INFLUENCE OF OLIVE PRUNING USE FOR FEEDSTOCKING A SUSTAINABLE RURAL BIO-REFINERY

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Introduction

Spanish olive groves cover an area of 2 million hectares, of which a million and a half are located in Andalusia. The high quality of oil and olives produced has enabled the development of a powerful agro-food industry. Olive cultivation under Mediteranean climates, presents as one of the main issues, low fertility and high soil erosion. The use of cover crops in the lanes between olive trees as sustainable agricultural strategy has also been introduced thorough spontaneous weeds, planting specific cover species and using olive pruning residues as inert soil cover. The new philosophy of Circular Economy Package, recently adopted by European Commission, promotes innovative industrial processes, as local bio-refineries, where the waste of one company or process can become the resource of another company.

Materials and methods

Biomass waste from pruning olive trees has traditionally been burned in the field. However, these residues from olive pruning can follow alternative paths: 1a) as a protective cover for the olive grove after grinding, improving the organic carbon and fertility of the soil increasing the amount of C that would be sequestrated into the soil. Experimental assay data has been use in calculations. 1b) introduction of inert cover in agriculture management involves the elimination of ploughing and no till conservation agriculture practice which helps to sequester carbon. IPCC methodology has been used. 2) as an energy source for the production of heat and electricity and 3) as a substrate for local bio-refineries producing biofuels and/or bio-products (project data no available yet). The study analyses what is/are the better ways to use olive residue in relation to its GHG emissions and their contribution to climate change.

GHG emissions analysed in the systems are those referred to the stages that are going to be modified when agricultural management system is changed.

Results and Discussion

Reference system – residues burning

Dissagregated GHG emissions

Activities	*kg CO_2/ha*	*kg CH_4/ha*	*kg N_2O/ha*	*kg CO_{2eq}/ha*
In situ burning (CO_2 biogenic)	2721,62			2721,62
Herbicide production	8,40	0,02	1,43E-03	9,39
Herbicide application on field	7,84	0,01	2,78E-04	8,14
Tillage	36,58	0,04	1,30E-03	37,98
N_2O emissions from olive pruning residues leave on field			2,25E-03	0,60

Olive pruning cover system

Dissagregated GHG emissions

Activities	*kg CO_2/ha*	*kg CH_4/ha*	*kg N_2O/ha*	*kg CO_{2eq}/ha*
Wood waste chopping	17,22	0,02	0,00	17,88
Additional mineral fertiliser production (50 kg/ha)	176,70	0,34	0,41	295,22
Additional mineral fertiliser production (25 kg/ha)	88,35	0,17	0,21	147,61
Mineral fertilizer application	5,21	0,01	0,0002	5,41
Organic fertilizer application	27,97	0,03	0,0010	29,03
N2O emissions from fertilizer application (mineral 50 kg/ha)			1,04	275,88
N2O emissions from fertilizer application (mineral 25 kg/ha)			0,52	137,94
N2O emissions from fertilizer application (organic 50 kg/ha)			1,12	296,71
N2O emissions from fertilizer application (organic 25 kg/ha)			0,56	148,35
N2O emissions from olive pruning residues as cover			0,113	29.84
Carbon oxidation olive residues on field	318.27			318.27
Soil organic carbon sequestration	654,06			654,06

Avoided emissions using olive pruning versus fossil heat and power production chains

Heat

Balance	*kgCO_2/ha*	*kgCH_4/ha*	*kgN_2O/ha*	*kgCO_{2eq}/ha*
Emissions from heat production using natural gas	1942,64	6,11	0,06	2130,14
Emissions from heat using olive pruning				
Biomass transport	7,72	0,01	7,47E-05	7,93
Pelletizing	59,60	0,11	4,31E-03	59,60
Pellets transport	18,53	0,02	1,79E-04	19,04
Emissions from boiler use ($CH_4$and N_2O)				7,61
Avoided emissions				2035,97

Electricity

Balance	*kgCO_2/ha*	*kgCH_4/ha*	*kgN_2O/ha*	*kgCO_{2eq}/ha*
Emissions from electricity mix	7234,06	13,87	0,56	7771,39
Emissions from prunning transport	7,72	0,01	7,47E-05	7,93
Avoided emissions				7763,45

C stock sequestration- conservation management practices

Calculated e_{sca} for conservation agriculture scenarios by climate and soil type in Andalusia (kg CO_{2eq}/ha).

Climate type	*Soil type*	*Scenarios*	
		Low no till	*High without manure no till*
Warm Temperate Dry	High Activity Clay Soils	661,4	1350,6
Warm Temperate Dry	Sandy Soils	330,7	675,3
Tropical Dry	High Activity Clay Soils	1124,3	1857,4

Comparative results along scenarios

		Kg CO_{2eq}/ha				
Residues burning of field	*Total emissions*	2777.7				
			Mineral 50	Mineral 25	Organic 50	Organic 25
Olive pruning cover system	*Total emissions*		942,50	656,95	691,73	543,38
	Organic carbon sequestration		*654,06*	*654,06*	*654,06*	*654,06*
	Balance		*288,44*	*2,89*	*37,67*	*-110,68*
			Low no till	High without manure no till		
Improved management practices	*Carbon stock sequestration*		From 330 to 1124	From 675 to 1857		
Olive pruning heat	*Avoided emissions*	*2035.97*				
Olive pruning electricity	*Avoided emissions*	*7763.45*				

Competition for olive pruning residues for soil protection in agriculture and for energy or biorefineries purposes will be common in near future. Circular Economy Strategy implementation will convert residues into raw materials, where GHG behaviour of the different possible options of utilisation, will be crucial to select the best chain from an environmental point of view.

Sustainability strategy on conservation agriculture goes in the line of no disturb the top soil profile and increase organic matter to improve fertility. In this context significate carbon sequestration is verified both using modelling approach as IPCC methodology and accounting experimental data from soil carbon balance joint to agricultural activities needed when olive pruning is employed as protective soil cover. Additional research on wide experimental assays is needed to account global figures, which would help to determine what to do with olive pruning residues.

One of the challenges in actual society to combat climate change is eliminating the burning of coal, oil and, eventually, natural gas. Energy valorisation of this olive residues replacing energy consumption from Spanish electrical mix avoids the release of important quantities of GHG emissions.

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