Crops for better soil

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ACTION A9.
Conclusions and Recommendations

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The conclusions are based on the results of the technical evaluations and input as provided by UPM, MEDUSA, VIDA SANA, TRANSFER and TRANSATI over the course of the project.

For the Conclusions report, the project results were set and compared with a series of ecological and economic parameters in order to verify:

1. ***Whether organic farming may be economically and technically feasible for the improvement of dry agricultural soil conditions in certain areas and with certain types of crops if applied according to the demonstrated methodologies.***

   In this regard, the main restrictive factor for improving yield production in rainfed crops is clearly the lack of water. In this sense, it is important to first clarify that yields and soil conditions cannot be fairly compared between rainfed and irrigated areas. This project has addressed this issue since its inception and has focused on successfully demonstrating that certain operational inputs during crop production in a rainfed climate can be significantly reduced, thereby increasing a farmer's competitiveness and environmental sustainability.

   The case for organic agriculture on rainfed land

   Conventional agriculture implies **higher spending on the use of agrochemicals**, more specifically, 43% of the total distribution of costs (Progress Report, 2015). This spending can be avoided in the case of organic agriculture, or rather alternatively spent on more sustainable options such as organic compost, fulvic acids, beneficial bacteria or mycorrhizae. It is also important to take into account the **savings incurred in machinery labour**, since it is no longer required if agrochemicals are not applied. For example, in a wheat production field many of the conventional land preparation tasks become unnecessary for organic production, such as previous managements with disc cultivator and ploughs, fertilizing and treatment against rust. It is important to mention that the increase in prices of fertilizer, fuel and machinery as well as the stabilizing of the price for grain are all important factors that contribute to the inefficiency of agrochemical use (Moreno et al, 2011). Furthermore, the environmental conditions of Spanish drylands are **not adequate for chemicals fertilizers to be fully efficient**. In this sense, in semi-arid conditions where rainfed crops are grown, it is not recommended to use topsoil fertilizers if it does not rain enough during the growing period, since the fertilizers cannot dissolve completely and therefore cannot be assimilated by the crops.

   The main fixed costs associated with any conventional production are mainly divided amongst three factors: machinery, chemical fertilization and herbicides. These costs represent approximately 60% of the total costs and can be avoided when organic farming practices are applied. Furthermore, the final product has a much higher market price and is consequently more profitable and sustainable than those produced in a conventional manner.

Higher profitability in organic production: wheat & chickpea

One of the main activities during the project compared the cost estimations of conventional versus organic production of wheat and chickpea on rainfed lands. In the case of wheat, the total costs for conventional production are clearly higher than those related to organic production- 378€/ha and 239€/ha, respectively. Furthermore, the income of conventional cereal is clearly lower- 190 €/ha compared to 300 €/ha.

In the case of conventional chickpea production, these practices cost less than producing them organically- 220€/ha and 289€/ha respectively. However, there are still important incentives to produce under organic means since income potential becomes significantly higher: conventional productions give yields of up to 270€/ha while organic chickpea can be sold at 675€/ha.

In conclusion, the profit balance of organic products is clearly higher even without taking into account the government subsidy for using greening practices (CAP and other grant for the production of legumes according to the Autonomous Communities). Further breakdown of these calculations can be found in the Layman's Report and Progress Reports.

2. ***Whether farming all year round is feasible with crop rotation and if it can represent an advantage for farmers and regions in terms of employment and economic growth;***

   The project has proven that **farming all year round is feasible even in rainfed lands** by selecting winter and summer crops, but it doesn't mean that harvesting occurs in each campaign.

   Rotation schemes were performed for the duration of the project and farmers are willing to continue implementing them. Moreover, farmers are interested in once again producing certain re-introduced crop species that were tested throughout these years such as lentils, chickpea, durum wheat and hard wheat. Some are even interested in trying out oilseed crops such as camelina and sunflower even when these did not obtain the most positive results. In the case of sunflower seeds, its production would be interesting if it were integrated into a much higher surface area. In addition, farmers have also perceived **intercropping as a positive management practice** by adjusting the doses and the species that were of their interest with combinations such as vetch with oats, cereal with lentils, wheat with chickpea.

   The economic growth for many of the participating farmers during this project suggests that implementing a **coherent set of interventions** that address greening measures have led to **significant profits** obtained by commercializing organic products.

3. ***Whether there are specific agricultural areas for which the innovative equipment of Medusa could become particularly useful instruments;***

   Looking at the results, we can conclude that the developed methodology has produced a wealth of information about the fields that complements and quantifies the knowledge already intrinsic to the participating farmers and agronomists. The variation maps and the integration of all data sources are essential elements of the methodology

and enable better communication, impact assessment and fields and regions characterizations. The most accurate and valuable results have been found in the cases of Illana and Zamora, where soil compaction assessments and the characterization of geological layers found in the data were combined and complemented with digging and analyzing soil pits and looking at yield and crop growth differences. In these cases, we were able to obtain a better understanding of the soils and its potential problems. Therefore, Medusa's technology becomes especially useful when it is combined with all of these approaches simultaneously to improve overall soil understanding.

4. ***Whether organic agriculture is a good and affordable instrument for restoration (on large scale) of eco-systems***

This project has demonstrated that the k**ey to long-term agricultural sustainability in rainfed** areas is the implementation of appropriate soil management techniques, such as: 3-year cycle crop rotations (or longer), mixed crops (legumes-cereals), mechanical methods for weed control, vertical tillage systems to prepare the land and avoid compaction and the re-introduction of traditional crops that adapt well to semiarid Mediterranean areas. Thus, **organic farming** provide mid- and long-term effects for soil recovery, while also increasing the yield performance due to the decrease in production costs (especially consumables) this way obtaining higher profits for the farmers, and clearly can be replicated to a number of hectares. Furthermore, this project contributes information and results for policy deliberation at all governmental levels in order to help make greening practices a top priority in the European agenda.

In addition, this project has resulted in the creation of a new company named VOLTERRA ECOSYSTEMS S.L: that approach for sustainable and integrated land management. The company is a recent joint-venture between Transfer Consultancy and Blonk Quality Ingredients (the company of one of the subcontracted agronomists by TRANSATI SL), both based in Spain. VOLTERRA aims to restore ecosystems through innovative agro and forestry techniques in Spain. The company offers a proven integral management approach with a healthy soil and active water storage as the basis for successful regeneration of both rainfed and irrigated croplands. A well-designed agroforestry system is resilient and not only restores degraded areas but also generates multiple ecosystem services.

VOLTERRA believes that landscape restoration offers large untapped opportunities for sustainable economic development. The new company is performing large-scale landscape restoration with local farmers, land-users and experts, based on sustainable agroforestry practices and novel technologies. New projects have initiated and all of them do not only provide transfer of knowledge in practice but also positive economic returns to the area, which brings back jobs and generates multiple business activities in those areas. Accompanied by private and public investors, VOLTERRA aims to claim stakes in contracts for long-term leases of large terrains or as an intermediate for land purchases. These types of associations involve coordination and management over longer periods of time, while accounting for joint investments and returns. Currently, VOLTERRA has 4 employees, all young agronomists and forestry engineers.

Secondly, an inventory was made, based on consultations with all involved partners, on future opportunities and further useful or necessary research, development or industrialization, following the demonstrated performances. The following specific items were considered:

5. ***Is it economically and environmentally preferable to use Medusa´s techniques to monitor and improve organic agriculture's yields? How could these techniques be improved or industrialised, in order to lower the costs per hectare and facilitate it to a larger public?***

   Medusa's equipment, which consists of a gammaspectrometer, a GPR (ground penetrating radar), GPS and logging software, is usually used in The Netherlands. However, these tools are not rugged enough to properly endure Spanish rainfed land conditions since for example the logging software is separate for each sensor and the buildup per field takes too long. Medusa has developed the Agribox in order to be able to effectively and efficiently measure soil texture and soil compaction of all project fields. The aim was to gather relevant, detailed and field-covering soil information for the farmers, the agronomists and the other project partners.

   Medusa has integrated the measurements with a gammaspectrometer (soil texture and parent material variation in the top 30 cm of the soil), Ground Penetrating Radar or GPR (soil compaction and differences in soil layering and structure in the top 1 m of the soil) and GPS. The data was logged and visualized in the field using a single software package to minimize errors and improve data interpretation (by relating the data to the visible characteristics of the soil and the geomorphology/geology during measurements). This was mounted on a vehicle that is rugged and able to drive on the often ploughed, rocky and steep slopes of Spain. The technology was transportable from one field to the next, to be able to efficiently measure 300+ hectares throughout the north of Spain.

   The soil texture and structure measured with the Agribox resulted in an array of extremely detailed maps and tables. Furthermore, the RhoC, a sensor that measures the actual bulk density of the top 15 cm of the soil and hence gives data on the actual soil structure and level of compaction the crop, has been extensively used. The sensor is based on gamma-radiation and attenuation of the signal by the amount of matter that is between sender and receiver. The RhoC, originally designed for soil bulk density measurements on salt marshes, was adapted in subsequent years to be able to cope with the Spanish soil conditions. In addition, for soil structure testing also a penetrologger was used.

   In conclusion, the measurements of soil physical properties (scanning, sampling and pits), soil chemical properties (sampling) and soil biology properties (pits and sampling) have proved to be complementary and their integration gives a better knowledge of the soil characteristics. In this sense, only if the physical, chemical and biological properties in a soil are balanced we can say that the soil is healthy and capable of providing yields sustainably. So, the amount of organic matter present in the soil is of lesser importance.

With regards as to whether this technology is viable, the scanning techniques are still considered expensive to be widely adoptable for farmers of rainfed land in Spain. More concretely, Medusa estimates that an entire day of work including texture maps, sample taking and lab analyses (on a minimum area of 45 ha) implies a price of 100€/ha. Evidently, these costs are considered high for Spanish farmers of semiarid lands.

However, Medusa's instruments have been combined with soil sampling and soil properties analysis during the production of other valuable commodities such as strawberries in Egypt. In these cases, the combination of these technologies has led to more sustainable soil management (and accuracy in water retention measurement) as well as up to a 40% reduction in costs associated with water savings, becoming an important monitoring tool to these producers. Therefore, this tool has shown to be very valuable in the cases of more expensive crops in conditions of water scarcity.

6. ***Could farmers obtain financial support for innovation if they want to restore poor soils by transitioning from conventional agriculture into organic? (rural innovation, sustainability and restoration, f.e. Rural Development Funds, Less Favoured Areas Facility, or ERDF funds);***

For now, there is no evidence that such support exists within current funding programs but there is a governance subsidy for farmers that implement organic practices. However, subsidies and grants for organic agriculture are unevenly spread across Autonomous Communities (*Comunidades Autónomas*, or CCAA) in Spain and many budgets are being cut or are expected to decrease in the future. All of these funds are dedicated to agro-environmental measures and are financed by the *Plan de Desarrollo Rural* (Rural Development Plan, or PDR) financed by the EU, the Spanish government and each CCAA. On the one hand, each CCAA has to decide if they are willing to contribute their share. Due to the economic situation in the country, many of them are unable or unwilling to contribute all or part of the available funds and the subsidies/ grants are lost. Moreover, each CCAA has the discretion to choose which agro environmental measures to finance, so it is not guaranteed that every organic farmer who enters the program is financed. Furthermore, funds are not increased even if the amount of farmers applying does; the same amount of funds is re-distributed, meaning that each farmer receives less financial support.

For example, this year [2016] in Castilla La Mancha, new organic farmers will not receive subsidies, and those who were already benefitted from the program will receive less funds. These problems are exacerbated by the high volatility in political decision-making, where changes in governmental representatives can mean long-lasting effects on rural development.

Currently, the main reassurance for organic farmers comes from the CAP reform where greening measures receive financial support. However, these grants do not provide much higher support than conventional ones. **The general consensus shows that unless significant changes in agrarian policies in the country at a national level are made**,

rural economic development faces too many challenges. Ironically, those CCAA with the highest funds available are those with less rainfed land such as the Basque Country and Navarra (also some of the CCAA with the highest GDPs). Finally, since agrarian policies have been transferred to CCAA jurisdiction, the national government can do little to incentivise further development and this might be another reason why Spain's agriculture has been left behind. CAP payments in conventional farming are conditioned to greening measures regulated at CCAA level and organic farmers are *per se* fulfilling those requirements.

7. ***Could Spanish governmental institutions, on local, regional or national level, improve policy on the outcome of this research? Which possibilities would exist to apply these means of organic agriculture outside of Spain? Is this economically feasible in other countries?***

   In Spain an estimated 10 million hectares are under threat of abandonment and desertification according to the Spanish Ministry of Agriculture and Environment (MAGRAMA). CAP and "Greening" policies are ideal to promote sustainable agricultural practices, especially if combined with initiatives in other Southern European countries (south of Portugal, Italy, Greece). For now, MAGRAMA's General Director on Rural Development and Forestry Policies, who spoke at our Final Conference, hinted at the possibilities of extending the number of hectares that are available to convert into organic fields.

   The main challenge once again is to find the available funds to support farmers in the transition period. This would imply finding some administrative body interested in taking advantage of the project's results and implementing them at a larger scale. The governmental entities that could most easily be reached (in terms of distance and available funds) are the *Diputaciones* (Provincial Councils).

   For example, information could be sent to those *Diputaciones* with predominance of rainfed land and interest in improving its potential. This would require an implementation plan and a technician to develop it at a larger scale. The process would even be simpler if the project strategy was repeated and Transati were interested in buying the crops produced. Asociación Vida Sana also sees the possibility of informative training sessions in selected villages to see how farmers respond, including the opportunity to discuss with the farmers that participated first-hand during the project. The same could be said for other countries where the climate and edaphic conditions are similar.

8. ***In how far could the lessons learnt within the project be used to design and elaborate broader strategies within other European initiatives on this issue, and which could be the contribution to EC agricultural policy in general.***

To start, one of the most important actions to be taken, is to increase the benefits for organic farmers that receive CAP greening incentives. Organic farmers should receive selective and significant subsidies so that organic farming can be viewed as an advantage compared to conventional production methods. Also, farmers that work with marginal and/or low-profit areas should be more protected by these financial support systems. They play an important role in landscape and ecosystem preservation which would otherwise be jeopardized. This is especially the case in rainfed lands that serve as habitats for many bird species, such as the sandgrous, bustard, or quail. Some of the species are at risk of extinction in Europe, as is the case for much of the vegetation associated with rainfed lands[1]. Therefore, EU policies must reward farmers that work on rainfed land and provide valuable ecosystem services much more.

Moreover, organic land is a perfect producer of forage for animals. Forage allows to mix legumes and cereals. They are much less sensitive to weed competition and don't need fertilization. Spain has a vocation for extensive livestock production (pigs, sheep, cows etc.) so governments should realise that supporting the extensive livestock sector will create an outlet for rainfed forage production. In addition, the regulations should be changed to stimulate planting perennial plants for feed, fruit and biomass. Perennial plants mixed with annual crops improve the soil in the long term and increase the yield per hectare. Finally, farmers often need to invest in equipment in order to implement sustainable practices such as a decompacter and a flexible harrow, therefore the *Diputaciones* in that matter should maintained or preferably increased their contributions.

Further information of our project is available at www.traditional-crops.com, where the Layman's report can also be downloaded.

[1] See https://jolube.files.wordpress.com/2008/05/puente_1997_quercus.pdf for more information.