Project Workshop in Santorini (Greece)

Congress Hall of the "Wine Tourism Center"

uPrunning

Take-off for sustainable supply of woody biomass from agrarian pruning and plantation removal

# Sustainable Soil Conditions and Pruning Removal from Vineyards

Call H2020-LCE-2015-3
Coordination and support action


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# Pruning to soil or pruning to energy: a trade off decision

Sustainable Soil Conditions and Pruning Removing from Vineyards

# What fate should pruning residues have?

- Pruning residues can be considered simply as a **waste**; in this case, they have to be disposed; **burning** is usually the easiest way. Although this is not an option! Pruning burning in the field and open-air conditions should be avoided
- Differently, pruning residues can be considered as a **resource** to be valorized. In this case, two contrasting but complementary approach are possible:
  - Pruning **removed from the field** to be addressed to a wide range of possible uses: energy conversion, livestock bedding, industrial raw material (paper pulp, fibre boards), mushroom substrate, etc.
  - Pruning **left on the field**, to be used as soil improver

# What fate should pruning residues have?

# What fate should pruning residues have?

Pruning can be considered a suitable feedstock for renewable energy production, both thermal and/or power, to be addressed to farming operations, agro-industrial processes or to be sold to single or collective consumers

# What fate should pruning residues have?

- Due to multiple possible uses, trade-offs in managing crop residues exists and should be carefully considered
- In terms of GHG emissions, "***pruning to energy***" allows the replacement of fossil fuels (reducing the $CO_2$ atmospheric increase), while "***pruning to soil***" allows $CO_2$ sequestration, at least temporarily
- Both the two approaches belong to the so-called climate change "mitigation" strategy
- Apart climate change, considering the scarcity of alternative organic amendments, the retention of crop residues on the field (or into the soil) could be a key factor in promoting ***soil health and quality***
- A holistic approach, combining the two perspectives (soil and climate), should be developed

# Rethink conventional agricultural practices

- Drive a change towards more sustainable agricultural practices
- Provide an alternative to current pruning residues management
- Reduce farmers costs avoiding traditional operations
- Reduce the risks of pest and diseases propagation

# The main issue: targeting the soil quality of vineyard

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# Soil quality is the main issue

- Wine-grape growing areas are usually located in semi-arid environments (mostly Mediterranean)
- Soils in these areas are inherently characterized by low content in organic matter, generally with less than 1%
- Sustainable crop production is related to soil health and a healthy soil is rich in organic matter
- The arid climate and the intensive, humus-consuming conventional growing operations require every kind of organic amendment which is readily available
- The addition of regular inputs of organic amendment is therefore necessary to increase or maintain soil organic matter content and thus contributes to soil health
- The most accessible form of soil amendment is crop residue (i.e. pruning from vineyard)

# Soil fertility, quality and health

- Soil is a component of the **agro-ecosystem** and an ecosystem itself. Soil, therefore, is made of a biotope plus a complex **living system** (the ecological debris chain made of organism along a sequence of trophic relationships)
- A healthy soil is rich in organic matter which allows a high diversity of soil organisms to flourish and act as a reservoir of soil nutrients and moisture
- Organisms in the soil perform several activities including nutrient cycling, symbiotic relationships with plant roots, pest, weed and disease control, they contribute (together with humus) to the soil aggregation and aeration which influence susceptibility to erosion and water infiltration

# The function of SOM* in the frame of the orchard soil management

***SOM = Soil Organic Matter**

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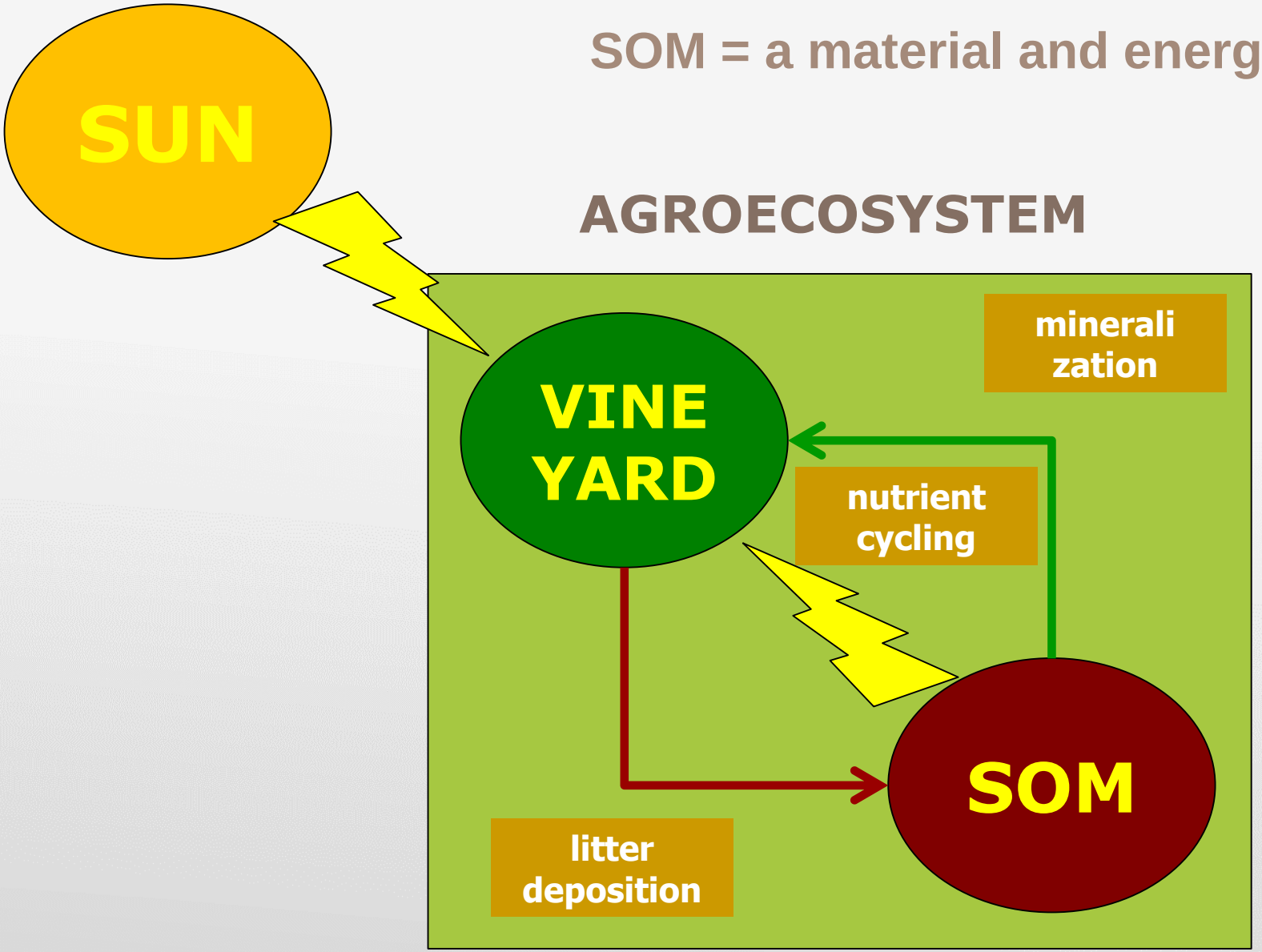
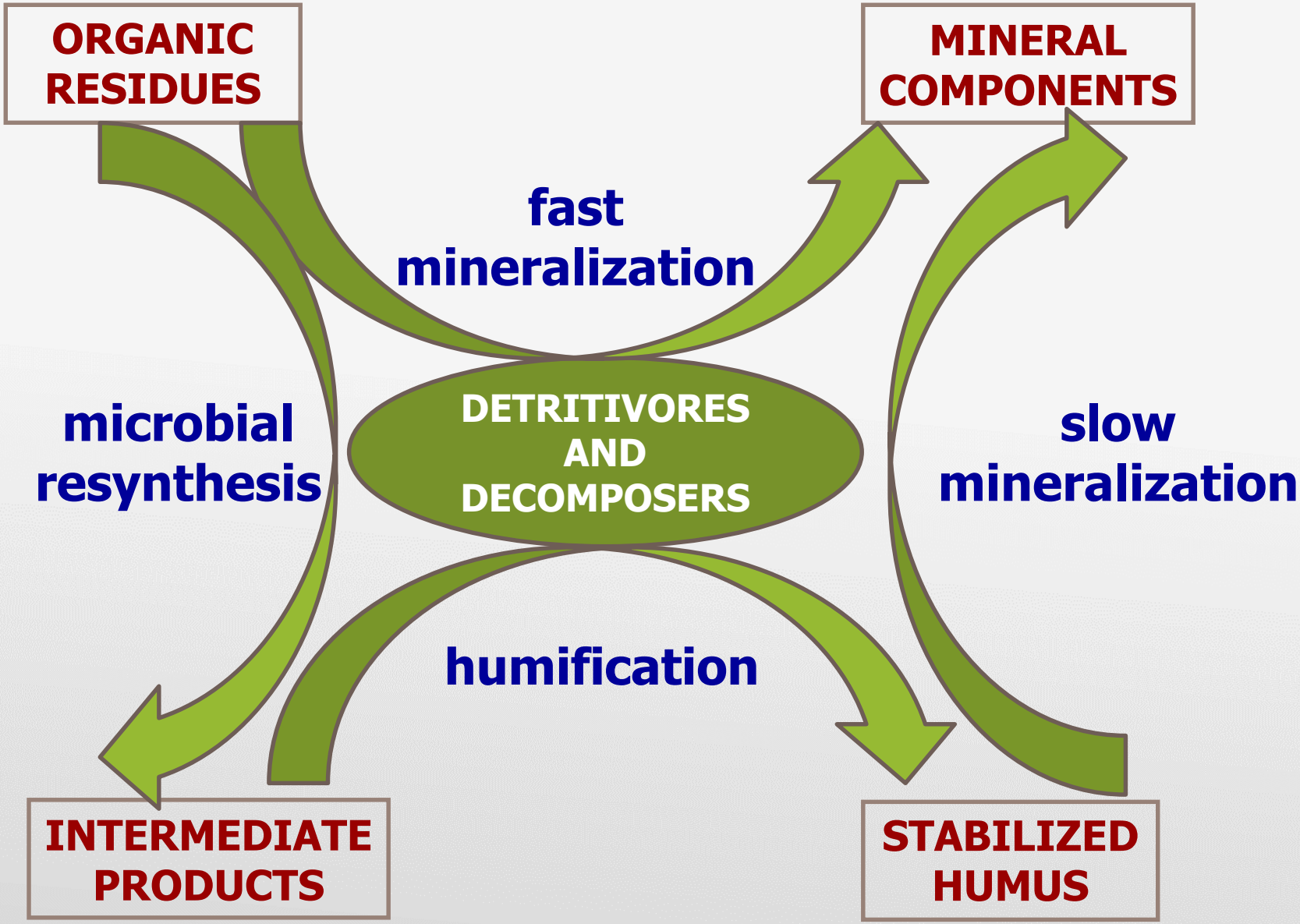
# The role played by SOM

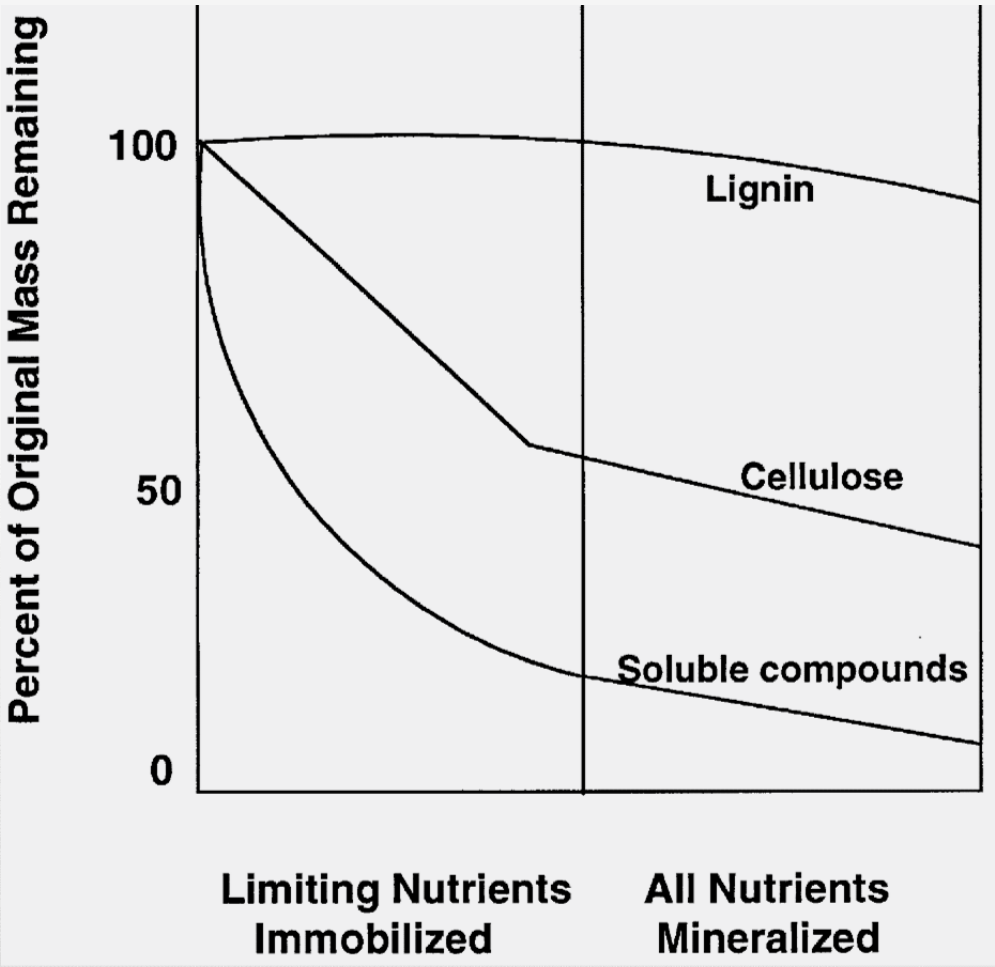
SOM = a material and energy flywheel



# The SOM dynamic



# Residue degradation and SOM formation




The quality of the pruning has a crucial influence in determining the impact on soil fertility, especially with regard to nutrient supply and SOM formation

- ✓ "high-quality" organic inputs (high N but low lignin and polyphenol contents) will release nutrients rapidly.
- ✓ "low-quality" organic inputs (poor in N and high in polyphenols and lignin) will release nutrients slowly or even immobilize them

**SUGARS PROTEINES HEMICELLULOSE WAX TANNINS**

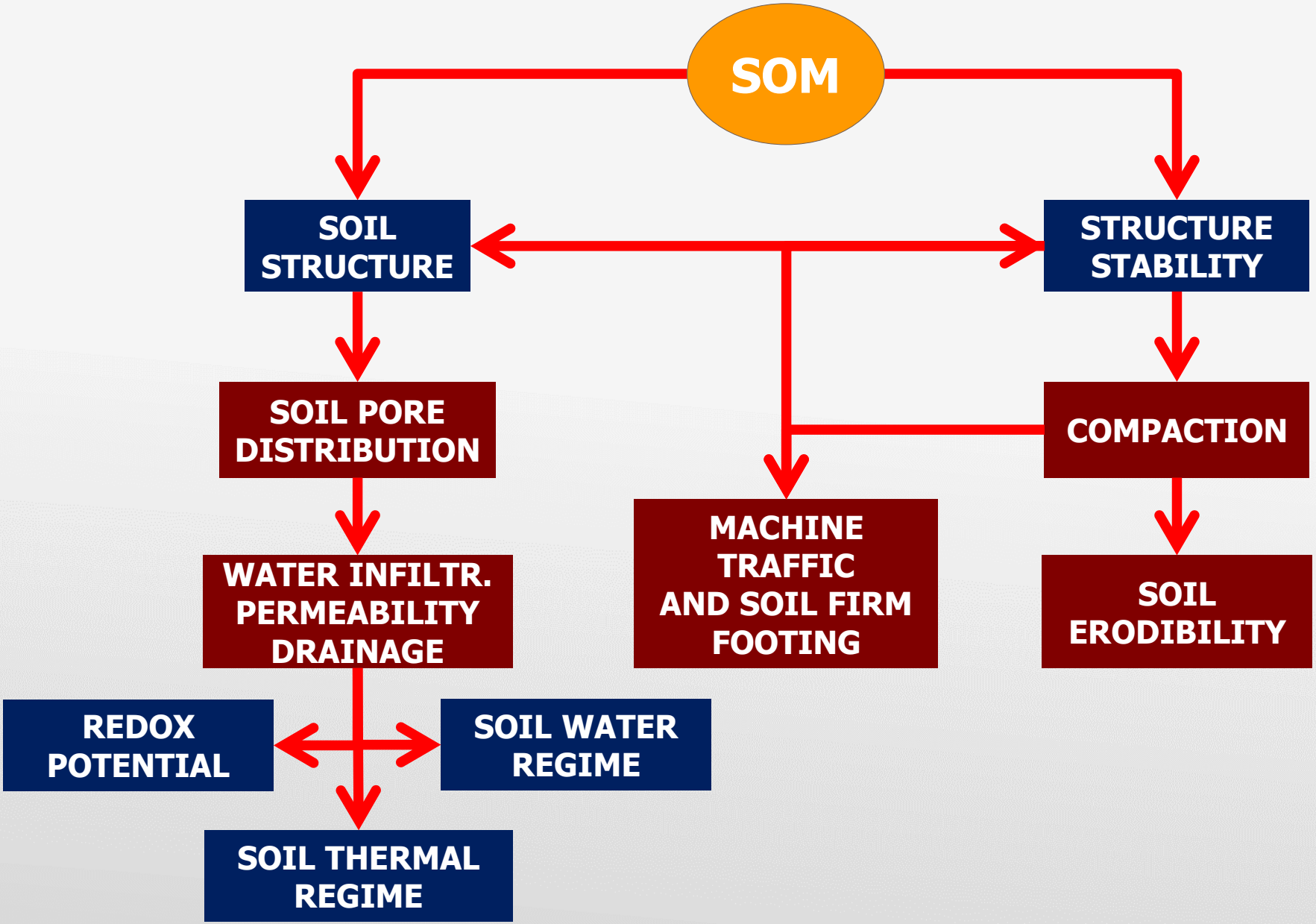
**INCREASING RESISTANCE TO DEGRADATION**

**STARCH PECTINS LIGNINS RESINS**

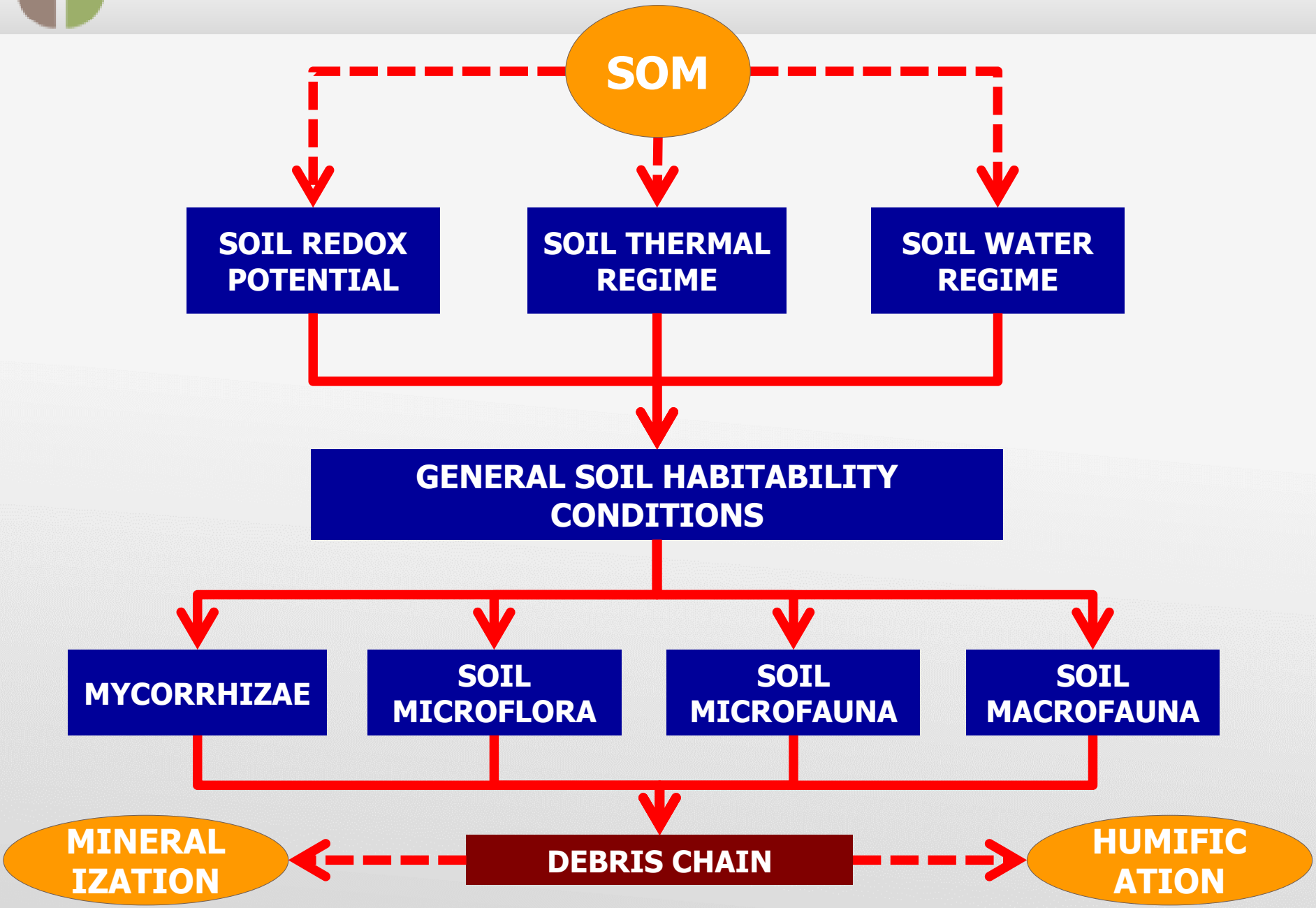
# Pruning degradation and SOM build up

- Under an arid climate, soil microbial activity in vineyard is low and the pruning residues (mulched or buried) are unlikely to be rapidly degraded
- The high initial C:N ratio causes a slower beginning of the process and requires a longer composting time together with the supplement of a nitrogen source (manure, sewage sludge, urea, etc.)
- Because of the slow release of N and P from SOM, organic inputs have a greater residual effect on soil fertility than do inorganic fertilizers
- Possible negative effects are also waterlogging and decrease in soil temperature
- Again: trade-offs are needed in favour of promoting long-term soil health

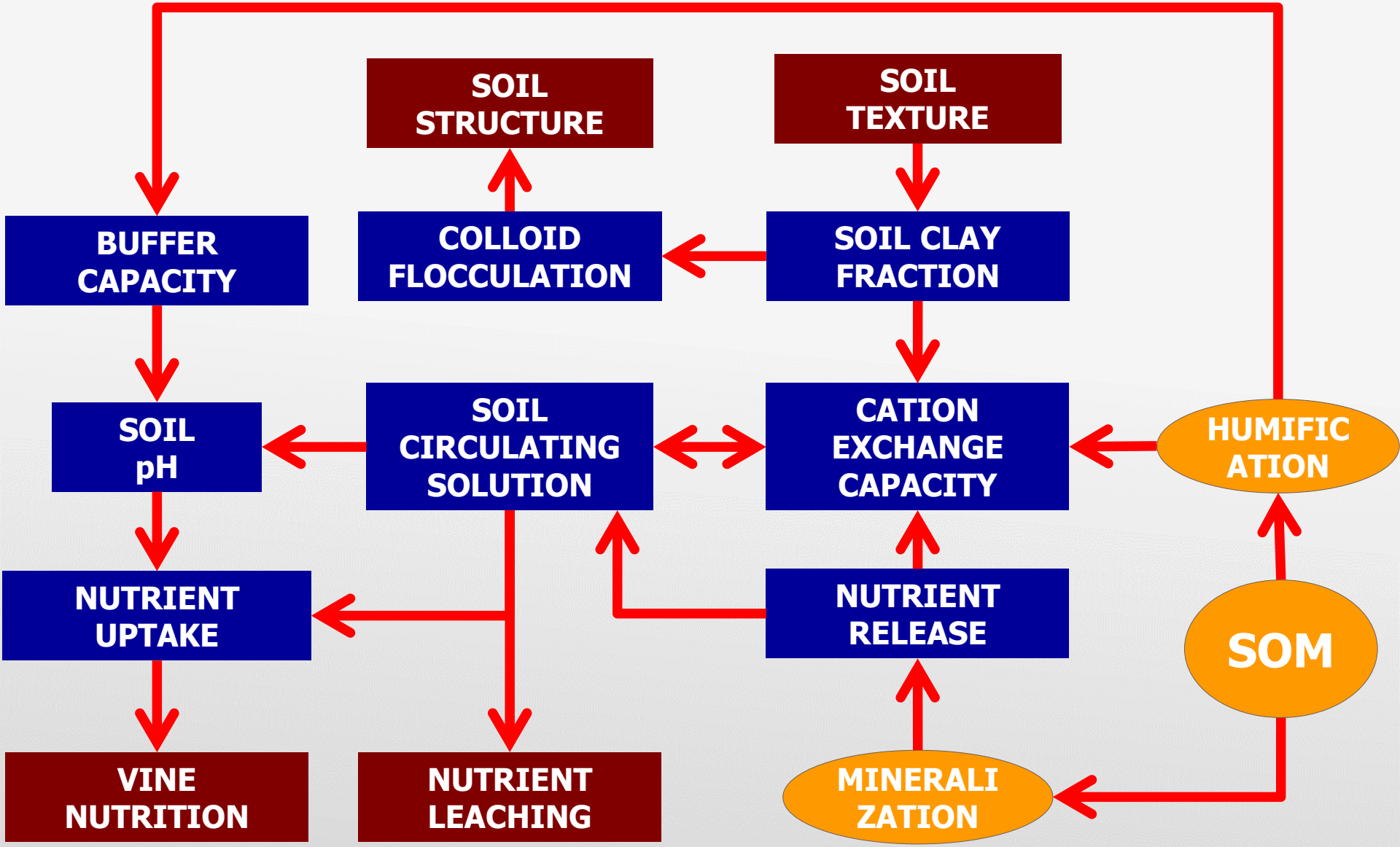
# SOM and soil physical properties



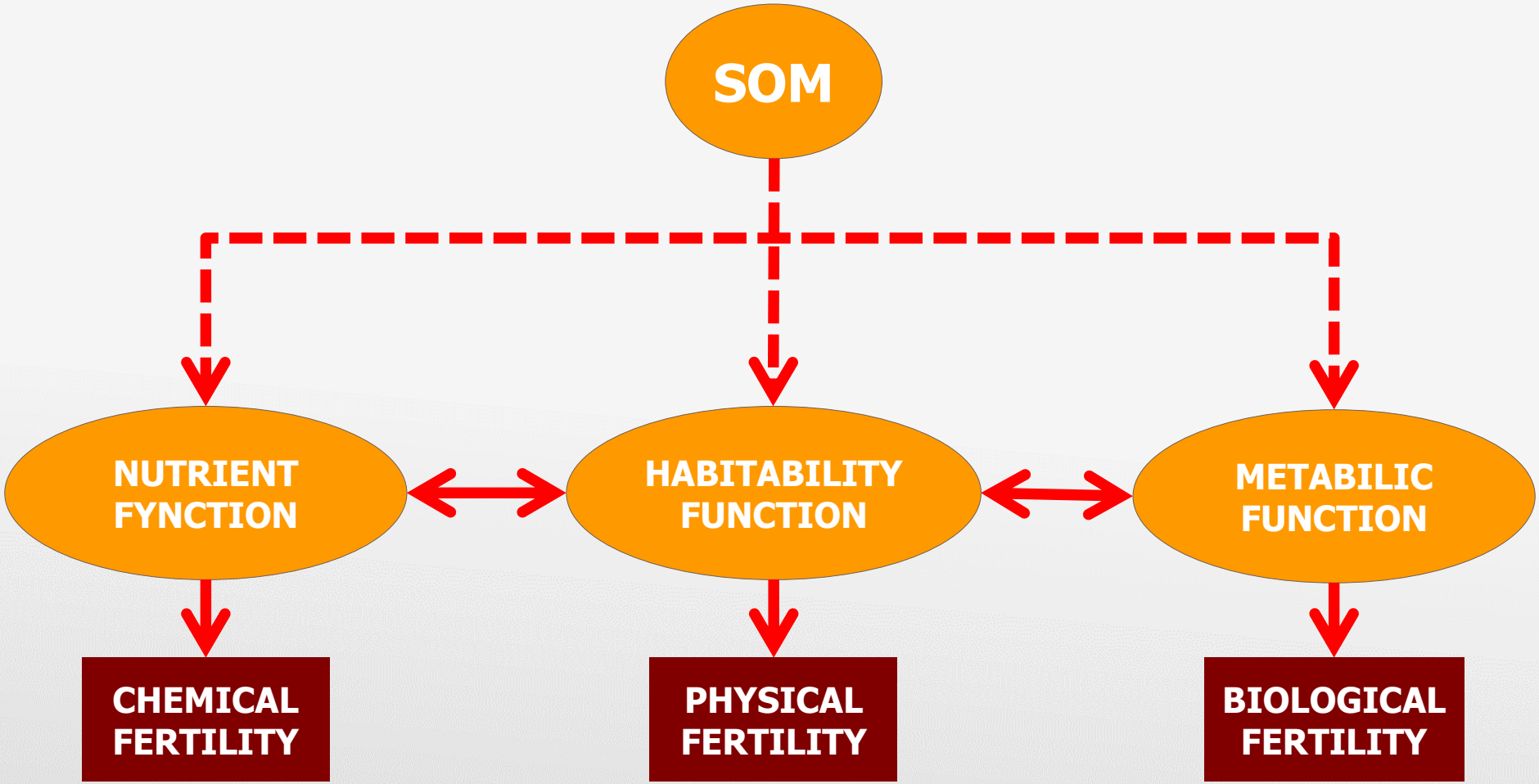
# SOM and soil biotic properties



# SOM and soil chemical properties



# Soil functions = soil quality




**VINE PRODUCTION AND QUALITY**

# Soil condition to remove vineyard pruning: an operative check

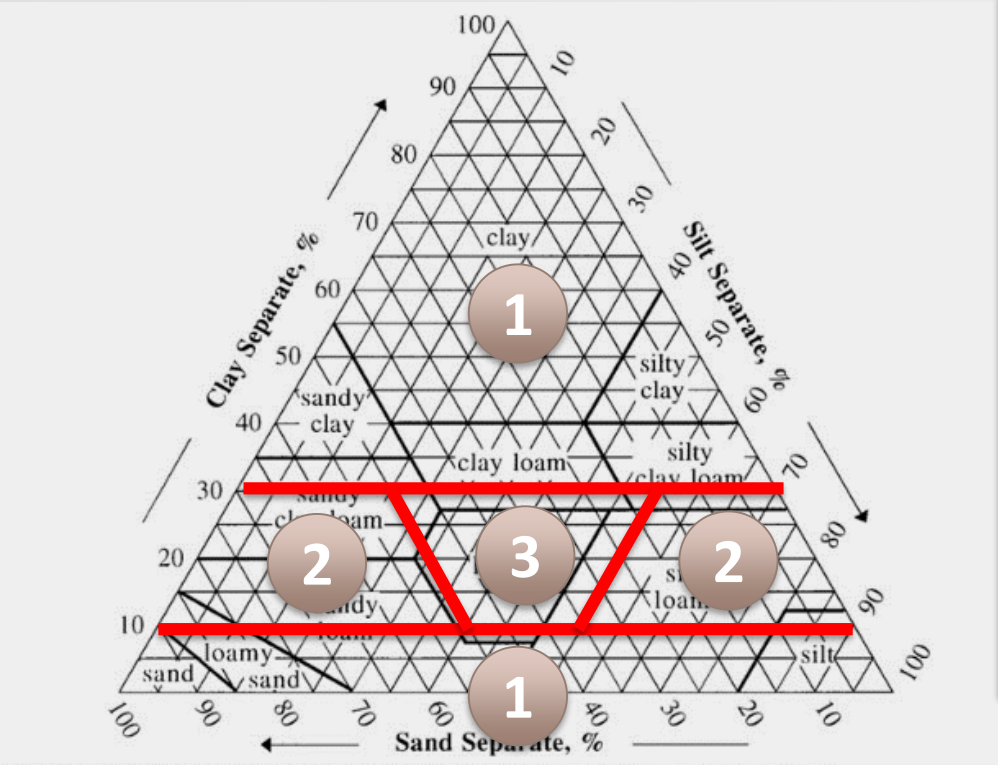
Sustainable Soil Conditions and Pruning Removing from Vineyards

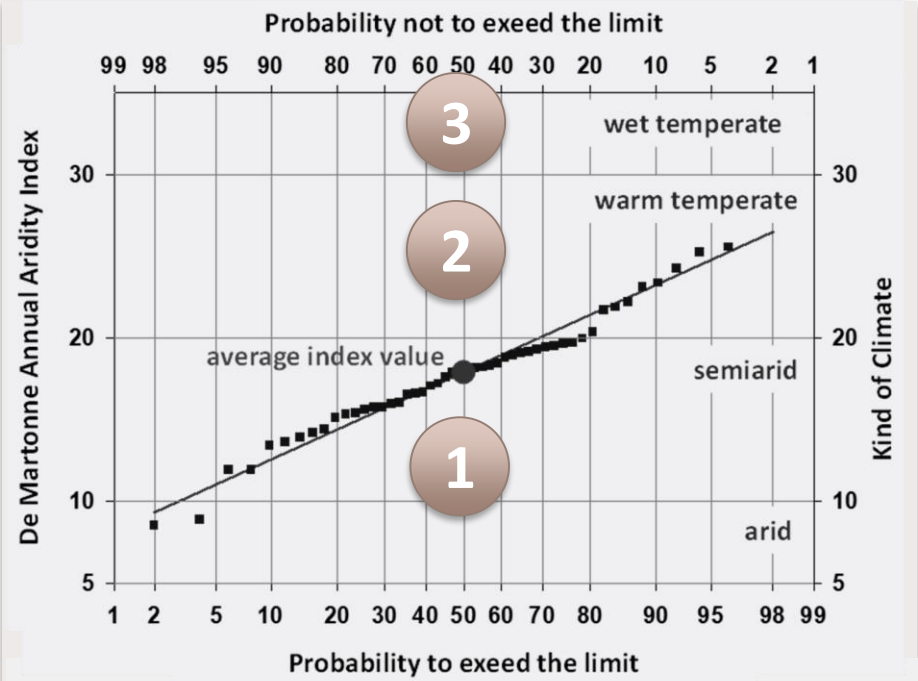
# Soil conditions to remove pruning residues

| SCORE | SOC (%) | TEXTURE (%) | SOIL SLOPE (%) | CLIMATIC CONDITION* |
|---|---|---|---|---|
| 3 | > 3.0 | CLAY 10-30;<br>And SILT < 50;<br>And SAND < 50 | < 5 | > 30 |
| 2 | 1.5 - 3.0 | CLAY 10-30;<br>And SILT > 50;<br>Or SAND > 50 | 5 - 20 | 20 - 30 |
| 1 | < 1.5 | CLAY < 10<br>Or<br>CLAY > 30 | > 20 | < 20 |

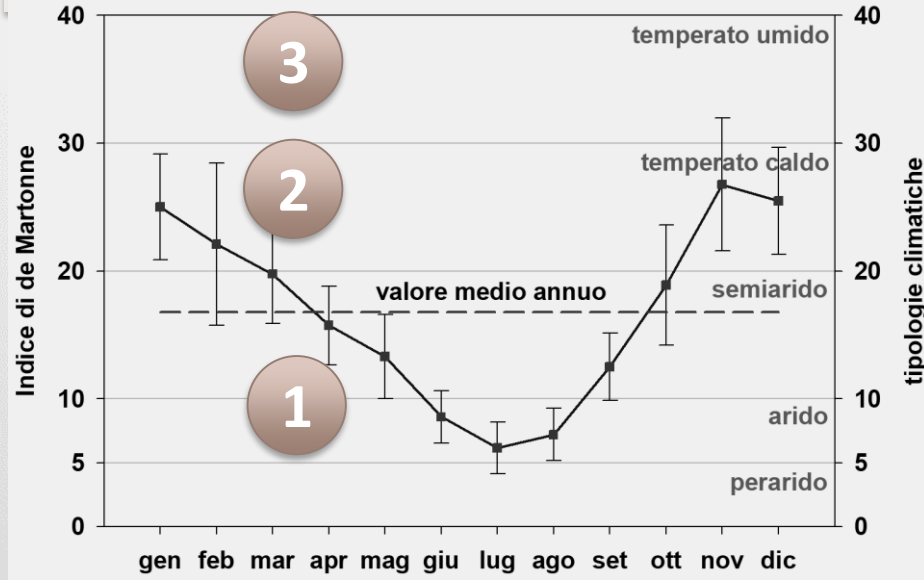
* Aridity Index AI = P/(T+10); P = average annual rain (mm,); T= average annual temperature (°C)

# Soil conditions to remove pruning residues



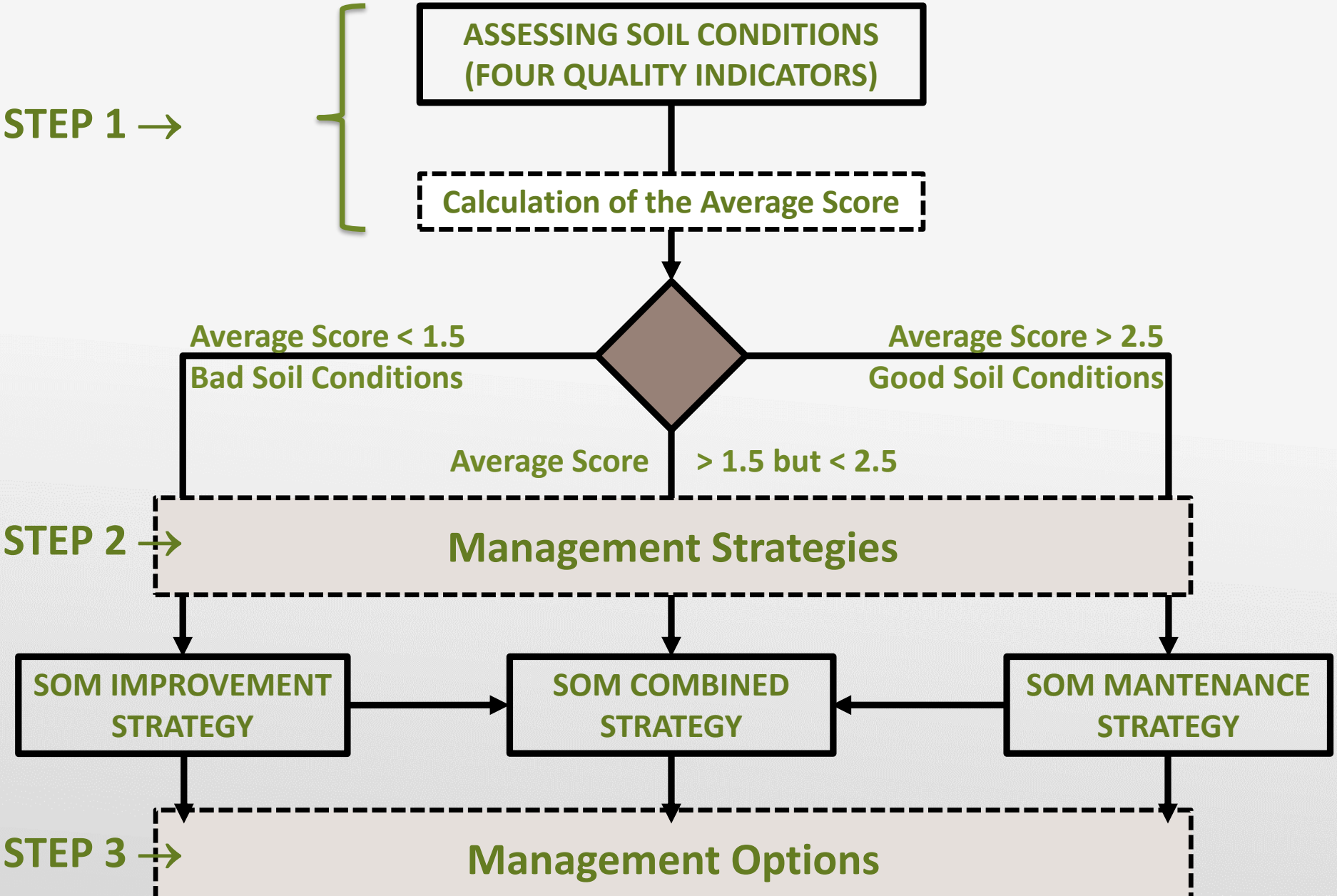




Soil texture




De Martonne Aridity Index

# Soil conditions to remove pruning residues



# Soil conditions to remove pruning residues

| | MANAGEMENT OPTIONS | | | | |
|---|---|---|---|---|---|
| **MANAGEMENT STRATEGIES** | **ORGANIC FERTILIZATION** | **DEGREE OF SOIL COVER** | **PERIOD OF SOIL COVER** | **MECHANICAL SOIL TILLAGE** | **MECHANICAL TRAFFICABILITY** |
| **SOM INCREASING** | organic fertilization or manuring | total cover | permanent annual cover | no-tillage | low |
| **SOM COMBINED STRATEGY** | organic fertilization or green manuring | total or partial cover | permanent annual cover or extended winter cover | minimum-tillage | low or moderate |
| **SOM MAINTENANCE** | green manuring | partial cover | extended winter cover | significantly reduced (minimum tillage) | moderate |
| **SOM DIMINISHING** | no manuring or organic fertilization | no cover | no cover | conventional tillage | high |

# Soil conservative operations in the vineyard: how to approach the new paradigm

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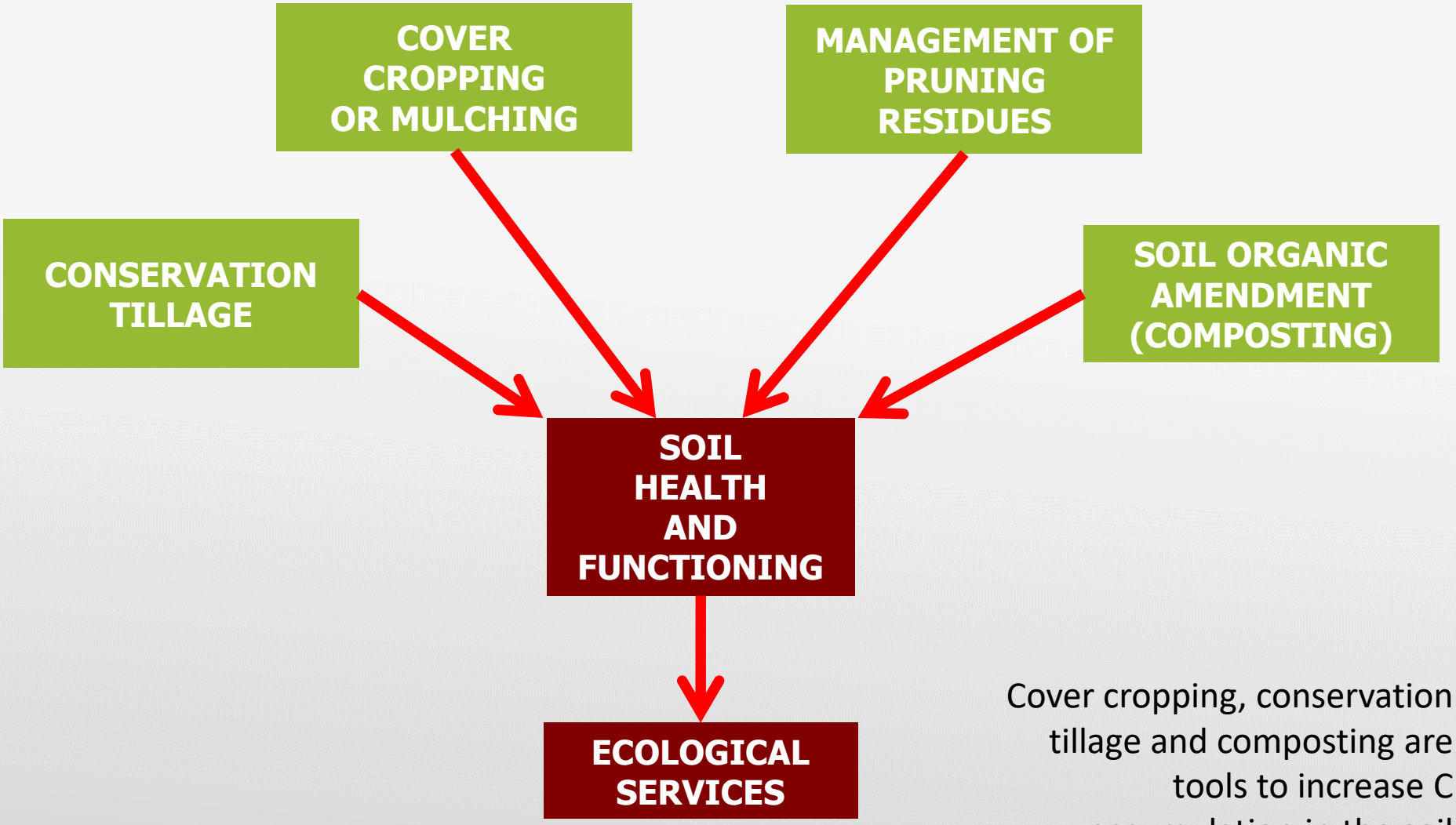
# Soil management in practice




Cover cropping, conservation tillage and composting are tools to increase C accumulation in the soil

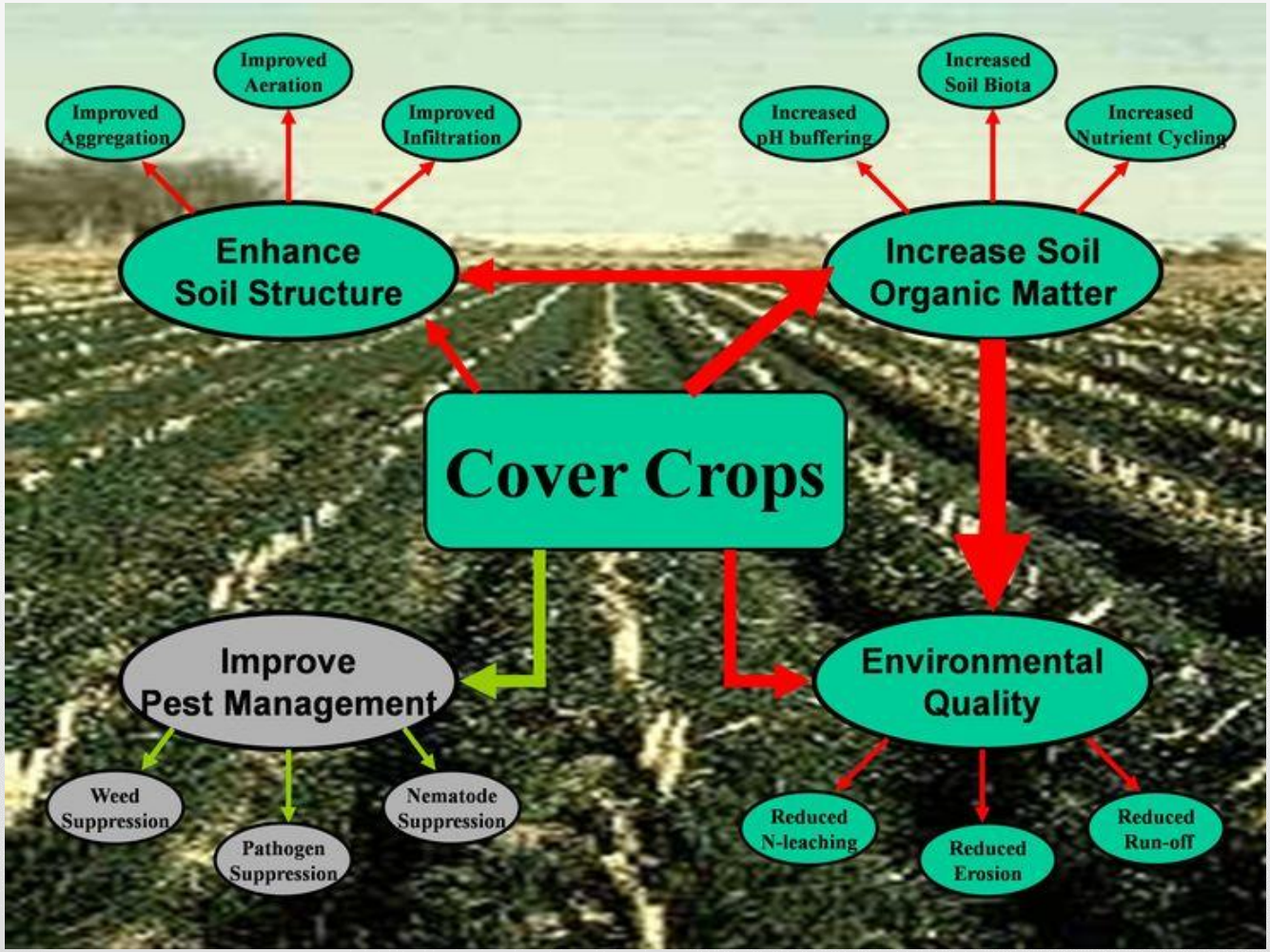
# Cover cropping

- A cover crop is any plant species usually grown in a mixture between vine rows (alleys)

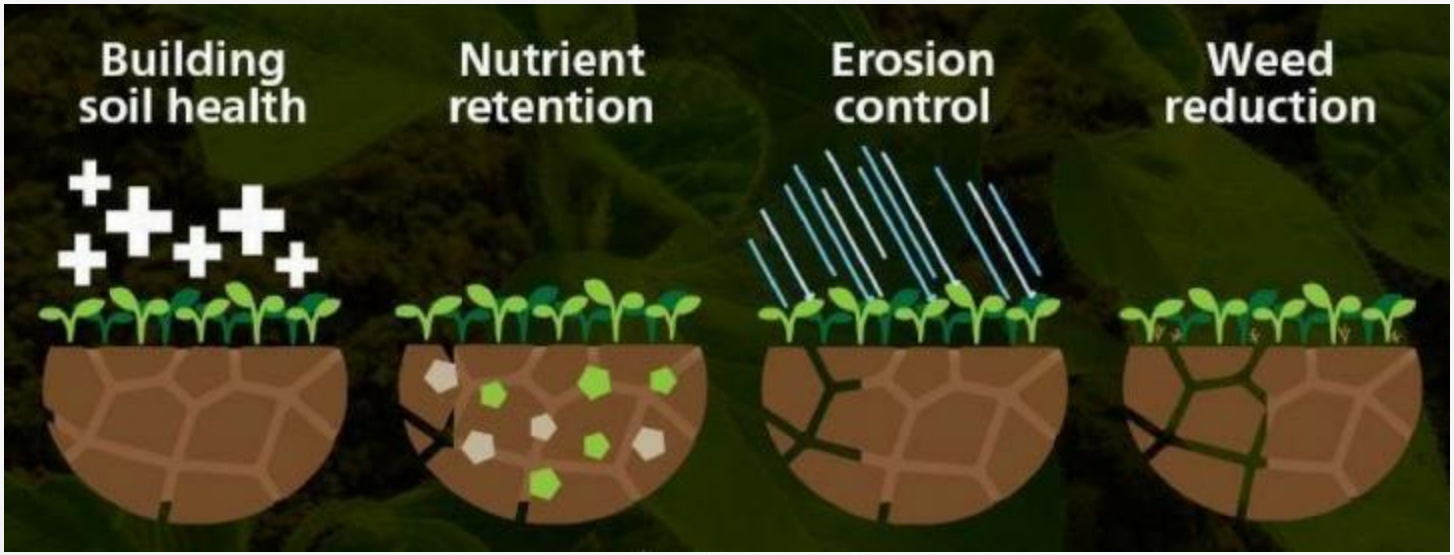
- Perennial or annual cover crop mixtures of grass, legumes, native flowering plants and/or other forbs year round
- Cover crops, once planted, can be replanted annually or maintained year after year
- Self-reseeding annual cover crops can be planted without tillage, but can regenerate for multiple years

# Cover cropping and composting

- Compost  can also be applied as soil amendment and fertilizer
- This is useful for both vines and cover crops



# Advantages of cover cropping and composting




And much more:

- improve soil structure and water-holding capacity
- protect the soil from crusting
- can fix nitrogen (if legumes)
- enhance biological diversity in the root zone
- provide habitat for pollinators, generalist predator and parasitoid insects
- regulate vine growth and vigour
- provide firm footing for harvest and cultural operations

# Advantages of mulching and composting

- **Mulch** can be defined as material, mainly organic, that is used for placement on the soil surface as a protective cover (cereal straw, wood chippings, etc.)
- The use of mulch offers a number of potential benefits including improved soil moisture retention, weed suppression and reduced topsoil temperature variation and erosion
- **Compost** is organic material undergone to controlled biological and chemical decomposition resulting in a stable substance, slowing releasing carbon and nutrients
- Compost is applied either to the topsoil or incorporated into the subsoil as a conditioner
- you can use compost as mulch but you cannot use mulch as compost

# Advantages of mulching and composting

## MULCH IMPROVES THE PHYSICAL SOIL PROPERTIES

| Potential benefits of mulch | Reason for benefit |
|---|---|
| Improved soil water retention and water use efficiency / less irrigation requirements | Reduces solar radiation and wind speed at the soil surface, thereby reducing water loss through evaporation. Additional increases in organic matter through decomposition, improves soil structure and hence, soil water storage, aeration and drainage. |
| Reduced weed growth / less herbicide requirements | Suppresses the emergence and growth of weeds. Weed suppression increases as the thickness of the layer increases. |
| Reduced fluctuation in topsoil temperature / less heat damage and vine stress | Buffers changes in topsoil temperature and radiation, thereby promoting a more even temperature regime for root survival and fruit ripening. Darker products generally heat up more than lighter products. |
| Reduced soil and nutrient loss / less vineyard inputs | Protects topsoil from the direct impact of rain and wind, thereby reducing erosion and land degradation. |

## COMPOST IMPROVES DIRECTLY THE BIOLOGICAL SOIL PROPERTIES AND, INDIRECTLY, ALL THE OTHERS

| Potential benefits of compost | Reason for benefit |
|---|---|
| Improved soil health and vine performance / less vineyard inputs | Under suitable environmental conditions, increases topsoil organic matter and humus levels with subsequent improvements in soil physical, chemical and biological properties. Benefits include improved soil aggregation and structure, water infiltration and aeration, water and nutrient holding capacity and soil organism population, diversity and activity. Micro-organism activity in the rhizosphere (area immediately surrounding roots) is particularly beneficial. |
| Improved soil fertility / less fertiliser requirements | Contains nutrients (particularly N, P, K) present in both inorganic and organic forms. Inorganic nutrients become available immediately, while organic nutrients are released slowly over time as material undergoes further microbial decomposition. The decomposition rate of organic matter and subsequent release of nutrients is determined by climate, soil types and management practices. |
| Reduced pests and diseases issues / less chemical inputs and reduced risk of crop loss | Increases the population, diversity and activity of beneficial soil organisms which reduces the risk of pathogen growth and may also increase vine resistance to diseases. |

# The management of pruning residues in the frame of the orchard soil improvement

Sustainable Soil Conditions and Pruning Removing from Vineyards

# Cover cropping

# Mulching and no-tillage

# Models of circular economy

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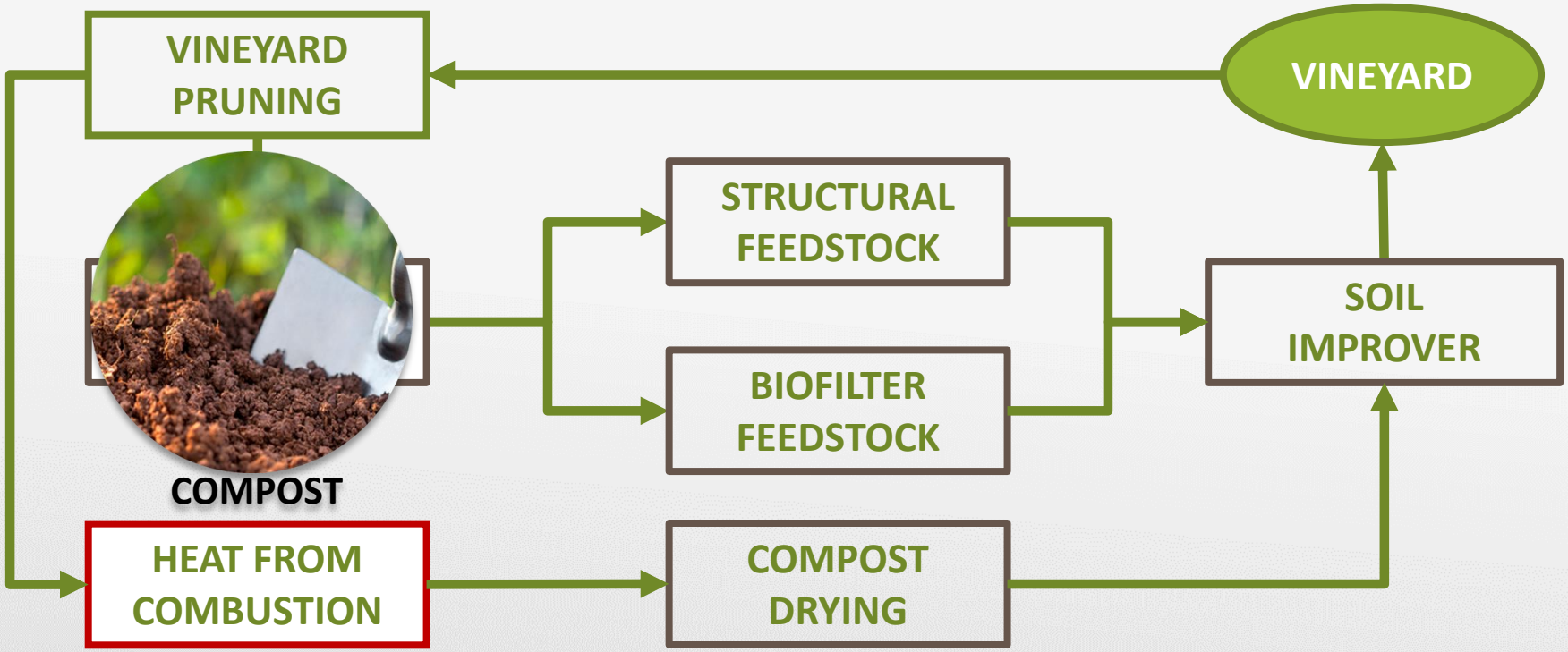
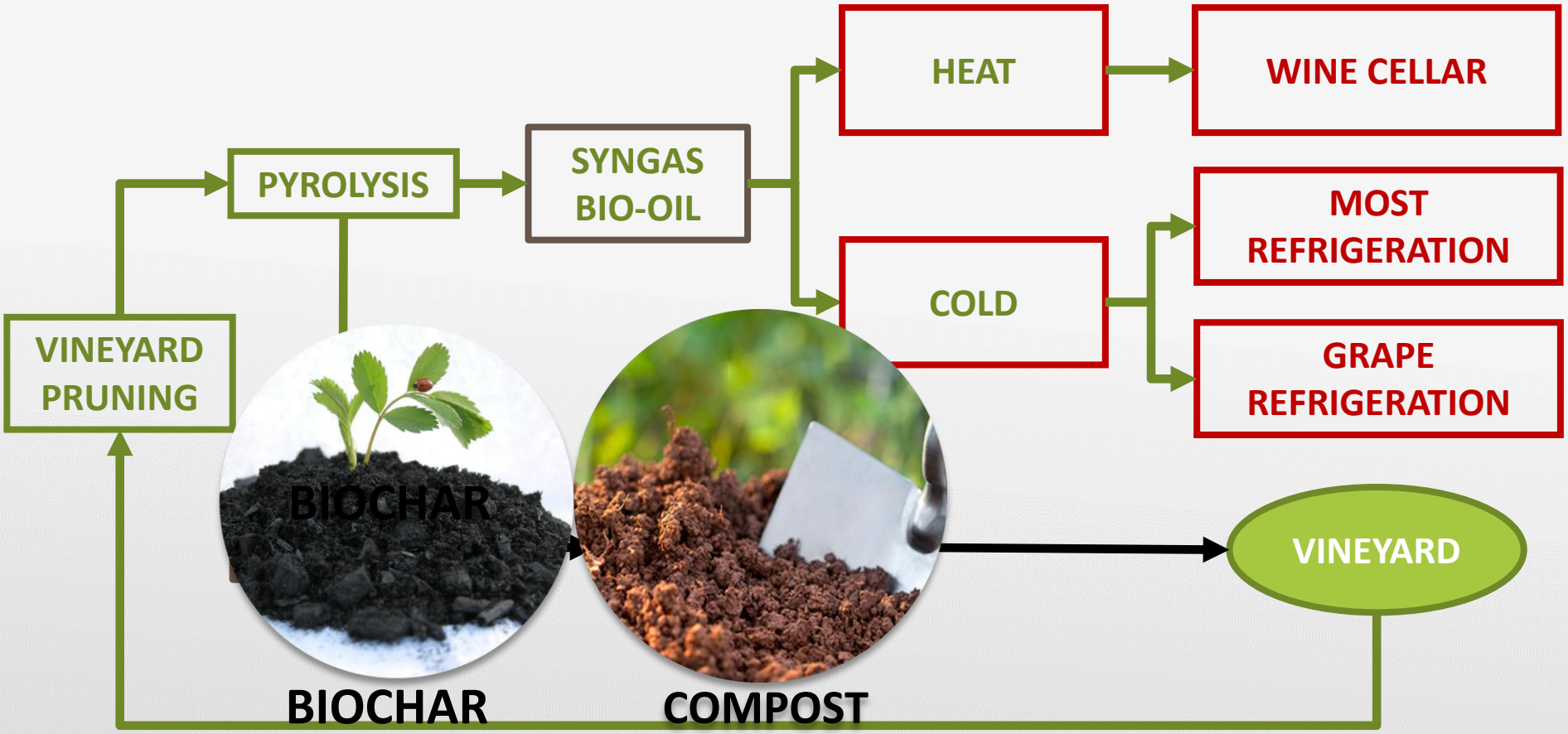
ORGANIZZAZIONE DI PRODUTTORI

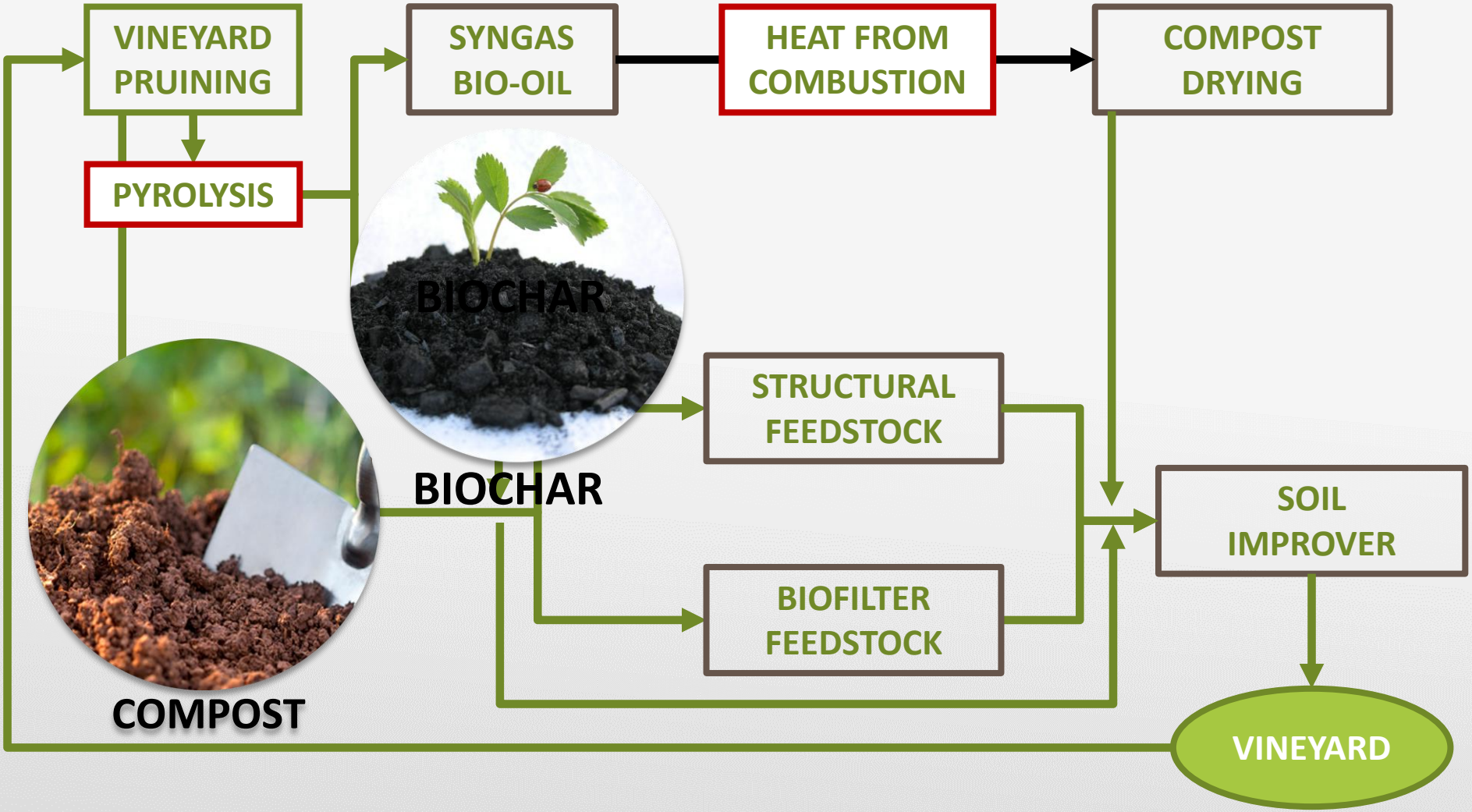
# A model of circular economy (1)



# A model of circular economy (2)



# A model of circular economy (3)



# An operational group is born

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STAR FacilityCentre

TERSAN PUGLIA
I COMPOSTATORI. DA SEMPRE.

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# THANK YOU VERY MUCH FOR YOUR ATTENTION