Regenerative agroforestry systems in the Mediterraneanbasin and the integrationof commonpractices into traditional olive orchards - Proposal

Introduction:

On the island of Sicily and all over the Mediterranean, olives (*Olea europaea L.*) are one of the mostabundant crops which are usually grown in monoculture systems (Loumou and Giourga 2003).Yet, plenty of these olive groves are neither very economic nor do they go beyondsustainability (Mairech et al. 2021, Duarte et al. 2008). In order to meet (future) challenges of the likes ofextreme weather events, desertification, higher mean temperatures, biodiversity loss, pest pressureor food security a changein land use is necessary (Fraga et al. 2020,Martínez-Nunez et al. 2020, Brito et al. 2019).One possible solution for these threats could be the integration of regenerative agroforestry(RAF) practices into olive orchardsin order to design an agroecosystem with various ecosystem services.

There is no genuine definition for 'regenerative agriculture'yet.It is a farmer-driven movement which is considered as a possible solution for sustainable food production(LaCanne and Lundgren 2018). Practices that are commonly used are no-tillage, mulching of plant residues, sowing of catch crops, wide crop rotations, integrated pest control and nutrient management, and the introduction of trees, shrubs and livestock on the same area. In addition, some farmers introduce biochar into the system in order to sequester CO2 (Lal 2020).

'Regenerative agroforestry' is commonly referred to as a complex cropping system with variousperennial and annual plants in different levels of height (strata) (Elvitch 2018).The design cues derive from traditional forest garden systems which were developed byobservation of natural forests over decades. The outcome are diverse, multifunctional agroforestry systems that were establishedas a basis for food production worldwide (Nair 1993; Smith 2010).

The term 'foods forests'which originates from the permaculture movement and successional agroforestry(SAF)developed by Ernst Götsch are both a form of land usethat are similarin their principlesandfit the Elvitch's description (2018) of a 'regenerative agroforestry' ((Schulz et al. 1994, Götsch 1995). These philosophies

Commento [JS1]: Loumou, A.; Giourga, C. Olive groves: The life and identity of the Mediterranean. Agric. Hum. Values 2003, 20, 87–95

Commento [JS2]: Mairech, H., López-Bernal, Á., Moriondo, M., Dibari, C., Regni, L., Proietti, P., ... &Testi, L. (2021). Sustainability of olive growing in the Mediterranean area under future climate scenarios: Exploring the effects of intensification and deficit irrigation. *European Journal of Agronomy*, *129*, 126319.

Commento [JS3]: Martínez-Núñez, C., Rey, P. J., Manzaneda, A. J., Tarifa, R., Salido, T., Isla, J., ... & Molina, J. L. (2020). Direct and indirect effects of agricultural practices, landscape complexity and climate on insectivorous birds, pest abundance and damage in olive groves. *Agriculture, Ecosystems & Environment*, *304*, 107145.

Commento [JS4]: Brito, C., Dinis, L. T., Moutinho-Pereira, J., & Correia, C. M. (2019). Drought stress effects and olive tree acclimation under a changing climate. *Plants*, *8*(7), 232.

Commento [JS5]: LaCanne, C. E., & Lundgren, J. G. (2018). Regenerative agriculture: merging farming and natural resource conservation profitably. *PeerJ*, *6*, e4428.

Commento [JS6]: Lal, R. (2020). Regenerative agriculture for food and climate. *Journal of soil and water conservation*, *75*(5), 123A-124A.

Commento [JS7]: Smith, J. The History of Temperate Agroforestry; Progressive Farming Trust Limited: Newbury, UK, 2010.

Commento [JS8]: Schulz B, Becker B, Götsch E (1994) Indigenous knowledge in a 'modern' sustainable agroforestry system-a case study from eastern Brazil. Agrofor Syst 25:59–69

Commento [JS9]: Götsch, E. (1995). *Break-through in agriculture* (p. 22p). Rio de Janeiro: AS-PTA.

have been the role model for many regenerative farmers who adapted the principles to different climates and soil types.But so far research on RAF systems in general and especially in the Mediterranean basin are at a nascent stage. Little is known about design elements, plant selection, plant functions and traits, management, economics and marketing of such abundant systems.

The integration of such practices on a bigger scale has only been done by handful of pioneers(that could be foundby internet research) in the Mediterranean. Therefore,it is the aim of this work to close this gap in knowledgewith a qualitative approach. Havingin-depth interviews with pioneers to get an inside to the above information in order to give an overview of established RAF systems.

Furthermore, the secondaryobjectiveis anexperimental (re)design of an olive orchard with RAF as inspiration. Through a participatory design processtwo designs with different focus (more economic; new establishment) are developed with the goalof amore biodiversity friendly, resilient and productive agriculture system.

Whydo traditional olive orchards need a paradigm shift?

Agroforestry systems in Italy are mainly consisting of fruit- and nut trees as well as olives whichaccounttogether for about 0,4% of the total territorial area. Many of the traditional olive groves are still extensive systems with low density of trees (<100 plants per ha) and are managed with little input e.g.,no irrigation or mechanization.The results are lower yields and little incomecompared to intensive and super intensive systems (up to 2500 plants per ha) with mechanical pruning and harvest (Den Herder et al. 2017, Tous et al. 2010, Villalobos et al. 2006).For that reason,many traditional olive groves have already been abandoned or are threatened by land abandonment since 77% of farmers in Italy are nearthe verge of retirement (>55 years or older) and numerous do not have successors that are willing to take over the business because of the hard physical work and little economic outcome (Duarte et al. 2008, Eurostat data 2016). On the other hand, upcoming young farmers are more open to diversification of their farms as well as for introducing sustainable agriculture practices (Suess-Reyes and Fuetsch 2016).

Besides the unsure succession of many small-size orchards, there are many other factors why the management of traditional olive groves may need a paradigm shift:

Commento [JS10]: Den Herder, M., Moreno, G., Mosquera-Losada, R. M., Palma, J. H., Sidiropoulou, A., Freijanes, J. J. S., ... & Burgess, P. J. (2017). Current extent and stratification of agroforestry in the European Union. *Agriculture, Ecosystems & Environment*, *241*, 121-132.

Commento [JS11]: Tous, J.; Romero, A.; Hermoso, J.F. New trends in olive orchard design for continuous mechanical harvesting. Adv. Hortic. Sci. 2010, 24, 43–52.

Commento [JS12]: Villalobos, F.J.; Testi, L.; Hidalgo, J.; Pastor, M.; Orgaz, F. Modelling potential growth and yield of olive (Olea europaea L.) canopies. Eur. J. Agron. 2006, 24, 296–303.

Commento [JS13]: Duarte F, Jones N, Fleskens L (2008) Traditional olive orchards on sloping land: Sustainability or abandonment? J Environ Manage 89: 86-98.

Commento [JS14]: Suess-Reyes, J., & Fuetsch, E. (2016). The future of family farming: A literature review on innovative, sustainable and succession-oriented strategies. *Journal of rural studies*, *47*, 117-140.

Extensive olive orchards are mostly located on slopes with a high risk of soil erosions especially during heavy rainfall events. Traditional olive groves with no-tillage and cover crops may not be as affected as conventional systems in terms of soil erosion, butthe erosion rates vary widely depending on the management strategy (Zuazo et. al 2020)

Even though Olive trees are very well adapted to the Mediterranean climate with its very hot and dry summers and mild and wet winters, climate change could have a strong influence on future yields, water availability and occurrence of pests (Fraga et al. 2020).

Ponti et al. (2014) expects high economic losses in Italy especially for small olive farms in marginal areas as well as a total decline in net profits of 21% for Italy which is very variable depending on location of olive production. Fraga et al. (2019) projections under two different scenarios emphasize this variability in yields in Italy ranging from -30% to +45% depending on the region.Furthermore,Tanasijevic et. al (2014) works suggests that olive cultivation without irrigation will not be practicable anymore by 2050.

Another issue is the bacterium *Xylella fastidiosa*which is bacterial plant pathogen that was first found on olives trees in Apulia, Italy in 2013 (Wells et al. 1987, Sabella et al. 2019). It causesdeadly damage to olive plants by obstruction of the vessels of the xylem of the olives. Its distribution takes place through infected plant material (long distance) or through cicadas (short distance) (Sabella et al. 2019, Schneider et al. 2020). Because of the warm winter climate, Sicily is especially at risk for the establishment of the bacterium (Martelli et al. 2016). Even though there are resistant varieties of *Olea europaea L*., replanting of lost trees takes time and comes witha period of economic loss. Diversifying the yield with other marketable fruits and nuts in olive orchards could therefore be way of mitigating possible economic consequences of farmers (Schneider et al. 2020).

Monocultures in general are more prone to pests because of the low diversity in the crop system. One of the reasons is often the shortage of genetic diversity within the culture which makes the system more sensitive for pest outbreaks because some olive varieties are more resistant than others. An additional cause for the vulnerability is the low interspecific botanical diversity. For example, some plants attract beneficial insects while others function as a repellent for certain pests. Although it stillunknown

Commento [JS15]: Zuazo, V. H. D., Rodríguez, B. C., García-Tejero, I. F., Ruiz, B. G., &Tavira, S. C. (2020). Benefits of organic olive rainfed systems to control soil erosion and runoff and improve soil health restoration. *Agronomy for Sustainable Development*, *40*(6), 1-15.

Commento [JS16]: Fraga, H., Pinto, J. G., Viola, F., & Santos, J. A. (2020). Climate change projections for olive yields in the Mediterranean Basin. *International Journal of Climatology*, *40*(2), 769-781.

Commento [JS17]: Ponti, L., Gutierrez, A. P., Ruti, P. M., &Dell'Aquila, A. (2014). Fine-scale ecological and economic assessment of climate change on olive in the Mediterranean Basin reveals winners and losers. *Proceedings of the National Academy of Sciences*, *111*(15), 5598-5603

Commento [JS18]: Fraga, H., Pinto, J. G., & Santos, J. A. (2019). Climate change projections for chilling and heat forcing conditions in European vineyards and olive orchards: A multi-model assessment. *Climatic Change*, *152*(1), 179-193.

Commento [JS19]: Tanasijevic, L., Todorovic, M., Pereira, L. S., Pizzigalli, C., &Lionello, P. (2014). Impacts of climate change on olive crop evapotranspiration and irrigation requirements in the Mediterranean ...

Commento [JS20]:

Commento [JS21]: Wells, J. M., Raju, B. C., Hung, H. Y., Weisburg, W. J., Mandelco- Paul, L., & Brenner, D. J. (1987). Xylella fastidiosagen. nov., sp. nov.: Gram-negative, xylem-limited, fastidious plant bac- teria related to ...

Commento [JS22]: Sabella, E., Aprile, A., Genga, A., Siciliano, T., Nutricati, E., Nicolì, F., ... &Luvisi, A. (2019). Xylem cavitation susceptibility and refilling mechanisms in olive tree ...

Commento [JS23]: Schneider, K., Van der Werf, W., Cendoya, M., Mourits, M., Navas-Cortés, J. A., Vicent, A., &Lansink, A. O. (2020). Impact of Xylella fastidiosa subspecies pauca in European olives. *Proceedin* ...

Commento [JS24]: Martelli, G. P., Boscia, D., Porcelli, F., &Saponari, M. (2016). The olive quick decline syndrome in south-east Italy: a threatening phytosanitary ...

Commento [JS25]: Schneider, K., Van der Werf, W., Cendoya, M., Mourits, M., Navas-Cortés, J. A., Vicent, A., &Lansink, A. O. (2020). Impact of Xylella fastidiosa subspecies pauca in European olives. *Proceedin* ...

which of the two attributes of multiplicity are more important for crop protection (Stenberg 2017).

Nevertheless, the diversifying of olive groves could be a way of mitigating the damage of common pests in olive groves like the olive fruit fly (*Bactroceraoleae*) orolive moth (*Prays oleae*) (Proetti 2018& Regni 2018).

Commento [JS26]: Stenberg, J. A. (2017). A conceptual framework for integrated pest management. *Trends in plant science*, *22*(9), 759-769.

Commento [JS27]: Proietti, P., & Regni, L. (2018). Climate change Mitigation through a sustainable supply chain for the olive oil Sector. *Mid-term Report Olive4climate Life project number LIFE15 CCM/IT/000141*, *30*.

Scientific research questions

1) What are design goals and functions of existing regenerative agroforestry systems in the Mediterraneanand how are these systems managed and marketed?
2) How can traditionalolive orchards in the Mediterraneanbe converted into regenerative agroforestry systemswithout jeopardizing their harvest and economics?
3) Whatwould a (re)design for a traditional olive orchard under two scenarios (economic; newly established RAF with main cash crop olives) look like and how would it be managed?

Material &Methods

Study site:

Methods

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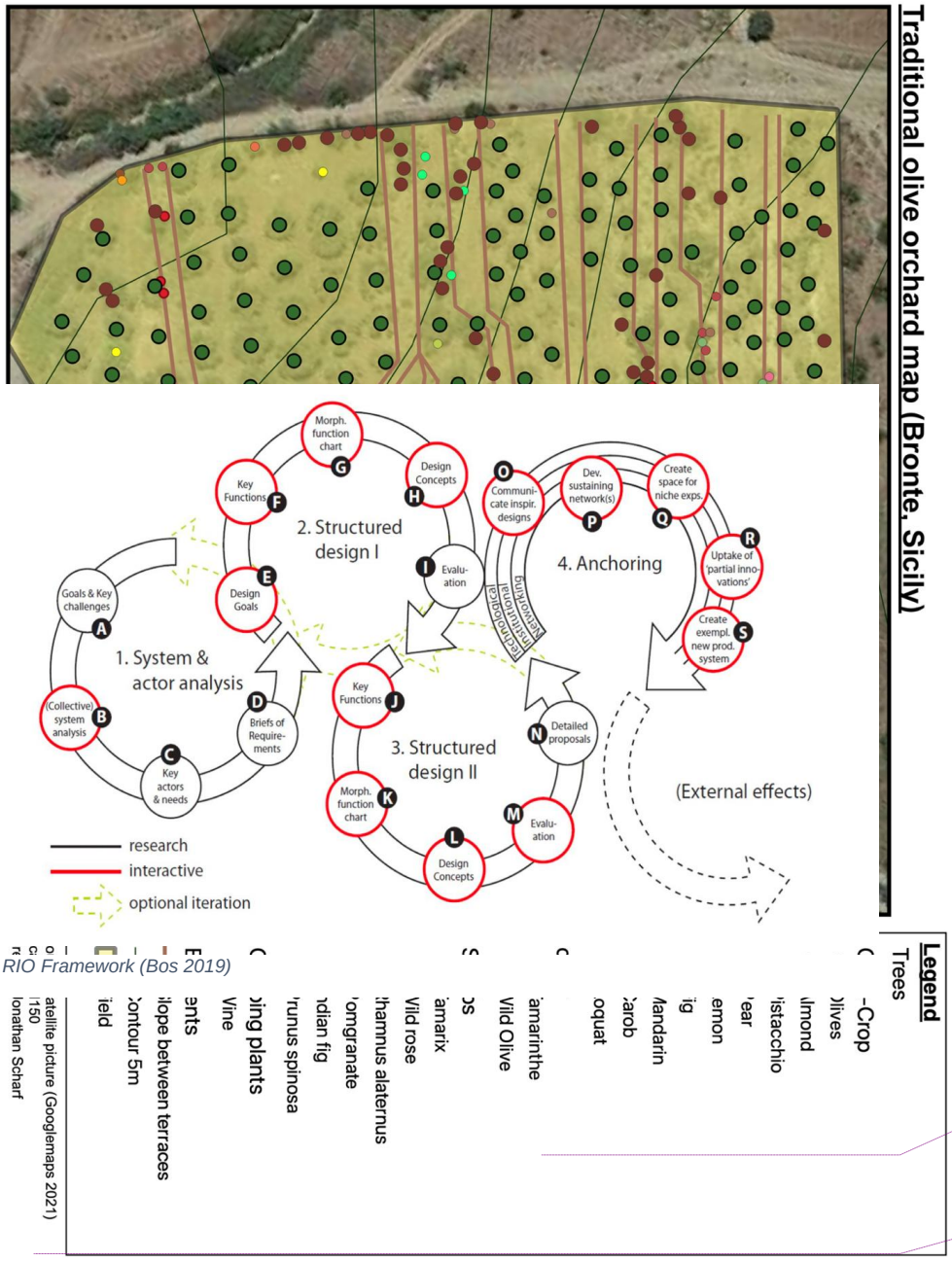


Figure2 RIO Framework (Bos 2019)

from

RIOis

(Bos

Figure 1: Map of Giacche Verdi Olive Orchard (own elaboration with QGIS)

with various stakeholders. The main assumption of RIO is that what we presently

Commento [JS28]: Malézieux, E. (2012). Designing cropping systems from nature. *Agronomy for sustainable development*, *32*(1), 15-29.

Commento [JS29]: Bos, A. P., Koerkamp, P. G., Gosselink, J. M. J., &Bokma, S. (2009). Reflexive interactive design and its application in a project on sustainable dairy husbandry systems. *Outlook on AGRICULTURE*, *38*(2), 137-145.

consider as improvement in agriculture systems, is just the reflection of common objectives of the past (De Koning et al. 2021). The main aim isto integrate stakeholdersin the design process and make innovation relevant to its future adopters.

Commento [JS30]: de Koning, S., de Haas, W., de Roo, N., Kraan, M., & Dijkshoorn-Dekker, M. (2021). *Tools for transitions: An inventory of approaches, methods and tools for stakeholder engagement in developing transition pathways to sustainable food systems* (No. C001/21). Wageningen Marine Research.

Malézieuxsuggests to first observe the natural ecosystem in the surrounding area to identify not only species but their functions in the system. Further scientific and traditional knowledge should be combined to design an experimental innovative cropping system (Fig. 3).

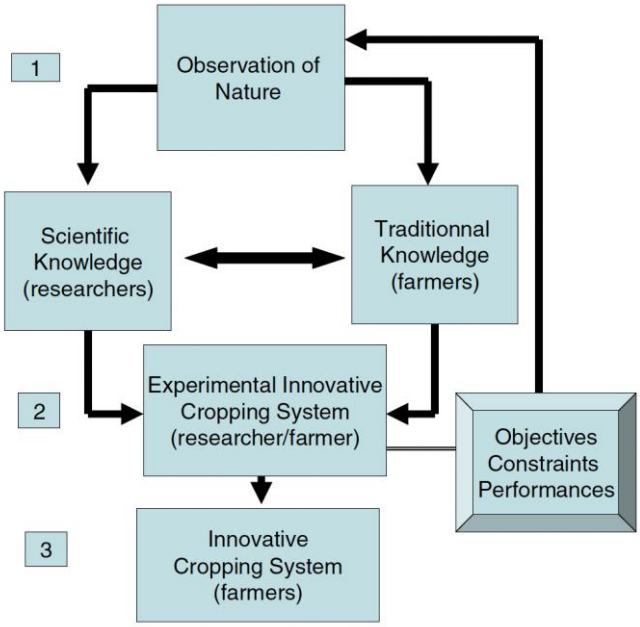


Figure 3 designing farming system from nature (Malézieux 2012)

As the proposed frameworkswere not developed to transferalready existing innovative ideasfrom pioneerfarmers in other similar contexts to a specific regional situation, the frameworkswere merged and adjusted to fit the aim and scope of this study (see Fig. 4).

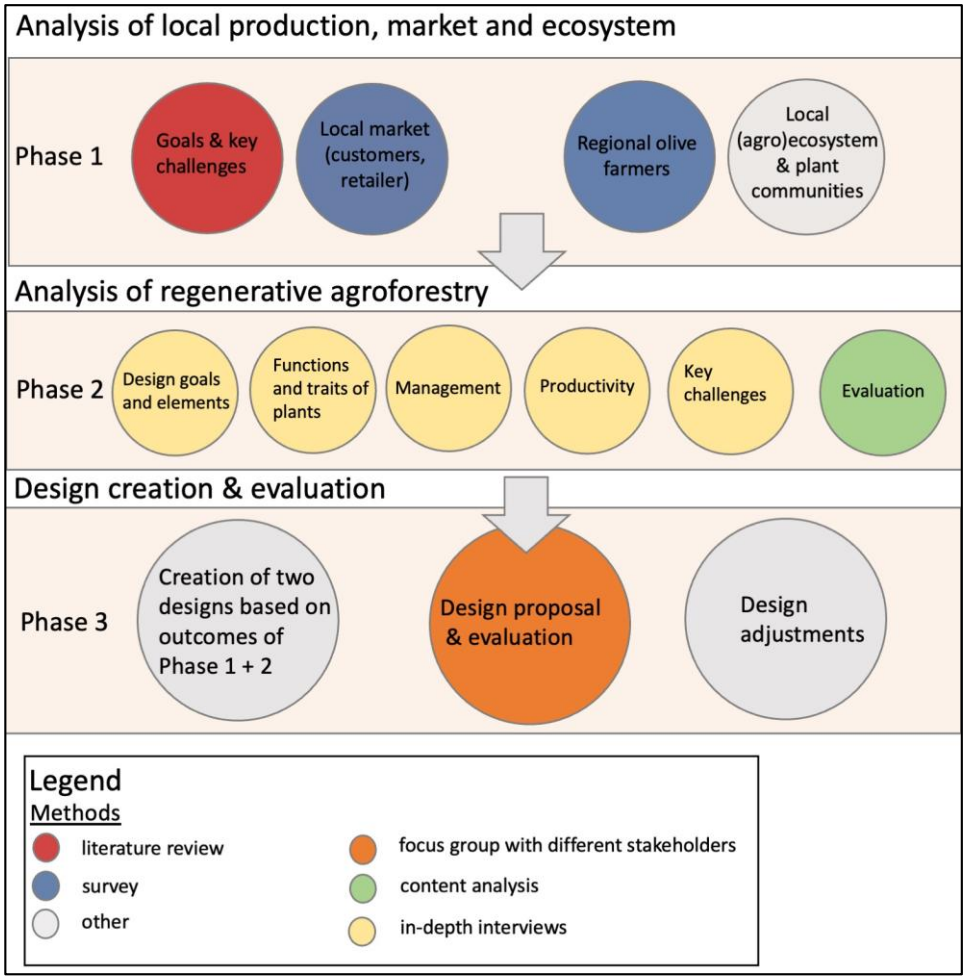


Figure 4 Framework for transforming an olive orchard into an RAF (own elaboration)

Phase 1

In the first step of this study the goals of the redesign and key challenges in olive farmingin the Mediterranean were determined by literature review. Then the situation of the local market was assessed through a survey of customers and merchants. The regional traditional olive practices were analyzed with a questionnaire conducted by Giacche Verdi Bronte (NGO), which was created to assess good agriculture practice in the province of Catania. The data was partly used as a source to get information about agriculture practices and structures of olive farmers in the region.
Further information that was missing in the survey but seemed useful for this work (exactpractices during the year, work peaks, available land machines) was acquired through a short questionnaire to farmers via email (see appendix B).

The local vegetation of semi-natural landscapes close to the study area was quantified on several transects of 150 m (see appendix A). Every 50 m the vegetation cover of a 5m2 square was estimated with the Braun-Blanquet (1964) scale. The vegetation was categorized into 4 classes: herbaceous, shrubs, understory trees (<2 m height with <10cm stem diameter) and canopy (>2m height and >10 cm stem diameter).

Braun-Blanquet scale	Range of cover
r	< 5%; very few individuals
+	< 5 %; few individuals
1	< 5%; numerous individuals
2	5 – 25 %
3	25 – 50%
4	50 – 75%
5	75 – 100%

Along three olive orchards adjoining marginal structures were assessed by identifying and categorizing the discovered plants (shrubs, small trees, trees). The herbaceous layer of the olive orchards was estimated with Braun-Blanquet (1964) scala and along three transects of 150m.

Phase 2

In the second phase in-depth semi-structured interviewswith innovative practitioners of regenerative agroforestry from the Mediterranean basin were conducted with the goal to explore the designs of different systems, understand the function of plants, system elements andmanagement practices (see appendix D for interview guide). An overview of retrieved functions and subfunctions of SAFS (Gasparro 2019) from the tropics was shown to the interviewees in order to evaluate if these functions apply to comparable Mediterranean systems and what plant trait or management practiceofthe system contributes to a certain function.

Further productivity, processing and key challenges were discussed with the interviewees. The interviews were evaluated through a content analysis (Erlingson and Brysiewcz 2017).

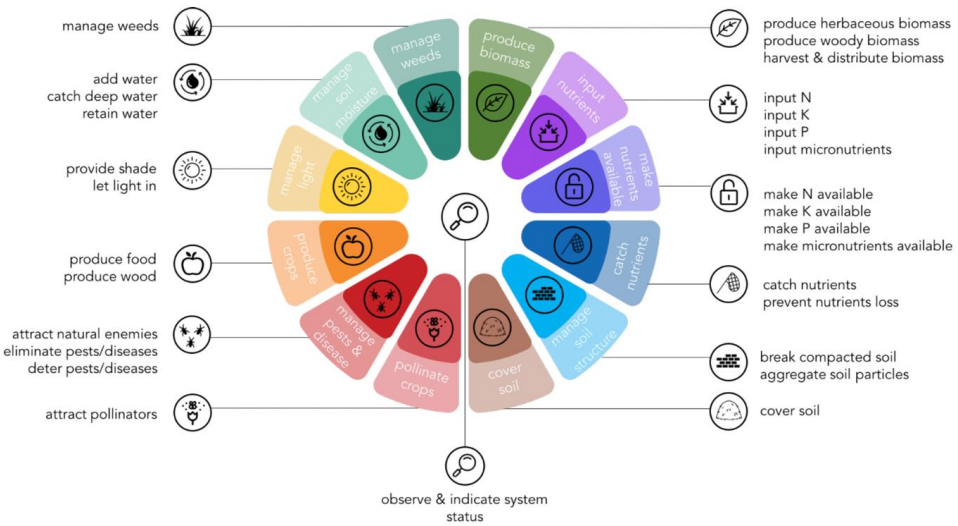
Commento [JS31]: Gasparro, Donatella (2019). From the Atlantic forest to the Mediterranean shrub land: a Farm Performance Assessment and a Functional Design Framework for Large-Scale Successional Agroforestry Systems (SAFS) Wageningen University, Netherlands. Retrieved from https://edepot.wur.nl/528942

Commento [JS32]: Erlingsson, C., &Brysiewicz, P. (2017). A hands-on guide to doing content analysis. *African Journal of Emergency Medicine*, *7*(3), 93-99.

Figure 5: Functions and subfunctions of SAF in the tropics (Gasparro 2019)

Phase 3

In the design process plants were selected by considering the resources of local farmers, preferences of the local market, the surrounding (agro)ecosystem of the farm, soil type, climate and annual precipitation of site. Based on the key functions of the RAF system of the pioneers, plants with the needed traits to realize therequired functions for the (re)design were chosen backed by scientific literature, trait-base



database (https://www.try-db.org) or through pioneer's observations.

To evaluate the proposed design and get the feedback of different stakeholder (olive farmers, traditional farmers, plot owner, forestry expert, scientists, permaculture practician) a focus group was initiated to discuss the design and the proposed management of such a system. The aim of this technique is the use ofin-depth groupinterviews with participants that are selected because theyare a representative ofa specific group. Participants are therefore selectedbecause they can comment on and discuss the proposed redesign(Rabiee 2004).The meeting was recorded and transcribed and used to modify the proposal before implementation.

Commento [JS33]: Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the nutrition society*, *63*(4), 655-660.

Structure

1 Introduction
- 1.1 Oleaeuropaea L.
  - 1.1.1 History, cultural importance and current extent
  - 1.1.2 Phenology
- 1.2 Biodiversityloss and land degradation in the Mediterranean
- 1.3 Climate Change
  - 1.3.1 Prediction for the Mediterranean and Sicily
  - 1.3.2 Impact on olive orchards
    - 1.3.2.1 Yield
    - 1.3.2.2 Water balance
    - 1.3.2.3 Heat stress
    - 1.3.2.4 Pests
- 1.4 Socio-economic
  - 1.4.1 Land abandonment
  - 1.4.2 Ageing of farmers
  - 1.4.3 Youth unemployment
- 1.5 Strategies for a sustainable future of agriculture in the EU
  - 1.5.1 Agenda 2030
  - 1.5.2 Biodiversity Strategy 2030
  - 1.5.3 European Green Deal
- 1.6 Regenerative agriculture
  - 1.6.1 Agroecology
  - 1.6.2 Permaculture
  - 1.6.3 Regenerative agroforestry systems
    - 1.6.3.1 Food forests
    - 1.6.3.2 Successional Agroforestry

Bibliography

Andrade, D., Pasini, F., & Scarano, F. R. (2020). Syntropy and innovation in agriculture. *Current Opinion in Environmental Sustainability*, *45*, 20-24.

Brito, C., Dinis, L. T., Moutinho-Pereira, J., & Correia, C. M. (2019). Drought stress effects and olive tree acclimation under a changing climate. *Plants*, *8*(7), 232.

Cossel, M. V., Ludwig, H., Cichocki, J., Fesani, S., Guenther, R., Thormaehlen, M., ... & Winkler, B. (2020). Adapting Syntropic Permaculture for Renaturation of a Former Quarry Area in the Temperate Zone. *Agriculture*, *10*(12), 603.

Den Herder, M., Moreno, G., Mosquera-Losada, R. M., Palma, J. H., Sidiropoulou, A., Freijanes, J. J. S., ... & Burgess, P. J. (2017). Current extent and stratification of agroforestry in the European Union. *Agriculture, Ecosystems & Environment*, *241*, 121-132.

Duarte F, Jones N, Fleskens L (2008) Traditional olive orchards on sloping land: Sustainability or abandonment? J Environ Manage 89: 86-98.

Götsch, E. (1995). *Break-through in agriculture* (p. 22p). Rio de Janeiro: AS-PTA.

Leitão[1], r., Sandes[1], w., Silveira, p., &Mendes-Moreira[1], p. (2021). Successional agroforestry systems for europe: the portugueseexample.B*reeding and seed sector innovations for organic food systems*, 182.

Loumou, A.; Giourga, C. (2003). Olive groves: The life and identity of the Mediterranean. Agric. Hum. Values,20, 87–95.

Martelli, G. P., Boscia, D., Porcelli, F., &Saponari, M. (2016). The olive quick decline syn-drome in south-east Italy: a threatening phytosanitary emergency. *European Journal of Plant Pathology*, *144*(2), 235-243.

Mairech, H., López-Bernal, Á., Moriondo, M., Dibari, C., Regni, L., Proietti, P., ... &Testi, L. (2021). Sustainability of olive growing in the Mediterranean area under future climate scenarios: Exploring the effects of intensification and deficit irrigation. *European Journal of Agronomy*, *129*, 126319.

Martínez-Núñez, C., Rey, P. J., Manzaneda, A. J., Tarifa, R., Salido, T., Isla, J., ... & Molina, J. L. (2020). Direct and indirect effects of agricultural practices, landscape complexity and climate on insectivorous birds, pest abundance and damage in olive groves. *Agriculture, Ecosystems & Environment*, *304*, 107145.

Fraga, H., Pinto, J. G., & Santos, J. A. (2019). Climate change projections for chilling and heat forcing conditions in European vineyards and olive orchards: A multi-modelassessment. *Cli-matic Change*, *152*(1), 179-193.

Fraga, H., Pinto, J. G., Viola, F., & Santos, J. A. (2020). Climate change projections for olive yields in the Mediterranean Basin. *International Journal of Climatology*, *40*(2), 769-781.

Ponti, L., Gutierrez, A. P., Ruti, P. M., &Dell'Aquila, A. (2014). Fine-scale ecological and economic assessment of climate change on olive in the Mediterranean Basin reveals winners and losers. *Proceedings of the National Academy of Sciences*, *111*(15), 5598-5603

Proietti, P., & Regni, L. (2018). Climate change Mitigation through a sustainable supply chain for the olive oil Sector. *Mid-term Report Olive4climate Life project number LIFE15 CCM/IT/000141*, *30*.

Tanasijevic, L., Todorovic, M., Pereira, L. S., Pizzigalli, C., &Lionello, P. (2014). Impacts of climate change on olive crop evapotranspiration and irrigation requirements in the Mediterranean region. *Agricultural Water Management*, *144*, 54-68.

Tous, J.; Romero, A.; Hermoso, J.F. New trends in olive orchard design for continuous mechanical harvesting. Adv. Hortic. Sci.
2010, 24, 43–52.

Sabella, E., Aprile, A., Genga, A., Siciliano, T., Nutricati, E., Nicolì, F., ... &Luvisi, A. (2019). Xylem cavitation susceptibility and refilling mechanisms in olive trees infected by Xylella fastidiosa. *Scientific reports*, *9*(1), 1-11.

Schneider, K., Van der Werf, W., Cendoya, M., Mourits, M., Navas-Cortés, J. A., Vicent, A., &Lansink, A. O. (2020). Impact of Xylella fastidiosa subspecies pauca in European olives. *Proceedings of the National Academy of Sciences*, *117*(17), 9250-9259.

Schulz B, Becker B, Götsch E (1994) Indigenous knowledge in a 'modern' sustainable agroforestry
system-a case study from eastern Brazil. Agrofor Syst 25:59–69

Schulz J (2011). Ch 1: imitating natural ecosystems through successional agroforestry for the regeneration of degraded lands—a case study of smallholder agriculture in northeastern Brazil. In: Montagnini F, Francesconi W, Rossi E (eds) Agroforestry as a tool for landscape restoration. Nova Science, New York, 3–17.

Stenberg, J. A. (2017). A conceptual framework for integrated pest management. *Trends in plant science*, *22*(9), 759-769.

Suess-Reyes, J., & Fuetsch, E. (2016). The future of family farming: A literature review on innovative, sustainable and succession-oriented strategies. *Journal of rural studies*, *47*, 117-140.

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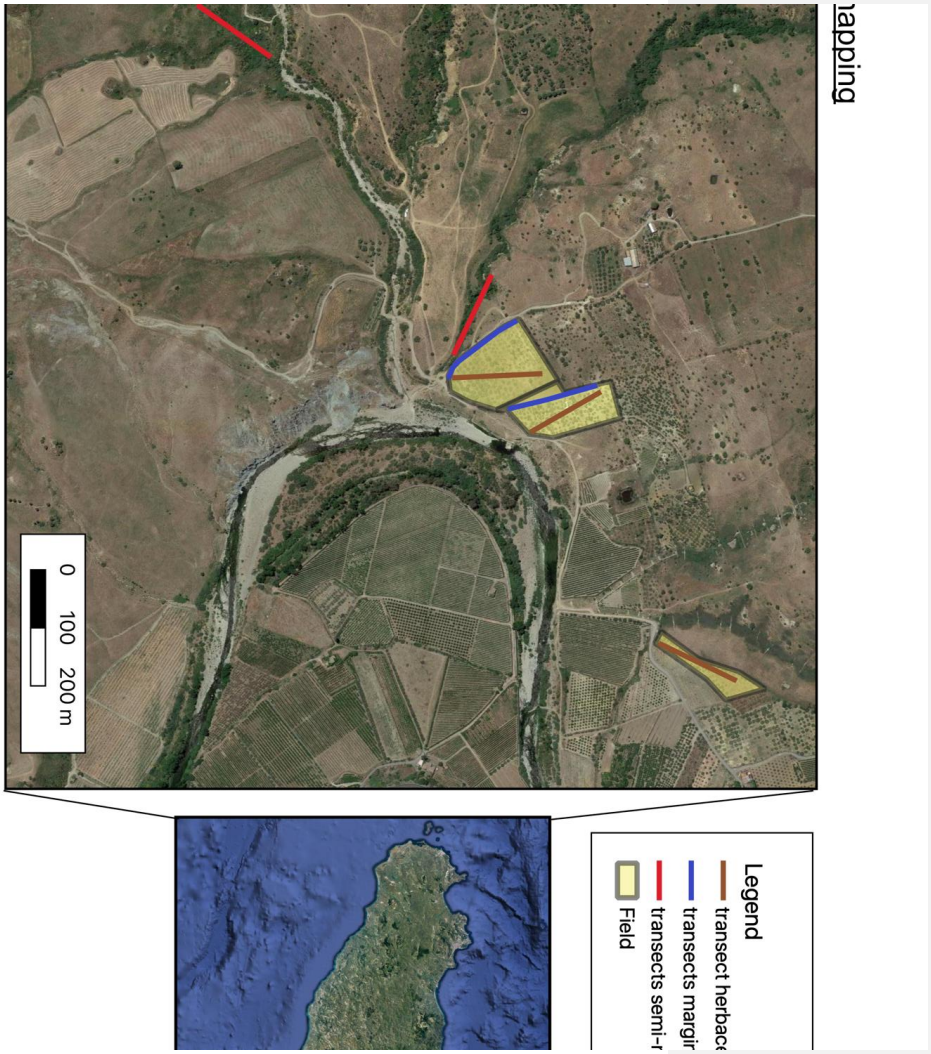
Wells, J. M., Raju, B. C., Hung, H. Y., Weisburg, W. J., Mandelco- Paul, L., & Brenner, D. J. (1987). Xylella fastidiosa gen. nov., sp. nov.: Gram-negative, xylem-limited, fastidious plant bacteria related to Xanthomonas spp. International Journal of Systematic Bacteriology, 37, 136–145.

Zuazo, V. H. D., Rodríguez, B. C., García-Tejero, I. F., Ruiz, B. G., &Tavira, S. C. (2020). Benefits of organic olive rainfed systems to control soil erosion and runoff and improve soil health restoration. *Agronomy for Sustainable Development*, *40*(6), 1-15.

Appendix A



B

Olive farmers survey questions

What tasks do you fulfill in the olive orchard during the year?

Winter

_____

Spring

_____

Summer

_____

Fall

_____

Approximately how much of your time (hours) do you spent per ha with the following tasks during the year?

Soil cultivation/seeding _____

Harvest _____

Pruning _____

Other _____

Are there times in the year where there is little or no work to be done in the olive grove?

O Yes O No

If yes, during what months _____

To what kind of shredder do you have access to?

O I don't have access O Modell name:

What other land machines do you have access to?

_____

C

Nr.

Survey questionnaire of costumers of local weekly market

1. How old are you?

O<18 years **O** 18-30 years **O** 30-40 **O** 40-50 **O** 50-60 **O**>60

2. What is your profession?

_____

3. How often do you come to the local market?

O every week **O** two times a month**O** one time a month **O** less

4. For what products do you come here?

O Dairy products **O** Meat products **O** Fruits **O** Nuts **O** Vegetables **O** other

5. How much does seasonality in terms of fruits and vegetables matter to you?

O very important **O** important **O** neutral **O** not very important **O** not important

6. How important is the regionality of the products for you?

O very important **O** important **O** neutral **O** not very important **O** not important

7. How much money do you spent on average on the market?

O 0-10 € **O** 10-20 € **O** 20-50 € **O**>50€

8. What vegetables do you buy here regularly during different periods of the year?

Winter: _____

Spring: _____

Summer: _____

Fall: _____

9. Do you buy nuts on the market?

O yes **O** No

If, yes what kind _____

10. Do you buy fresh/dried herbs on the market?

O yes **O** sometimes **O** No

If yes, what kind_____

11. Do you buy berries on the market?

O yes **O** No

If, yes what kind _____

12. Which of the following wild herbs/vegetables are buying here?

Owild fennel **O**caper **O** wild asparagus **O** None, I collect them myself **O** I do not eat them

13. What is missing in the supply of the market in terms of fruits, nuts, herbs?

_____

Thank you for your participation!

Nr.

Survey questionnaire of merchants of local weekly market

1. How old are you?

   O<18 years **O** 18-30 years **O** 30-40 **O** 40-50 **O** 50-60 **O**>60

2. Do you grow the products, that you sell, yourself?

   O yes, all my products **O** some of it **O** none

   List the main products that you produce yourself:

   _____

3. How many of the products you sell are from the region (radius of 10 km)?

   Onone **O**<10% **O** 10-30 % **O** 30-50% **O**> 50% **O** 100 %

4. What locally produced vegetables, nuts and fruits do you sell during different seasons?

Winter:

_____

Spring:

_____

Summer:

_____

Fall:

_____

5. What products do you buy from outside Sicily?

_____

6. Where do you get your products from?

O local farmers **O** wholesale market **O** only own products **O** other

7. Would you prefer selling only regional products if they were available?

O Yes **O** No **O** only the price that I can achieve matters to me

8. What products gives you the most financial return?

_____

9. What products are easy to sell in terms of customer demand?

_____

10. Are you happy with the financial return overall?

O Yes **O** somewhat **O** No

Thank you for your participation!

D

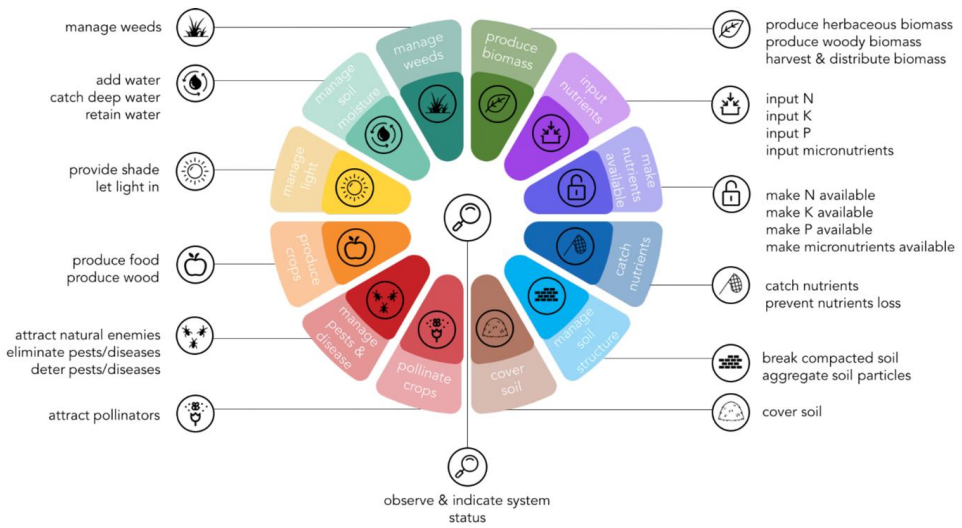
Semi-structured in-depth interviews regenerative agroforestry

Introduction:

How did you start farming and what lead you to the kind of agriculture system that you're doing now?
How would you define your farming system?
Farm size, Precipitation, Soil type, Slope?
What is distinguishes your system from other farming system in the area?

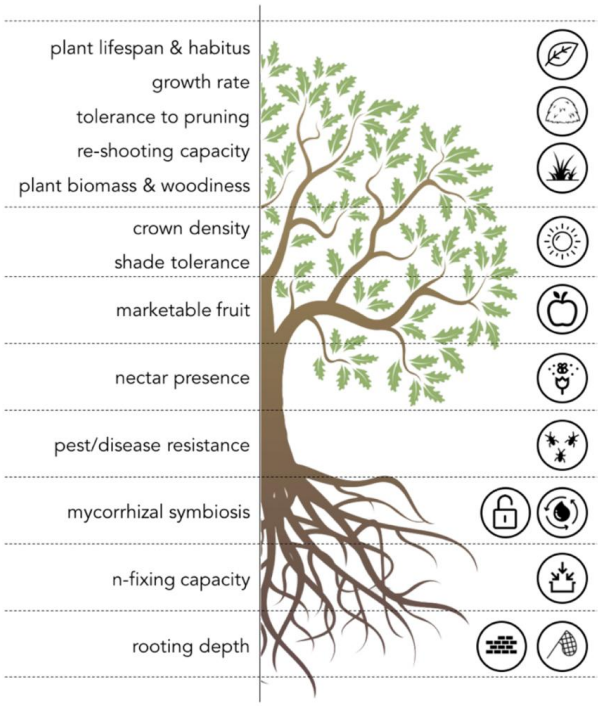
Main Design Functions and Plants:

What are the main objectives of your established agroforestry system?
What elements are part of the system?
Let's look at functions retrieved from regenerative agroforestry system of the tropics:



Apply the same or similar functions to your established system?
What other functions are key to your system?
What traits do the chosen plants in your system have to fulfill these functions?

e.g.:



What is the spacing between the plants?
How diverse is your system in terms of plant families?
Would you say your designed system is comparable to native forests in your region?
What is your view on bringing invasive species into the system?

Management

How many people work in the system?
How much time do you spent on weeding and pruning? How much on harvest?
Is the workload over the year constant?

During what times in the year do prune trees and shrubs, what do you do with the pruning?
What machines do you use?
How do you manage the harvest with the dense planting of the system?
Do you use mulch?
What is yours source of mulch and where do you use it?
Do you make compost on site, or do you produce terra preta to integrate it in the system?
What other sources of fertilizer/soil enhancer do you use?
Do you do anything to manage pests?
How do you water?
How much water to you use?

Economics/Marketing

How productive is the system? How much yield do you get approximately from each crop?
What gives you the most financial return?
How do you sell your products?
(Why don't you sell your products locally?)
Do you process some of your products yourself?
Can you make a living from selling your products?

Key challenges

What are problems that you face with your agroforestry system?
What do you do in order to solve them?

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