Review Report on Soil Fertility Improvement Scheme

ORGANIKO LIFE+ PROJECT

Revamping organic farming and its products in the context of climate change mitigation strategies

Type of deliverable: Report

Partner: Agricultural Research Institute

Author: Michalis Omirou

Contributors: Dionysia Fasoula, Panagiotis Dalias

Table of Contents

Executive summary

Σκοπός

Στόχος του παραδοτέου είναι παροχή λεπτομερών πληροφοριών για τις στρατηγικές διαχείρισης της γονιμότητας του εδάφους στην βιολογική γεωργία στα πλαίσια της δράσης C1. Συγκεκριμένα τα παραδοτέα “Review Report of Soil Fertility Improvement Scheme” και “Soil Fertility Manual for each crop” συνενώθηκαν για σκοπούς συνοχής.

Αντίκτυπος

Για την ολοκλήρωση της έκθεσης, πραγματοποιηθήκε ανασκόπηση όλων των διαθέσιμων μεθόδων καθώς επίσης και μελετών ανοργανοποίησης διαφόρων τύπων κοπριάς που έγιναν στα πλαίσια του έργου. Στο παραδοτέο γίνεται εκτενής αναφορά για τις πρακτικές που μπορούν να εφαρμοστούν για τη βελτίωση της γονιμότητας του εδάφους.

Αποτελέσματα

Στη βιολογική γεωργία η βελτίωση της γονιμότητας των εδαφών είναι καθοριστικής σημασίας για το λόγο αυτό και οι καλλιεργητικές πρακτικές που εφαρμόζονται θα πρέπει να βελτιώνουν τις φυσικοχημικές ιδιότητες καθώς και την βιολογική δραστηριότητα των εδαφών έτσι ώστε να βελτιστοποιηθούν οι αποδόσεις και η ποιότητα των παραγόμενων προϊόντων. Η οργανική ουσία των εδαφών είναι ένας από τους σημαντικότερους συντελεστές παραγωγής στη βιολογική γεωργία και είναι το προϊόν αποσύνθεσης των οργανικών εισροών όπως κοπριές, κομπόστες, χλωρή λίπανση από την μικροβιακή κοινότητα των εδαφών. Η χρήση οργανικών υλικών παρέχει στο σύστημα επιπλέον ποσότητα άνθρακα και οργανικής ύλης.

Συμπεράσματα

Η ποιότητα και η ποσότητα των εισροών οργανικής ουσίας στα βιολογικά συστήματα παραγωγής παρουσίαζουν τεράστια παραλλακτικότητα και για την επίτευξη των στόχων που αφορούν τη θρέψη των φυτών, πρέπει η εφαρμογή τους να βελτιστοποιηθεί.

Purpose

The aim of the deliverable is to provide detailed information on soil fertility management schemes and practices in organic farming under Action C1. In particular, “Review Report of Soil Fertility Improvement Scheme” and “Soil Fertility Manual for each crop” have been brought together for consistency purposes.

Outcome

For the completion of the deliverable, we reviewed all available soil fertility management practices in Cyprus as well as N mineralization studies on different types and maturity stage manures that can be included as inputs in organic farming systems. The measurements were performed in the framework of ORGANIKO project. Different management practices are extensively discussed.

Results

In organic farming systems, improving soil fertility is fundamental and soil management practices should enhance the chemical, physical and biological properties of the soil in order to optimise crop yields and quality. Organic matter is a key component of an organic farming system, and is the product of plant residues or manure decomposition by soil microbial and fauna community. The use of organic amendments like manures and composts are providing the system adequate C and organic matter. However the quality and the quantity of the organic amendments vary greatly and much research is needed to optimize organic inputs management in organic farming systems

Conclusion

Our finding denotes that it is essential to evaluate how different practices like tillage interacts positively with the soil microbial communities and organic amendments also with GHG emissions.

Introduction

In areas where water availability can support agriculture, soil is the most important resource which determines the productivity of all agricultural systems. This ability is called soil fertility and is defined as the ability of th a soil to sustain plant growth. In organic farming systems, improving soil fertility is fundamental and soil management practices should enhance the chemical, physical and biological properties of the soil in order to optimise crop yields and quality. This report presents the current practices that are implemented in organic farming and which are the main factors that contribute to soil quality and the ways that a farmer can implement in order to enhance soil fertility in organic farming systems.

The significance of soil organic matter

Organic matter is a key component of an organic farming system, and is the product of plant residues or manure decomposition by soil microbial and fauna community. This long-term process eventually leads to the formation of stable forms of organic substances called humus which constitute 70 to 80% of the organic matter found in soils. This part of soil organic carbon is crucial for climate change since through this process carbon sequestrates and soil stores carbon for years. The remaining particulate organic matter is composed of an easily degradable material and is usually derived from newly added plant residues or animal wastes. This part of soil organic matter is the most important in terms of plant nutrition and soil biological activity since it is the nutrient pool supporting plant growht and and creating favorable environment for soil microorganisms and fauna.

The type of organic matter that is introduced soil has a detrimental effect on nutrient cycling. For example plant residues that are high in carbon (C) and low in nitrogen (N) such as barley straw and its post harvest residues decompose slowly and are efficient residues for the production of humic substances. On the contrary, legume biomass that is usually incorporated into the soil, has low C content and high levels of N, decomposed rapidly, producing much less humic substances. This

example clearly shows that simple soil management practices have a great impact on soil ability to provide available for plants and microbes nutrients. Besides its significant role of nutrients supply, organic matter improves specific chemical and physical properties of the soil making its build up crucial for sustainable and low input agriculture. For example, cation exchange capacity (CEC) is an important soil fertility property and is the ability of the soil to hold exchangeable cations like NH4+, Ca, Mg and K. Organic matter has a significant contribution of soil CEC and is acounted to from 20 to 70% depending on the amount of organic matter of the soil. Thus increase of organic matter of a soil it is expected to improve its CEC. Soil aggregation is highly correlated with soil organic matter. Soil aggregates improve soil structure and increases soil water holding capacity. This physical property of the soil is extremely important in semi-arid regions, where water availability is a crucial factor especially for rainfed crops like barley. Small changes in these parameters through organic matter provide favorable habitat for soil microbes and fauna which in turn are significant biomarkers for a healthy soil.

Management practices improving soil fertility

Soils under organic farming schemes are systematically receive organic inputs and are typically differ substantianly from soils where conventional farming is implemented. However this trend in semi-arid regions is variable since the microbiological processes controling organic matter fate in soils are water and temperature depended. The following toolbox is available through organic farming legislation but this is not exhaustive and should be site-specific taking into account the needs of the farmer and the environmental conditions.

Crop rotations and green manuring

A well designed crop rotation scheme includes species which are providing a significant portion of income for the farmer and species which are supporting soil health and soil fertility. The use of legumes as green manures is a usefull strategy in rainfed crops for increasing short-term soil organic matter which in turns increasing soil microbial activity. In addition, the use of green manures enhance carbon storage and improve nutrient and water use efficiency of the system. The annual water

balance in a field where green manures have been included is expected to be improved compared to fields grown under fallow or monoculture conditions. The increase of short term carbon in soils could be also serve as an alternative mitigation measure for GHG emissions through carbon sequestration.

The «key» factor in green manure and in general plant residues usage to cover crop nitrogen requirements and the increase of soil carbon is the amount of produced biomass. In rainfed crops, besides legumes, brassicaceae could be used as an alternative source of cover crops. The use of Brassica species could be beneficial especially during conversion period or when soil-born pathogens are present. During soil incorporation, tissue disruption results in the formation of isothiocyanates, which are compounds with increased antimicrobial activity.

Under Cyprus conditions, the use of vetch as a winter cover crop provides a substantial amount of nitrogen for barley production. The amount of vetch biomass produced and incorporated into the soil depends on water availability and ranged between 4000 to 8000 kg/ha. So far no alternatives to vetch have been proposed for the farmers. For example intercropping triticalle or rye with vetch could also be used. Cover crop mixtures are gaining wider adoption worldwide but their usage under semi-arid conditions is not well understood.

In perrenial crops like apples, floor managenment is essential to maintain the sustainability of the system. In organic apple orchards, no cover crops are included in the system and no measures are taken in order to control weeds besides tillage practices. Extensive tillage has been shown to enhcance GHG emissions and soil organic matter decomposition. Cover crops and pruning residues management in apple orchards could be used as alternatives in order to create favorable conditions for soil carbon build up, to impove nutrient management and short term soil water storage and weed suppression.

Organic amendments

Farmyard manures and compost are the main organic inputs that are used in organic farming systems in order to cover the crop nutrient requirements. However, their

nutritive value vary significantly. For example we found a considerable variation among different types of manures and this had an impact on their mineralization potential (Table 1).

	N%			
Maturation time (months)	Goats	Cows	Pigs	Poultry
0*	1.45	1.98	2.02	3.89
3	2.26	2.02	2.09	5.11
6	1.48	1.06	2.04	5.08
9	2.51	1.99	2.30	2.55

In organic amendments not only nutrient content varies but also carbon and is ranging from 20 to 40 percent on a dry weight basis and this is the reason why the farmer should know the nutritive value of the organic inputs through chemical analysis. Usually, organic farmers in Cyprus are adding 25 to 30 tons/ha composts or farmyard manures every 2 or 3 years. However they never know the precise amount of nutrients or carbon that is added into the system. The significance of organic inputs relies in an environmental prespective relies on the fact that through their application significant amounts of carbon are incorporated into the soil. Organic carbon addition in the soil increases water infiltration, improve soil tilth and lowers bulk density of the soil. So far in Cyprus no studies have been conducted to monitor changes in key soil fertility indicators or processes that may result from this management practices neither in apple orchards or barley.

Tillage practices

In general tillage has a negative effect on soil organic matter. The disruption of soil aggregates during intensive tillage enhance microbial decomposition of organic matter and its oxidation. This process is detrimental in the long term and this is the reason why intensive tillage led to substantial losses of soil carbon ranging from 30 to 50%. Deep tillage that is usually performed by the farmers before sowing is an energy demanding process leading also to increased GHG emissions. The current practices in Cyprus are not favored systems that leave a substantial amount of

surface plant residues because they enhance nitrogen immobilization conditions. For example, barley residues found after hurrow tillage in farrows results in stand loss and delayed emergence of the subsequent crop probably due to phytotoxicity effects. These residues also cause a significant immbilization of nitrogen and defficiency symptoms are visible very early in the growing season.

For apple orchards the situation is different and it seems that no tillage conditions might increase yields and improve fruit quality. Mowing of weeds and the systematic inclusion of cover crops in apple managenment practices it is expected to minimized GHG emissions and the maintain the nutrient cycling in orchards ecosystems. So far no data are available regarding the impact of these practices on soil fertility key parameters and how these are related to soil fertility indicators.

Conclusion

Organic farming systems rely on soil fertility and the maintainance of organic matter reservoirs is essential to secure long-term sustainability of the agroecosystem. The use of organic amendments like manures and composts are providing the system adequate C and organic matter. However the quality and the quantity of the organic amendments vary greatly and much research is needed to optimize organic inputs management in organic farming systems It is also essential to evaluate how different practices like tillage interacts positively with the soil microbial communities and organic amendments also with GHG emissions.