of water pumped for irrigation related to energy consumed. It represent the energy needs for 1 unit of water used for irrigation
	EUE	adimensional	Range (0 – n) energy embedded in product/energy used to produce it
	EP	Mj/t	Energy used for unit of yeld. Depends from irrigation technique, private-public (direct) and also from ammount of fertilizers (indirect energy)
FOOD/LAND based	LEP	Ha/kWh	In case of energy production the indicator show the production capacity for unit of land.
	LP	t/ha	Production capacity of land

Table 3 - Indicators' description

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ANNEX 1 – Templates and training material

A) General information of farm

Country:……………………..

Pilot area:……………………

ID (farm):……………………..

A.1) structural data

Item	Unit	Value											
Total area[2]	ha												
Cultivated area	ha												
Irrigable area with available water resources	ha												
Irrigated area	ha												
Irrigation season	(month)*	1	2	3	4	5	6	7	8	9	10	11	12
Total water used	m^3												
Average use of machinery	h/ha												
Average human labor	h/ha												

* Please mark the month when irrigation is needed

A.2) Energy frame

Is there a reference professional figure for energy management (Energy manager)?	Y		N	
Is there a monitoring system for energy consumptions?	Y		N	
Is there a public reference Institute for issues concerning energy management?	Y		N	

Is the farm equipped with renewable energy production plants?	Y		N	

If yes:

Type of plant*	Hydroelectric		Photovoltaics		Wind power	
	Geothermal		Biogas		Biomass	
id						
Power installed (kWp)						
Annual production (kWh/year)						
Production revenues (€/year)						
O&M expenditures (€/year)						
General state of mantainance	Excellent		Good		Fair	
Year of costruction						
Year of last O&M						

**Add if necesseray*

[2] The total farm area should be not equal with the sum of the cultivated land parcels area as some of the farm area could be unutilised.

If not:

Which are the main constraints that hamper investiments in this sector?

Financial	
Authorization processes	
Environmental	
Management	
Social	
Political	
Other (specify):	

A.3) Economic data

Item	Unit	Value
Total Gross Saleable Production	€/year	
Total seed expenditures	€/year	
Total electricity expenditures	€/year	
Total fuels expenditures	€/year	
Total gas expenditures	€/year	
Total fertilizer expenditures	€/year	
Total crop protection expenditures	€/year	
Total cost for irrigation and drainage	€/year	
Total human labor expenditures	€/year	
Other costs	€/year	

A.4) Agronomic data

Item	Unit	Value
Total Gross Saleable Production	kg	
Total seed	kg	
Total electricity	kWh	
Total fuels	l	
Total gas	l	
Total N	kg	
Total P	kg	
Total K	kg	
Farmyard manure	kg	
Commercial compost	kg	
Green manure	kg	
Total herbicides	kg	
Total fungicides	kg	
Total insecticides	kg	

B) Detailed information of farm

B.1) FOOD

Cultivated land parcels registration

If possible for each land parcel the cartographic coordinates (polygon or central point) will be defined (with the Id as description (attribute)

Id	Municipality	Possession of the land (a)	Area (ha)	Crop type (b)	Irrigated (c)	Cultivation system (d)	Electricity (e)

a) (O) Own property; (R) Rent; Other (please specify)
b) (1) Arable crops; (2) Protected cultivation (greenhouse/tunnel, net house); (3) Permanent crop; (4) Vegetables in open field; (5) Other (please specify)
c) Yes/No
d) (O) Organic or (IM) Integrated Management or (CC) Conventional cultivation
e) Probably in order to get permission to use electricity for pumping water you submitted a plan contained the irrigation system layout, the irrigation period, the cultivation water needs and the relevant scheduling. Could you provide us with a copy of it?

Production

Yield type	Quantity (Kg)	Selling Price (€)	Total income (€)	Selling channel	Note

B.2) ENERGY

Type of consumption (to be filled for each crop reported in table Cultivated land parcels registration, in order to retrieve direct and indirect energy)

Source	Description	Unit	Value	Annual cost (€)
Production	Pumping for irrigation	[kWh/ha]		
	Human labour	[h/ha]		
	Fuel	[l/ha]		
	Machinery	[h/ha]		
	Fertilizers N	[kg/ha]		
	Fertilizers P	[kg/ha]		
	Fertilizers K	[kg/ha]		
	Farmyard manure	[kg/ha]		
	Commercial compost	[kg/ha]		
	Green manure	[kg/ha]		
	Herbicides	[kg/ha]		
	Fungicides	[kg/ha]		
	Insecticides	[kg/ha]		
	Seed	[kg/ha]		
Driving force and Services	Yield transfer	l (fuel)		
	Offices and Warehouses	l (fuel)		
	Other services	l (fuel), kWh or m^3 gas		
	Product delivery	l (fuel)		
Lighting	Interior	kWh		
	External	kWh		
	…………			
Climate control	Air control and treatment (d)	kWh		
	Cooling (d)	kWh		
	Heating plant (d)	m^3 gas		
	……..			
	……..			

WATER

Land parcels and cultivations of the farm

Irrigation (only for irrigated land parcels)

Crop Id	Irrigation water source (a)	Way of transportation in case of off-farm water source (b)	Annual cost of water (c)	Irrigation method - Specify (d)	Annual water volume (mm) (e)

a) Water User Association WUA (specify which), Private source (drilling, well, open reservoir etc), other public or private (lakes, rivers, streams, ponds, dugouts etc)
b) Off-farm water transported to the farm e.g., via pipeline, canal system or vehicle, including municipal water and any surface water located off-farm
c) From WUA rate or estimation in case of private source (if possible)
d) Sprinkler irrigation (solid set, center pivot irrigation system, linear move irrigation system, traveling guns (either cable tow or hard hose traveling sprinkler system)); Micro-irrigation (drip lines, tapes, emitters/drippers, bubblers, micro-sprinklers etc); Flood (surface) irrigation
e) Total volume of applied water per season (mm is the same as 10 m^3/ha).

Drillings (Water and Energy data)

Id (a)	Year of installation	Depth (m)	power intalled (kWp)	Average discharge flow rate (m^3/hour) at head (bar of m H_2O)	Energy source	Area served (ha)	Annual consumption (kWh)

a) In case of more than one drilling in a land parcel use a different line to register it

Economic information

1) Source of labor:
   - ☐ managed by farmer
   - ☐ managed using family labor (exclusively)
   - ☐ managed using family labor (prevalent)
   - ☐ managed using non-family labor (prevalent)
   - ☐ management using salaried field workers
   - ☐ other (please specify)

2) Costs incurred for the installation or upgrade/modernization of irrigation and/or storage system

Gross Saleable Yield derived from irrigated crops: - % on total Gross Saleable Production	
- amount €	

3) Specific expenses incurred in the last year for water. Specify items and amount

Cost items	**€**
Purchasing	
Maintenance	
Electric energy	
Fuel	
Other (please specify)	