

UNIVERSITY OF ALGARVE

Polo MED - Mediterranean Institute for Agriculture, Environment and Development

CROP ACCOUNTS REPORT

**Territorial Program +SOLO +VIDA: Adaptation and Mitigation of Climate
Change and Fight against Desertification**

**Faro
01/2024**

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Change and Fight against Desertification**

Alessandra Rodrigues

Advisor: Maria de Belém F. da Silva Costa Freitas

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Summary

The purpose of this report is to present the general crop accounts (oats and lupine) and general investment costs (permanent pasture, small woodlots, watercourse restoration and regeneration protectors) developed in the context of the Territorial Program +SOLO +VIDA: Adaptation and Mitigation of Climate Change and Fight against Desertification. The program in question is a pilot project whose development takes place in an area covering 94 hectares of the Guadiana Valley Natural Park. Crop account is an analysis method that allows the evaluation of a given crop from an economic point of view, as it results in a utility map that offers information of technical-economic origin that allows the evaluation and calculation of a series of economic indicators. For the development of the crop accounts and for investment costs, a methodology was applied that resulted from the union of scientific procedures and some of the principles of the Scientific Theory of Administration, which is included within the Classical Approach. This method was developed with the aim of better dividing and rationalizing the activities that integrate the implemented technologies and actions. Thus, analyzing and studying the operations developed, considering their execution time, and their divisions, a general picture was created that indicates how each technology develops and what would be the average time required for the operations to be executed, which allowed the development of crop and investment accounts.

Key words: climate change, crop account, desertification, mitigation, Vale do Guadiana.

Abstract

O presente relatório tem por objetivo apresentar as contas de cultura gerais (aveia e tremocilha) e custos de investimento gerais (pastagem permanente, bosquetes, restauro de linha de água, protetores de regeneração) que foram desenvolvidas no contexto do Programa Territorial +SOLO +VIDA: Adaptação e Mitigação das Alterações Climáticas e Luta contra a Desertificação. O programa em questão é um projeto piloto desenvolvido numa área que abrange 94 hectares do Parque Natural do Vale do Guadiana. A conta de cultura é um método de análise que permite a avaliação de uma dada cultura do ponto de vista económico apresentando um mapa utilitário que oferece informações de origem técnico-económicas que permitem avaliar e calcular uma série de indicadores económicos. Para o desenvolvimento das referidas contas de cultura e também para os custos de investimento aplicou-se uma metodologia que resultou da união dos procedimentos científicos e de alguns dos princípios da Teoria Científica da Administração, incluída dentro da Abordagem Clássica. Tal método foi elaborado com o intuito de melhor dividir e racionalizar as atividades que integram os modos de produção e ações implementados. Assim analisando e estudando as operações desenvolvidas, considerando seu tempo de execução, e suas divisões, criou-se um quadro geral que indica como cada tecnologia de produção se desenvolve e qual seria o tempo médio necessário para que as operações fossem executadas o que permitiu o desenvolvimento das contas de cultura e investimento.

Palavras – chaves: alterações climáticas, conta de cultura, desertificação, mitigação, Vale do Guadiana.

1. Introduction

This report aims to present the general cultural accounts that were developed in the context of the Territorial Program +SOLO +VIDA: Adaptation and Mitigation of Climate Change and Fight against Desertification, which is a pilot project developed in an area covering 94 hectares of the Parque Natural do Vale do Guadiana, and seeks to establish “a participatory governance model that includes the design, implementation and evaluation of a territorial program based on cooperation and sharing in this territory vulnerable to desertification” (<https://maissolomaisvida.pt/>, consulted on nov. 13, 2023). The program results from an initiative by the Associação de Defesa do Património de Mértola (ADPM), in partnership with the Cooperativa Agrícola do Guadiana, Natural Business Intelligence, the University of Algarve and International Development Norway and is part of a group of four projects approved by the EEAGrants Fund in Portugal that aim to prepare for extreme weather conditions and manage risks in the context of climate change. The program aims to train local producers to adopt 10 good agricultural and livestock practices to combat soil degradation (https://maissolomaisvida.pt/wp-content/uploads/2022/09/Triptico_MaisSolo_MaisVida_AF.pdf, consulted on November 13th. 2023).

The set of 10 measures of good agricultural and livestock practices, which characterize the program, will be detailed below: functional biodiversity, erosion control and increased infiltration, circular economy and carbon farming, adaptive grazing management, soil improvement, improvement of the Mediterranean mosaic, permanent pastures, promotion of natural regeneration, restoration of water lines and retention and conservation of water in the landscape. In the context of the program, and in the particular case of the Vale do Guadiana Natural Park, seven actions were implemented that aim to meet six of the measures that make up the program:

- Erosion control and increased infiltration: implementation of small woodlets (using protectors in the initial phase) and annual cover crops (oats) without soil mobilization;
- Soil improvement: implementation of an annual soil-improving crop (lupine);
- Permanent pastures: implementation of permanent culture (pasture) without soil mobilization (direct seeding) and with soil mobilization (conventional tillage);
- Promotion of natural regeneration: installation of regeneration protectors (galvanized steel and cactus type);
- Reforestation of watercourse: restoration of the vegetation that accompanies the water lines (using protectors in the initial phase);

- Retention and conservation of water in the landscape: installation of artificial floating islands¹.

The objective of this report is to present the analysis of the activities carried out during the program and the crop accounts and general investment costs. To make this result possible, the actions implemented, and the operations carried out in the field during the program were analyzed. This work resulted in two general crop accounts: one for oats (*Avena sativa*) in a direct seeding system and another for lupine (*Lupinus luteus*) also in a direct seeding system. Furthermore, using a similar methodology, investment costs were calculated for the installation of permanent pasture (conventional tillage system and direct seeding system), the installation of small woodlots, the restoration of the watercourse and the installation of regeneration protectors (galvanized and cactus).

The crop account is an analysis method that allows the evaluation of a given culture from an economic point of view, resulting in a utility map. Investment costs are those whose objective is to generate future benefits, whether economic or, also in this case, environmental. The crop accounts, and also the investment costs, relating to the project, were prepared based on the actions implemented within the properties² registered in the program using data provided by the Associação de Defesa do Património de Mértola (ADPM).

Next, the methodology used to analyze the data will be presented, and the operations carried out during the actions will be delimited. The producers enrolled in the program and the actions implemented on their respective properties will be indicated, as well as tractors and implements used during agricultural operations, and other pertinent information that culminated in the development of crop and investment cost accounts (presented in the annexes), mentioned previously.

2. Material and methods

Gil, apud Silva and Menezes (2001, p. 25), states that scientific investigation depends on a set of intellectual and technical procedures so that its objectives are

¹In particular, in the case of the artificial floating islands, one of the several actions implemented, the entire production and installation process of the structures, was carried out by the company Islas de Corcho Natural (<https://www.islasdecorchonatural.es/>) therefore, this operation did not generate a crop or investment account.

²They consist of agricultural farms located in a protected area (Parque Natural do Vale do Guadiana) that covers the municipalities of Mértola and Serpa.

achieved. It is these procedures, collectively called the scientific method, that guide the development of the work in addition to explaining the line and research tools used. In this sense, therefore, the process to organize the data, delimit the processes and generate the data necessary to develop the crop accounts, was based on the scientific method seeking to create a simplified methodological architecture. To this end, after initial evaluation of the data provided by the ADPM, an attempt was made, through the union of scientific procedures and some of the principles of the Scientific Theory of Administration, which is included within the Classical Approach, to develop the aforementioned methodology.

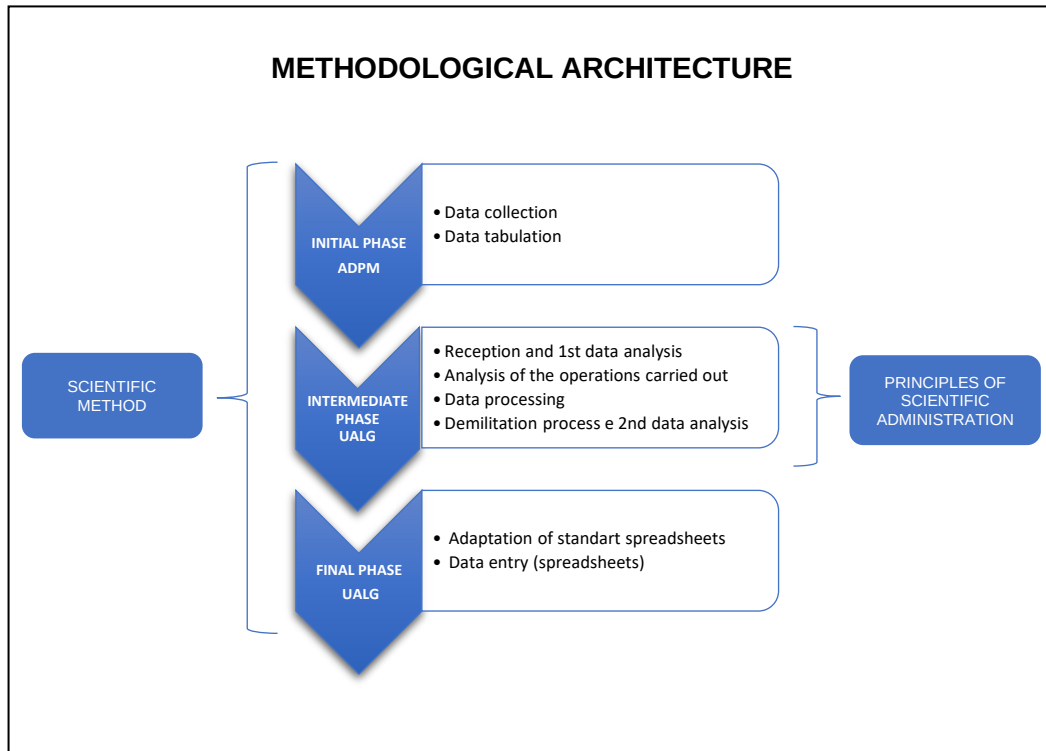
Considering the scientific method and based on its stages, which include observation, questioning, formulation of the hypothesis, experimentation and finally the conclusion, we sought to understand what would be the best way to develop the methodology that guides the process of data analysis and processing. After the initial analysis of the data and operations carried out in the field, it was decided to use some of the principles of the Scientific Theory of Administration³ to better divide and rationalize the activities that integrate production technologies and implemented actions. In this way, analyzing and studying the operations developed, considering their execution time, and their divisions, based on aspects of the Rational Work Organization⁴ (work analysis and study of times and movements, division of labor and worker specialization, standardization of methods and machines, design of positions and tasks) a general framework was created that indicates how each production technology and action implemented develops and what would be the average time needed for the operations to be executed.

Below is the diagram of the methodological architecture (table 1) that guided the entire development work:

³This theory was initially developed by Frederick W. Taylor, in the United States, and is based on the use of scientific methods in operational work with the aim of increasing industrial efficiency, avoiding waste and losses, in addition to increasing production (Chiavenato, 2004, p. 41).

⁴The Rational Work Organization constitutes a scientific analysis, associated with an accurate study of times and movements, which allows us to glimpse the fastest method and most appropriate instrument to carry out a given task/operation (Chiavenato, 2004, p. 44).

Table 1



As can be seen in the diagram above, the process, which was divided into three major phases, with the indication of each responsible institution, is composed of the steps detailed below:

- Data collection: data was collected in the field, by technicians who are part of ADPM's staff, when carrying out the operations (conventional and direct seeding, implementation of woodlets, restoration of the water line and installation of regeneration protectors).
- Data tabulation: the data was organized in a spreadsheet format, by the responsible technician, according to the operations carried out (as mentioned in the previous item) and sent to UAlg.
- Reception and 1st data analysis: upon receipt, the data was still analyzed in the format prepared by the responsible ADPM technician.
- Analysis of the operations carried out: at this stage, the operations carried out during sowing, and other actions implemented, were analyzed to better understand the dynamics of the fieldwork.
- Data processing: at this stage, the data previously provided by ADPM were reevaluated and reorganized in the specific format that best corresponded to the needs. Thus, the data relating to the required labor time (differentiated,

undifferentiated and technical), the quantity and type of seeds used, the implements and tractors and other materials used were reorganized at this stage. The values referring to the cost of tractors, implements, and other materials were also collected during this stage.

- Delimitation process and Second data analysis: at this stage the processes were delimited, and the time required to carry out each operation was determined, so that it would later be possible to establish the order of operations and calculate the average time required to carry out each one of them. This action was carried out so that it would later be possible to adapt and feed the spreadsheets with the information generated.
- Adaptation of standard spreadsheets: at this stage, the spreadsheets were adapted to the model originally adopted by the Direção Regional de Agricultura e Pescas do Algarve, considering the needs of each production technology⁵ and implementation actions in question, taking into account the delimitation of processes carried out in the previous stage.
- Data entry (spreadsheet): At this stage, the previously collected and processed data was inserted into the spreadsheets.

3. Registered producers

The program has 18 registered producers, however, according to Maria Bastidas, coordinator of the program +SOLO +VIDA and technician at the ADPM, some farms could not be considered because they are located outside the Parque and ZPE Vale do Guadiana. The project coordinator also warned that, if there is no favorable opinion from the competent authorities, the actions cannot be implemented on properties located outside the delimited area. Below is the list (table 2):

⁵In this context, for each agricultural crop, an account plan is drawn up according to its specific needs and conditions. This implies that each stage of the operations carried out during the actions, and others more in accordance with specific needs, must be included in the agricultural chart of accounts when necessary.

Table 2: List of producers

RURAL PRODUCERS PARTICIPATING IN THE PROGRAM	
1	ADPM - Barranco do Anho Monte do Vento
2	Ana Valente : Rochinha Branca
3	António Mateus : Mosteiro
4	Carlos Mestre: Cumeada Vicente
5	Fábio Cavaco : Vale Redondo Alves
6	Guilherme Rosa: Monte dos Moitas
7	Helena Manuel - Soc. MONVO : Herdade dos Lagos Montinho
8	Jacinto Palma : Corujinha Navarro
9	João Madeira : Ovil Corte Gafo de Cima
10	Joaquim C. Marques : Horta de D. José
11	Joaquim Falé : Vale do Linho
12	Luís Candeias : Herdade do Corcho
13	Manuel Candeias : Malhada dos Cachopos
14	Manuel Palma ('Palminha') : Almarginho Quinta
15	Mariana Palma : Vale Pimpim Corte Gafo de Baixo
16	Nídia Monteiro : Monte da Balança
17	Pedro Cupertino : Demengas de Baixo
18	Tiago Palma : Herdade do Pulo do Lobo

To develop the report and prepare spreadsheets, and to preserve information regarding producers, it was decided to replace their names with letters. It is also necessary to clarify that only producers who implemented actions designated by the +SOLO +VIDA Program were considered, as can be seen in table 3:

Table 3: Implemented actions

RURAL PRODUCERS	IMPLEMENTED ACTIONS							
	SMALL WOODLETS	ARTIFICIAL FLOATING ISLANDS	PERMANENT PASTURES - CONVENTIONAL TILLAGE	PERMANENT PASTURES - DIRECT SEEDING	REGENERATION PROTECTORS	WATERCOURSE REFORESTATION	ANNUAL SOIL-IMPROVING CROP (LUPINE) DIRECT SEEDING	ANNUAL COVER CROP SEEDING (OATS) DIRECT SEEDING
Producer C		X	X		X	X		
Producer D	X	X	X					
Producer E	X	X			X			
Producer F					X			
Producer G		X				X		
Producer H				X				
Producer J				X				
Producer L		X			X			X
Producer M				X	X			
Producer N			X				X	
Producer O					X			
Producer P		X		X	X			

4. Tractors and Implements

Below are the tables showing the machines and implements⁶ used during the execution of actions. Observations relating to particularities that arose during the preparation of the crops and investment accounts are also included. To develop the spreadsheets, regarding the cost of tractors and implements, online research was carried out on specialized websites. Below the list of tractors (table 4) and implements (table 5) used will be presented, and immediately after the model of tractor and implements that were actually chosen for the development of the basic spreadsheets.

Table 4: Tractor models used

RURAL PRODUCERS	TRACTORS	
	MODEL	POWER (hp)
Producer C	NewHolland T6	165
Producer D	NewHolland T6	115
Producer E	Retro Mini-giratória	110
Producer F **		
Producer G	New Holland T90	90
Producer H ***		
Producer J ***		
Producer L ***		
Producer M***		
Producer N	NewHolland tk4060	100
	NewHolland 80-66S	80
Producer O **		
Producer P	Fiat 70-66	70
	Fendt 818	190
AVERAGE (hp - POWER)		115

**No tractors were used in the actions implemented in the areas belonging to these producers.

*** In the case of these producers, to carry out direct seeding, a 330 hp Deutz-Fahr 9340 tractor and a direct seeder (Amazone brand) were used, however the machine and implement belong to the company contracted to carry out the planting in direct seeding method, therefore, for calculation and comparison purposes, this machine was excluded.

⁶It is necessary to clarify that no tractors and farm implements were used to install regeneration protectors. This is a process carried out manually.

Table 5: Producer implements

RURAL PRODUCERS	IMPLEMENTS WIDTH (METERS)								
	DRILL	BRUSH HOG	SEED AND FERTILIZER SPREADER	FERTILIZER SPREADER	SEED SPREADER	SCARIFIER	DISC HARROW	RIPPER	DIRECT SEEDER
Producer C				18	8	3	2		
Producer D	0,3			14	6	2	2		
Producer E								2,1	
Producer F **									
Producer G		1,2						1,5	
Producer H ***									
Producer J ***									
Producer L ***									
Producer M***									
Producer N			10				2,5		
Producer O **									
Producer P				18					3,5
AVERAGE	0,3	1,2	10	16,7	7	2,5	2,2	1,8	3,5

**No tractors were used in the actions implemented in the areas belonging to these producers.

*** In the case of these producers, to carry out direct seeding, a 330 hp Deutz-Fahr 9340 tractor and a direct seeder (Amazone brand) were used, however the machine and implement in question belong to the company contracted to carry out the planting in direct seeding, therefore, for calculation and comparison purposes, this machine was excluded.

Below is the tractor and implements used in the basic spreadsheets (table 6):

Table 6: Tractor and implements used to prepare the basic spreadsheets

TRACTOR AND IMPLEMENTS - SPREADSHEETS				
IMPLEMENT/TRACTOR	BRAND	WIDTH/ POWER	PRICE	PRICE + IVA (13%)
BRUSH HOG	Maqall	1,25 m	1.859,00 €	2.100,67 €
SEED AND FERTILIZER SPREADER	Centrifugal Spreader Fialho Linha Verde LV FI-880-2E	14 m	4.154,00 €	4.694,02 €
FERTILIZER SPREADER	Spreader Sulky-Burel DX 20	18 m	4.300,00 €	4.859,00 €
SEED SPREADER	Centrifugal Spreader Fialho FI- 70	9 m	2.949,00 €	3.332,37 €
SCARIFIER	Escarifier Agram CHISEL - ED 7	1,7 m	1.423,00 €	1.607,99 €
DISC HARROW	Bomet u 363/1	1,8 m	2.600,00 €	2.938,00 €
RIPPER	Ripper - STP GL2 (2 theet)	1,4 m	0,00 €	2.766,95 €
DIRECT SEEDER	Diretta Corso - 19 lines	3 m	39.500,00 €	44.635,00 €
TRACTOR	New Holland T5 4x4	120 hp	54.000,00 €	61.020,00 €

To choose the machines and implements used to develop the calculations, those that have the capacity to meet the demand of the processes carried out were considered. In the case of the tractor, the producers used several brands and powers; however, to obtain better performance, at a lower cost, it was decided to work with a 120 HP machine that is perfectly capable of towing the tools necessary to carry out the processes. In this sense, we decided to work with a machine (tractor) with intermediate characteristics. On the other hand, in the case of implements, after analyzing the table (table 5), where a calculation was developed considering the average working width of the implements used by producers, the aim in determining those that would be used was to meet the needs.

5. Calculations

The calculations necessary to feed the spreadsheets were carried out considering the information (data and values) made available by ADPM. Therefore, using the information previously provided, the necessary calculations were carried out to generate the relevant information (machine hours worked, labor hours worked, seeds, organic compost, fertilizers, seedlings, pine wood chips, protectors (initial phase),

regeneration protectors, etc.) for carrying out each activity⁷. Below are the spreadsheets used to collect and process the data (tables 7 to 12):

Table 7: Conventional tillage - implementation data

CONVENTIONAL TILLAGE															
RURAL PRODUCER	IMPLEMENTED ACTION	METHOD	LOCAL	AREA (ha)	TRACTOR (Rural operation)	TRACTOR (Brand and model)	MACHINE POWER (hp)	MACHINE WORKING HOURS	TOTAL HOURS (Operation)	TOTAL HOURS (Operation/ha)	LABOR (Type)	WORKING TIME (Hours)	TOTAL (Working time)	TRACTOR DRIVER (Working time)	HOURS (Working time/ha)
Producer N	Permanent pasture	Conventional tillage	Farm N1 & N2	3,5	Land preparation	NewHolland TK4060	100	12	12	3,43	Tractor driver	18,5	19	12	5,29
					Seed and Fertilizer distribution	NewHolland 80-66S	80	2,5	2,5	0,71	Tractor driver	0		3	0,86
					Seed burial	NewHolland TK4060	100	4	4	1,14	Unskilled	0,5		4	0,14
Producer D	Permanent pasture	Conventional tillage	Farm D	2	Land preparation	NewHolland T6	115	4	4	2	Tractor driver	4	11		2
					Fertilizer distribution	NewHolland T6	115	1	3	1,5	Tractor driver	1,5			2
					5	NewHolland T6	115	2			Tractor driver	2,5			
					Seed burial	NewHolland T6	115	3	3	1,5	Tractor driver	3			1,5
Producer C	Permanent pasture	Conventional tillage	Farm C	2	Land preparation	NewHolland T6	165	2,5	4	2	Tractor driver	2,8	10		2,25
					Land preparation	NewHolland T7	165	1,5			Tractor driver	1,7			
					Fertilizer distribution	NewHolland T6	165	0,6	2	1	Tractor driver	1			1,5
					Seed distribution	NewHolland T6	165	1,4			Tractor driver	2			
					Seed burial	NewHolland T6	165	2	2	1	Tractor driver	2,5			1,25

⁷Each activity (mode of cultivation, implementation of grove and watercourse restoration, installation of regeneration protectors, etc.) varies in specific site and management conditions despite consisting of similar and specific steps. In this context, for the development of general spreadsheets (crop accounts/investment costs), a table was considered representing the best development conditions for carrying out such activities.

Table 8: Direct seeding - implementation data

DIRECT SEEDING													
RURAL PRODUCER	IMPLEMENTED ACTION	METHOD	LOCAL	AREA (ha)	TRACTOR (Rural operation)	TRACTOR (Brand and model)	MACHINE POWER (hp)	MACHINE WORKING HOURS (Operation)	TOTAL HOUR (Operation/ha)	LABOR (Type)	WORKING TIME (Hours)	TOTAL (Working time)	HOURS (Working time/ha)
Produtor N	Annual soil-improving crop (lupine)	Direct seeding	Farm N	2	Seeding	Deutz-Fahr 9340	330	2,5	1,25	Tractor driver	2,5	3	1,25
										Unskilled	0,5		0,25
Produtor M	Permanent pasture	Direct seeding	Farm M	2	Seeding	Deutz-Fahr 9340	330	2,5	1,25	Tractor driver	2,5	2,8	1,25
										Unskilled	0,3		0,15
Produtor L	Annual cover crop (oat)	Direct seeding	Farm L1 & L2	3	Seeding	Deutz-Fahr 9340	330	3,5	1,17	Tractor driver	4	5	1,33
										Unskilled	1		0,33
Produtor H	Permanent pasture	Direct seeding	Farm H	1	Seeding	Deutz-Fahr 9340	330	1,5	1,5	Tractor driver	1,5	2	1,5
										Unskilled	0,5		0,5
Produtor J	Permanent pasture	Direct seeding	Farm J1 & J2	1,5	Seeding	Deutz-Fahr 9340	330	1,5	1	Tractor driver	1,5	2	1,00
										Unskilled	0,5		0,33
Produtor P	Permanent pasture	Direct seeding	Farm P	4,7	Fertilizer distribution	Fiat 70-66	70	1	0,21	Tractor driver	5,5	7,5	1,17
					Seeding	Fendt 818	190	3,5	0,74	Unskilled	2		0,43

Table 9: Cost, variety and quantity of seeds used (crop accounts)

SEEDS - CROP ACCOUNTS				
SEEDS	TOTAL QUANTITY (kg)	SEEDS kg/ha	TOTAL COST	COST €/kg
OATS (<i>Avena Sativa</i>)	450	150	381,60 €	0,848 €
LUPINE (<i>Lupinus luteus</i>)	120	60	248,04 €	2,067 €

Table 9.1: Cost and quantity of seeds used (investment costs)

SEEDS - INVESTMENT COSTS				
SEEDS	TOTAL QUANTITY (kg)	SEEDS kg/ha	TOTAL COST	COST €/kg
Pasture mixtures	87,5	25	482,30 €	5,512 €
Pasture mixtures	50	25	275,60 €	5,512 €
Pasture mixtures	55	27,5	303,16 €	5,512 €
Pasture mixtures	20	20	110,24 €	5,512 €
Pasture mixtures	37,5	25	206,70 €	5,512 €
Pasture mixtures	50	25	275,60 €	5,512 €
Pasture mixtures	125	26,596	689,00 €	5,512 €

Table 10: Cost, type and quantity of fertilizers used (crop accounts and investment costs)

FERTILIZERS - USED					
FERTILIZERS	CHEMICAL COMPOSITION	TOTAL QUANTITY (kg)	FERTILIZER kg/ha	TOTAL COST	COST €/kg
Action Plus 6.7.7	6% N 7% P ₂ O ₅ 7% K ₂ O	525	175	227,50 €	0,433 €
Melius FOSnatur 26,5	26,5% P ₂ O ₅ 40% CaO	350	175	159,25 €	0,455 €
Melius FOSnatur 26,5	26,5% P ₂ O ₅ 40% CaO	175	175	79,63 €	0,455 €
Melius FOSnatur 26,5	26,5% P ₂ O ₅ 40% CaO	800	170	364,00 €	0,455 €
Superfosfato 18 %	18% P ₂ O ₅ 28% CaO 30% SO ₃	350	175	162,05 €	0,463 €
Superfosfato 18 %	18% P ₂ O ₅ 28% CaO 30% SO ₃	350	175	162,05 €	0,463 €
Superfosfato 18 %	18% P ₂ O ₅ 28% CaO 30% SO ₃	275	183	127,33 €	0,463 €
Superfosfato 18 %	18% P ₂ O ₅ 28% CaO 30% SO ₃	525	150	243,08 €	0,463 €
Superfosfato 18 %	18% P ₂ O ₅ 28% CaO 30% SO ₃	350	175	162,05 €	0,463 €

Table 11: Data on implementation of small woodlots and watercourse restoration

IMPLEMENTATION: SMALL WOODLOTS AND WATERCOURSE RESTORATION											
RURAL PRODUCER	IMPLEMENTED ACTION	LOCAL	AREA (ha)	RURAL OPERATION	LABOR (Type)	WORKING TIME (Hours)	TOTAL (Working time)	TRACTOR (Operation)	MACHINE POWER (hp)	IMPLEMENT	MACHINE WORKING HOURS
Producer D	Small woodlets	Farm D	0,09	Land preparation	Tractor driver (Farmer)	0,5	0,5	Light tilling	115	Scarifier	0,5
					Tractor driver (Farmer)	3	3	Digging of holes	115	Drill	3
				Planting and Installation of irrigation system	Unskilled	8	16				
					Unskilled	8					
					Technical	8	8				
				Installation of protectors	Unskilled	3,5	7				
					Unskilled	3,5					
				Installation of protectors	Technical	1	2				
					Technical	1					
Producer G	Watercourse Restoration	Farm G	0,3	Land preparation	Tractor driver	6	6	Land clearing	90	Brush hog	6
					Tractor driver	6	6	Tilling	90	Ripper	6
				Digging of holes, Planting, Installation of irrigation system and Installation of protectors	Unskilled	13	26				
					Unskilled	13					
					Technical	7	14				
					Technical	7					
				Mulching and Installation of protectors	Technical	10	20				
					Technical	10					
				Producer E	Small woodlets	Farm E	0,1	Land preparation	Tractor driver	5	5
Technical	5										
Digging of holes and Planting	Unskilled	13	26								
	Unskilled	13									
	Technical	13	13								
Mulching and Installation of protectors	Unskilled	3,5	7								
	Unskilled	3,5									
	Technical	3,5	5,5								
Installation of protectors	Technical	2									
Producer C	Watercourse Restoration	Farm C	0,02	Digging of holes, Planting, Installation of irrigation system, Mulching and Installation of protectors	Unskilled	14,5	29				
					Unskilled	14,5					
					Technical	5	5				
				Installation of protectors	Technical	1	1				

Table 11.1: Additional data implementation of small woodlets and watercourse restoration

SMALL WOODLETS AND WATERCOURSE RESTORATION															
RURAL PRODUCER	CULTURAL OPERATION	LOCAL	AREA (ha)	SEEDLINGS **	TOTAL QUANTITY (unit.)	TOTAL COST	ORGANIC COMPOUND (Compost)	TOTAL QUANTITY (kg)	TOTAL COST	MULCH	TOTAL QUANTITY (kg)	TOTAL COST	PROTECTORS *** (Initial phase)	TOTAL QUANTITY (unit.)	TOTAL COST
PRODUCER C	Watercourse restoration	Farm C	0,02	Diverse	40	19,10 €	-	0	0,00 €	Chips	125	24,10 €	Diverse	40	22,40 €
PRODUCER D	Implementation of small woodlets	Farm D	0,09	Diverse	216	102,00 €	URSA/EDIA	720	84,93 €	Chips	300	24,10 €	Diverse	216	108,72 €
PRODUCER E	Implementation of small woodlets	Farm E	0,1	Diverse	204	107,00 €	URSA/EDIA	640	84,93 €	Chips	300	24,10 €	Diverse	204	106,72 €
PRODUCER G	Watercourse restoration	Farm G	0,3	Diverse	393	188,85 €	URSA/EDIA	1400	84,93 €	Chips	550	24,10 €	Diverse	393	211,96 €

** Seedlings: Medronho, alfarrobeira, tamujo, freixo, espirradeira, oliveira silvestre, lentisco, catapereiro, azinheira, sobreiro, rosa mosqueta, tamargueira and pilriteiro.

*** Types of protectors (final phase): perforated, paper, and with grooves.

Note: Total cost of composite and chips: only included transportation value and labor (Loading/unloading) as the compound/chips used did not generate costs. It is Necessary to clarify that Alqueva Byproducts Recirculation Units (Unidades de Recirculação de Subprodutos de Alqueva - URSA) it's a constellation of units serving the irrigated territory, producing organic fertilizer through composting, returned to farmers in exchange for the agricultural by-products delivered. This project aim to valorize the organic by-products of agriculture and promote their return to the soil in order to recover it, as well as to protect water and favor the efficient use of resources. This units serving producing organic fertilizer through composting, returned to farmers in exchange for the agricultural by-products delivered, for fertilizing crops, contributing to increased soil fertility and its rehabilitation as a filtering barrier, promoting downstream water quality and the long-term Sustainability of irrigation. For further information, please access: <https://www.edia.pt/ursa/index.html>

Table 12: Regeneration protector - installation data

REGENERATION PROTECTOR											
RURAL PRODUCER	CULTURAL OPERATION	LOCAL	DATE (Installation)	LABOR (Type)	LABOR FORCE GENDER (M/W)	LABOR (Hours)	TOTAL COST (€)	PROTECTOR	QUANTITY	PRICE	TOTAL COST (€)
Producer L	Promotion of natural regeneration	Farm L	25/07/2023	Technical	M	4	46,04	Galvanized steel type	10	10,88 €	108,80 €
				Technical	M	4	46,04	Cactus type	10	17,96 €	179,60 €
Producer M	Promotion of natural regeneration	Farm M	26/07/2023	Technical	M	3	34,53	Galvanized steel type	10	10,88 €	108,80 €
				Technical	M	3	34,53	Cactus type	10	17,96 €	179,60 €
Producer F	Promotion of natural regeneration	Farm F	09/08/2023	Technical	M	3	34,53	Galvanized steel type	10	10,88 €	108,80 €
				Technical	M	3	34,53	Cactus type	10	17,96 €	179,60 €
Producer C	Promotion of natural regeneration	Farm C	09/08/2023	Technical	M	3	34,53	Galvanized steel type	10	10,88 €	108,80 €
				Technical	M	3	34,53	Cactus type	10	17,96 €	179,60 €
Producer P	Promotion of natural regeneration	Farm P	17/08/2023	Technical	M	3	34,53	Galvanized steel type	10	10,88 €	108,80 €
				Technical	M	3	34,53	Cactus type	10	17,96 €	179,60 €
Producer O	Promotion of natural regeneration	Farm D	17/08/2023	Technical	M	3	34,53	Galvanized steel type	10	10,88 €	108,80 €
				Technical	M	3	34,53	Cactus type	10	17,96 €	179,60 €
Producer E	Promotion of natural regeneration	Farm E	13/11/2023	Unskilled labor	M	4	233,33	Galvanized steel type	10	10,88 €	108,80 €
				Unskilled labor	M	4		Cactus type	10	17,96 €	179,60 €

5.1 Calculation of hours worked - tractors and implements

To develop the calculations relating to the cost of hours worked per hectare of tractors and implements, a spreadsheet was prepared containing information relating to the hours worked by each tractor and respective implement; this way, it was possible to develop the necessary calculations and define the average time needed to carry out the procedures in the field. This procedure was used for both the crops and investment accounts, so the data will not be presented separately. The values in question were delimited considering the general average time required to carry out the operations. The results are presented below (tables 13, 14 and 15).

Table 13: Average hours worked - tractor and implement with conventional tillage

AVERAGE WORKING TIME: TRACTOR + IMPLEMENT	
Rural operation	h/ha
Land preparation	2,50
Seed and Fertilizer distribution	1,10
Seed burial	1,20

Table 14: Average hours worked - tractor and implement with direct seeding

AVERAGE WORKING TIME TRACTOR + IMPLEMENT	
Rural operation	h/ha
Seeding	1,20

Table 15: Average hours worked - tractor and implement: small woodlots and watercourse restoration:

AVERAGE WORKING TIME: TRACTOR + IMPLEMENT	
Rural operation	h/500 m²
Land clearing	1,30
Land preparation	2,30
Digging of holes, Fertilization/mulching, Planting, and Installation of protectors	0,00
Installation of irrigation system	0,00
Installation of fence	0,00

5.2 Calculation of hours worked – labor

The calculations relating to the cost of the hour worked (labor - undifferentiated, technical and tractor driver), as in the previous case, were carried out using the information previously provided, and a spreadsheet was prepared containing the information relating to the hours worked on by each employee; This way, it was possible to develop the necessary calculations and define an average time needed to carry out the procedures in the field, both in the case of conventional tillage and direct seeding method and other implemented actions. This procedure was used for both the crops and investment accounts, so the data will not be presented separately.

To develop calculations relating to the cost of labor hours worked by workers (undifferentiated, technicians and tractor drivers), the tables and data presented below were used (tables 16, 17, 18 19 20 and 21):

Table 16: Average hours worked with conventional tillage

AVERAGE WORKING TIME	
TRACTOR DRIVER LABOR	
Rural operation	h/ha
Land preparation	2,50
Seed and Fertilizer distribution	1,50
Seed burial	1,30
UNSKILLED LABOR	
Rural operation	h/ha
Land preparation	0,00
Seed and Fertilizer distribution	0,00
Seed burial	0,14

Table 17: Average hours worked with direct seeding

AVERAGE WORKING TIME	h/ha
Tractor driver labor	1,30
Unskilled labor	0,30

Table 18: Average hours worked by tractor driver – small woodlots and watercourse restoration

AVERAGE WORKING TIME: TRACTOR DRIVER LABOR	
Rural operation	h/500 m²
Land clearing	1,30
Land preparation	2,30
Digging of holes, Fertilization/mulching, Planting, and Installation of protectors	0,00
Installation of irrigation system	0,00
Installation of fence	0,00

Table 19: Average hours worked for technical labor

AVERAGE WORKING TIME: TECHNICAL LABOR	
Rural operation	h/500 m²
Land clearing	0,00
Land preparation	0,00
Digging of holes, Fertilization/mulching, Planting, and Installation of protectors	12,50
Installation of irrigation system	0,00
Installation of fence	0,00

Table 20: Average hours worked for unskilled labor

AVERAGE WORKING TIME: UNSKILLED LABOR	
Rural operation	h/500 m²
Land clearing	0,00
Land preparation	0,00
Digging of holes, Fertilization/mulching, Planting, and Installation of protectors	12,50
Installation of irrigation system	8,00
Installation of fence	16,00

Table 21: Average hour worked – regeneration protectors (installation 10 units)

AVERAGE WORKING TIME: TECHNICAL LABOR	h/ha
Galvanized steel type - regeneration protector (10 units)	3
Cactus type - regeneration protector (10 units)	3



Figure 1: Cactus - type regeneration protector (photo by the author).



Figure 2: Galvanized steel type Regeneration protector (photo by the author).

5.3 Calculation of production factors'

To develop calculations relating to the cost of materials used (seeds, fertilizers, organic compost, pine chips (mulch), protectors (initial phase), regeneration protectors, material for the irrigation system and fence) sheets were developed calculation containing information regarding the different materials used during the actions. Separate calculations were carried out for the crops and investments accounts according to the actions implemented. Therefore, each spreadsheet was prepared considering the particularities, in relation to the quantity and cost of each material used, as can be seen later:

Table 22: Cost and quantity of seeds and fertilizers used for calculations of oat and lupine crops (direct seeding)

SEED/FERTILIZER	kg/ha	COST €/kg
Oat seeds (<i>Avena sativa</i>)	150	0,848
Lupine seeds (<i>Lupinus luteus</i>)	60	2,067
Fertilizer Action Plus 6-7-7	175	0,433
Fertilizer Superfosfato 18 %		0,463

Table 23: Cost and quantity of seeds and fertilizers used for calculations - permanent pasture (conventional tillage and direct seeding)

SEED/FERTILIZER	kg/ha	COST €/kg
Pasture mixtures	25	5,512
Fertilizer FOSnatur 26.5	175	0,455
Fertilizer Superfosfato 18 %		0,463

It is necessary to clarify that, for the calculations relating to seeds, the specific values/quantities of each variety were considered. In the case of fertilizers, we chose to work with 18% Superphosphate, which was the type of fertilizer most used by registered producers (proportion of 175 kg/ha).

The calculations relating to spreadsheets for investment in pastures, implementation of small woodlots, restoration of watercourse and installation of regeneration protectors were carried out using the information presented in the tables below. It is also important to highlight that in the case of seedlings⁸ (table 24) and protectors (initial phase)⁹ (table 26) it was decided to work with the average cost referring to the items used while for the irrigation systems (table 27) and the fence (table 28) it was decided to work with the total cost; For the other materials, the unit cost was considered, as can be seen in tables 25 and 29.

⁸In this case, the choice of the variety of species to be used, as long as they meet the criteria and have the characteristics necessary for the location to be planted, is at the discretion of the producer, which is why we chose to use the average cost. euro/seedlings.

⁹To carry out the calculations relating to protectors (initial phase), a similar process was developed: the type of protector to be used (paper, perforated or grooved) is at the discretion of the producer, which is why we chose to use the average cost. euro/protector in spreadsheets. In the case of the +SOLO +VIDA program, the three types of protectors were used in order to observe which one presents the best results.

Table 24: Species, common name, unit cost and training subclass (small woodlets and watercourse restoration)

PLANT SEEDLINGS				
Nº	SPECIES	COMMON NAME (PORTUGUESE)	UNIT COST	FORMATION SUBCLASS
1	<i>Arbutos unedo</i>	Medronho	0,45 €	Umbrophile
2	<i>Ceratonia siliqua</i>	Alfarrobeira	0,50 €	Heliophile
3	<i>Crataegus monogyna</i>	Pilriteiro	0,55 €	Riparian
4	<i>Fluggea tinctoria</i>	Tamujo	0,45 €	Riparian
5	<i>Fraxinus excelsior</i>	Freixo	0,45 €	Riparian
6	<i>Nerium oleander</i> *	Espirradeira ou loendro	0,45 €	Riparian
			0,60 €	
7	<i>Olea europaea var. sylvestris</i> *	Oliveira silvestre	0,45 €	Heliophile
			1,20 €	
8	<i>Pistacia lentiscus</i>	Lentisco	0,45 €	Heliophile
9	<i>Pyrus bourgaeana</i>	Catapereiro	0,50 €	Heliophile
10	<i>Quercus rotundifolia</i> *	Azinheira	0,40 €	Heliophile
			0,50 €	
11	<i>Quercus suber</i>	Sobreiro	0,45 €	Umbrophile
12	<i>Rosa canina</i>	Rosa mosqueta	0,45 €	Heliophile
13	<i>Tamarix africana</i>	Tamargueira	0,50 €	Heliophile
Average cost			0,52 €	

* In the case of these species, seedlings of two different sizes were used (20 cm and 40 cm), which resulted in a different unit cost, as the supplier did not have seedlings in the size of 40 cm to meet the program's demand.

Table 25: Cost and quantity of organic compost and pine wood chips (small woodlets and watercourse restoration)

MATERIAL	kg/PLANT SEEDLING	COST t/€	COST kg/€
Compost (small woodlets and watercourse restoration)	3	74,25	0,07
Mulch (small woodlets and watercourse restoration)	1,5	5,69	0,01

Table 26: Protective cost and quantity (initial phase) – small woodlets and watercourse restoration

TREE GUARD (PROTECTORS)		
TYPE	UNITS	COST €/UNIT
Perforeted plastic tree guard	206	0,39 €
Cardboard tree guard	383	0,62 €
Corrugated tree guard	264	0,50 €
Average cost		0,50 €

Note: They are used to protect young seedlings from the elements, as they promote microclimatic conditions that favor their growth.

Table 27: Cost of the irrigation system (small woodlots and watercourse restoration)

IRRIGATION SYSTEM - 500 M ²					
MATERIAL	CAPACITY/ MEASUREMENT	QUANTITY (UNIT OR METERS)	€/unid.	€/m	COST
WATER TANK	1000 l	1	258,30 €	-	258,30 €
FILTRO DE MALHA (11/2)	130 µm	1	17,90 €	-	17,90 €
DRIPPERS (SELF-COMPENSATING)	4 l/h	100	0,31 €	-	31,00 €
GROMMET CONNECTOR	16 mm	9	0,62 €	-	5,58 €
DIGITAL IRRIGATION WATER TIMER	-	1	47,74 €	-	47,74 €
FEMALE THREADED CONNECTOR (50X1)	1'5	1	3,77 €	-	3,77 €
TAMPÃO	-	1	2,99 €	-	2,99 €
FAUCET	16 mm	9	0,64 €	-	5,76 €
ONLINE IRRIGATION DRIP PIPE	16 mm	138	-	0,23 €	31,74 €
MAIN TUBE	50 mm	30	-	1,30 €	39,00 €
QUICK CONNECTOR BALL VALVE JOINT 50	-	1	17,79 €	-	17,79 €
TOTAL SYSTEM COST					461,57 €



Figure 3: Irrigation system (photo by the author).

In this case, a complete irrigation system was considered, which would meet the need to irrigate an area of 500 m², with 100 seedlings, the minimum measure (for calculation purposes) considered for the implementation of a small woodlot and for carrying out the watercourse restoration (table 27). To carry out the necessary calculations for installing the fence, as in the case of the irrigation system, the cost of the materials necessary to fence an area of 500 m² was considered, as can be seen in table 28. For both cases, time and Installation labor costs are accounted for separately as can be seen in tables 20, 27 and 28 respectively. It is also necessary to highlight that a 15%

rate was considered for replantation (added in the calculation spreadsheet) considering the necessary material (seedlings, protectors, fertilizers, etc.) and labor.

Table 28: Cost of the fence (small woodlets and watercourse restoration)

FENCE - 500 M ²					
MATERIAL	CAPACITY/ MEASUREMENT	QUANTITY (UNIT OR METERS)	€/unid.	€/m	COST
IRON WIRE (ROLL)	25 KG	4	2,27 €	-	9,08 €
SAND	kg	260	0,05 €	-	13,00 €
CEMENT (BAG)	25 kg	3	5,89 €	-	17,67 €
STEEL WIRE FENCE STAPLE (BUCKET)	5 kg	2	19,61 €	-	39,22 €
PVC BOARD	20 cm x 10 cm	18	1,08 €	-	19,44 €
WOODEN FENCING POSTS (5/6)	150 cm	47	2,48 €	-	116,56 €
WIRE NAILS (GALVANISED)	kg	1,5	4,50 €	-	6,75 €
GALVANIZED WELD MESH (ROLL)	100 m x 1m	1	89,79 €	-	89,79 €
WALL PAINT (CAN)	1l	1	4,50 €	-	4,50 €
TOTAL SYSTEM COST					316,01 €



Figure 4: Enclosure - fence (Image provided by ADPM).

Table 29: Cost of regeneration protectors (promotion of natural regeneration)

REGENERATION PROTECTOR		
TYPE	UNITS	COST €/UNIT
Galvanized steel type	10	10,88 €
Cactus type	10	17,96 €

Note: They are used to protect young seedlings against herbivory.

6. Crop & investment accounts: general matrix

The general structure of the model, presented in the tables below, indicates the stages of the processes that were carried out during the cultural operations and the respective functions, that resulted in the values presented later in the spreadsheets. In addition to the processes, functions are indicated that calculated the costs of labor, tractors and implements, in addition to production factors (seeds, fertilizers, seedlings, ... etc.) used. Functions that indicate values relating to final cost and working capital are also presented here. Matrices were developed representing, respectively, the accounts for oat and lupine crops, the investment costs for permanent pasture (in direct and conventional seeding), implementation of small woodlots, restoration of watercourse lines, water and, finally, the installation of regeneration protectors.

6.1 Matrices: crop accounts and investment costs

The accounts for oat and lupine (direct seeding) are represented in table 30; the matrices representing the investment costs for permanent pasture (conventional and direct seeding) are presented, respectively, in tables 31 and 32. The matrix relating to the implementation of small woodlots and watercourse restoration is presented in table 33 and the installation of regeneration protectors in table 34.

Table 30: Crop account matrix (oats and lupine – direct seeding)

CROP ACCOUNT MATRIX - OATS AND LUPINE (DIRECT SEEDING)					
RURAL OPERATIONS	→	LABOR A	MACHINERY B	SUPPLIES C	
	F U N C T I O N	$f(x) = C (\text{€/h}) * \text{time (h/ha)}$ For: C: Cost (€/h) Time: (h/ha)	$f(x) = V.C. (\text{€/h}) * \text{time (h/ha)}$ For: V.C.: Variable costs (€/h) Time: (h/ha)	$f(x) = C (\text{€/kg}) * W (\text{kg/ha})$ For: C: Cost (€/kg) W: Weight (kg/ha)	COST
1 - Land preparation, Seed & Fertilizer distribution	O P P O R T U N I T Y	Unskilled: $f(x) = 6,46 * \text{time}$ Tractor driver: $f(x) = 10,63 * \text{time}$	Tractor 4X4 RM 120 hp + Direct seeder 3 m $f(x) = 29,85 * \text{time}$ Tractor 4x4 RM 120 hp: 61.020,00 € Direct seeder 3 meters (towed): 44.635,00 €	Seeds Oat (<i>Avena sativa</i>): $f(x) = 0,84 * 150$ Lupine (<i>Lupinus luteus</i>): $f(x) = 2,06 * 60$ Fertilizer Superfosfato 18%: $f(x) = 0,46 * 175$	$\Sigma = A+B+C+D+E+F+G$ For: A: Labor (unskilled/tractor driver) B: Tractor + implement C: Supplies (seeds/fertilizer/etc.) D: Total premium to pay (Crop insurance) E: Depreciation F: General expenses (3%) G: Farmer (Businessperson) return (5% previous expenses)
	C O S T				$f(x) = (W.C. * O.C.) / 12$ Onde: W.C.: Working capital (€) O. C. : Opportunity cost (months)
Crop insurance					D
Depreciation					E
General expenses					$F = 0,03 * (A+B+C+D+E)$
Farmer (Businessperson)					$G = 0,05 * (A+B+C+D+E+F)$

Table 31: Investment account matrix (permanent pasture - conventional tillage)

INVESTIMENT ACCOUNT MATRIX - PERMANENT PASTURE (CONVENTIONAL TILLAGE)					
RURAL OPERATIONS	⇒	LABOR A	MACHINERY B	SUPPLIES C	COST
	F U N C T I O N	$f(x) = C \text{ (€/h)} * \text{time (h/ha)}$ For: C: Cost (€/h) Time: (h/ha)	$f(x)= V.C. \text{ (€/h)} * \text{time (h/ha)}$ For: V.C.: Variable costs (€/h) Time: (h/ha)	$f(x)= C \text{ (€/kg)} * W \text{ (kg/ha)}$ For: C: Cost (€/kg) W: Weight (kg/ha)	
1- Land preparation		Tractor driver: $f(x) = 10,63 * \text{time}$	Tractor 4X4 RM 120 hp + Disc harrow 1,8 m $f(x) = 24,35 * \text{time}$ Tractor 4X4 RM 120 hp: 61.020,00 € Disc harrow 1,8 m (towed): 3.277,00 €	There is no material consumption in this phase.	$\Sigma = A+B+C+D+E+F+G$ For: A: Labor (unskilled/tractor driver) B: Tractor + implement C: Supplies(seeds/fertilizer/etc.) D: Total premium to pay (Crop insurance) E: Depreciation F: General expenses (3%) G: Farmer (Businessperson) return (5% previous expenses)
2 - Seed & Fertilizer distribution		Unskilled: $f(x) = 6,46 * \text{time}$ Tractor driver: $f(x) = 10,63 * \text{time}$	Tractor 4X4 RM 120 hp + Seed and fertilizer spreader 14 m $f(x) = 25,06 * \text{time}$ Tractor 4X4 RM 120 hp: 61.020,00 € Seed and fertilizer spreader 14 m (mounted): 4.694,02 €	Seeds Pasture mixtures: $f(x) = 5,51 * 25$ Fertilizer Superfosfato 18%: $f(x) = 0,46 * 175$	
3 - Seed burial		Unskilled: $f(x) = 6,46 * \text{time}$ Tractor driver: $f(x) = 10,63 * \text{time}$	Tractor 4X4 RM 120 hp + Scarifier 1,7 m $f(x) = 23,84 * \text{time}$ Tractor 4X4 RM 120 hp: 61.020,00 € Scarifier 1,7 m (mounted): 1.607,99 €	There is no material consumption in this phase.	
Crop insurance					D
Depreciation					E
General expenses					$F = 0,03 * (A+B+C+D+E)$
Farmer (Businessperson)					$G = 0,05 * (A+B+C+D+E+F)$

Table 32: Investment account matrix (permanent pasture - direct seeding)

INVESTMENT ACCOUNT MATRIX - PERMANENT PASTURE (DIRECT SEEDING)					
RURAL OPERATIONS	⇒	LABOR A	MACHINERY B	SUPPLIES C	COST
	F U N C T I O N	$f(x) = C \text{ (€/h)} * \text{time (h/ha)}$ For: C: Cost (€/h) Time: (h/ha)	$f(x) = V.C. \text{ (€/h)} * \text{time (h/ha)}$ For: V.C.: Variable costs (€/h) Time: (h/ha)	$f(x) = C \text{ (€/kg)} * W \text{ (kg/ha)}$ For: C: Cost (€/kg) W: Weight (kg/ha)	
1- Land preparation, Seed & Fertilizer distribution		Unskilled: $f(x) = 6,46 * \text{tempo}$ Tractor driver: $f(x) = 10,63 * \text{tempo}$	Tractor 4X4 RM 120 cv + Direct seeder 3 m $f(x) = 29,85 * \text{time}$ Tractor 4x4 RM 120 hp: 61.020,00 € Direct seeder 3 m (towed) : 44.635,00 €	Seeds Pasture mixtures: $f(x) = 5,51 * 25$ Fertilizer Superfosfato 18%: $f(x) = 0,46 * 175$	$\Sigma = A+B+C+D+E+F+G$ For: A: Labor (unskilled/tractor driver) B: Tractor + implement C: Supplies (seeds/fertilizer/etc.) D: Total premium to pay (Crop insurance) E: Depreciation F: General expenses (3%) G: Farmer (Businessperson) return (5% previous expenses)
	Crop insurance				D
	Depreciation				E
	General expenses				$F = 0,03 * (A+B+C+D+E)$
Farmer (Businessperson)				$G = 0,05 * (A+B+C+D+E+F)$	

Table 33: Investment account matrix (small woodlots and watercourse restoration)

INVESTIMENT ACCOUNT MATRIX - SMALL WOODLETS AND WATERCOURSE RESTORATION					
RURAL OPERATIONS	⇒	LABOR A	MACHINERY B	SUPPLIES C	COST
	F U N C T I O N	$f(x) = C (\text{€/h}) * \text{time (h/500 m}^2\text{)}$ For: C: Cost (€/h) Time: (h/500 m²)	$f(x)= E.V. (\text{€/h}) * \text{time (h/500 m}^2\text{)}$ For: V.C.: Variable costs (€/h) Time: (h/500 m²)	$f(x)= C (\text{€/a}) * Q (a/500 \text{ m}^2)$ For: C: Cost (€/h) Q: Quantity (a/500 m²) a: Unit of measurement (kilograms, meters, number of units)	
1- Land clearing & Land preparation		Tractor driver: $f(x) = 10,63 * \text{time}$	Tractor 4x4 RM 120 hp + Brush hog 1,25 m $f(x) = 26,91 * \text{time}$ Tractor 4x4 RM 120 hp: 61.020,00 € Brush hog 1,25 m: 2.100,67 € Tractor 4x4 RM 120 hp + Ripper 1,4 m $f(x) = 26,03 * \text{time}$ Tractor 4x4 RM 120 hp: 61.020,00 € Ripper (subsoiler) 1,4 m (mounted) : 2.766,95€	There is no material consumption in this phase.	$\Sigma = A+B+C+D+E+F+G$
2 - Digging of holes, Fertilization/mulching, Planting, and Installation of protectors		Unskilled: $f(x) = 8,92 * \text{time}$ Technical: $f(x) = 11,51 * \text{time}$	All the work is done manually in these phases.	Organic compound (compost) $f(x) = 0,07 * 300$ Note: 3 kg of compost are used per seedling, which represents a total quantity of 300 kg /100 seedlings. Mulch (pine wood chips) $f(x) = 0,01 * 150$ Note: 1.5 kg of pine wood chips are used per seedling, which represents a total quantity of 150 kg /100 seedlings. Seedlings (diverses) $f(x) = 0,52 * 100$ Note: 100 seedlings are planted per 500 m². Protectors (inicial phase) $f(x)= 0,50 * 100$ Note: 100 protectors are used per 500 m²	
3 - Installation of the irrigation system & Installation of the fence		Unskilled: $f(x) = 8,92 * \text{time}$		Irrigation System $f(x)= 461,57 * 1$ Note: The cost of a complete irrigation system is taken into account Fence $f(x)= 485,04 * 1$ Note: Total cost to fence an area of 500 m²	
Crop insurance					D
Depreciation					E
General expenses					F = 0,03*(A+B+C+D+E)
Farmer (Businessperson)					G = 0,05*(A+B+C+D+E+F)

For:
 A: Labor (unskilled/tractor driver)
 B: Tractor + implement
 C: Supplies (seeds/fertilizer/etc.)
 D: Total premium to pay (Crop insurance)
 E: Depreciation
 F: General expenses (3%)
 G: Farmer (Businessperson) return (5% previous expenses)

Table 34: Investment account matrix (regeneration protectors)

INVESTMENT ACCOUNT MATRIX - REGENERATION PROTECTORS (GALVANIZED STEEL AND CACTUS TYPE)				
RURAL OPERATIONS	→	LABOR A	SUPPLIES B	COST
	F U N C T I O N	$f(x) = C (\text{€/h}) * \text{time (h/ha)}$ For: C: Cost (€/h) Time: (h/ha)	$f(x) = C (\text{€/unity}) * Q (\text{unid./ha})$ For: C: Cost (€/unity) Q: Quantity (unidades/ha)	
1. Installing regeneration protectors Note: The entire process of installing regeneration protectors is done manually. The use of technical labor was considered because it is necessary to survey the area and identify the seedlings to be protected.		Technical: $f(x) = 11,51 * \text{time}$	Regeneration protector Galvanized steel type: $f(x) = 10,88 * 10$ Cactus type: $f(x) = 17,96 * 10$	$\Sigma = A+B+C+D+E+F$ For: A: Labor (technical labor) B: Supplies (Protector : galvanized steel type/cactus type) C: Total premium to pay (Crop insurance) D: Depreciation E: General expenses (3%) F: Farmer (Businessperson) return (5% previous expenses)
Crop insurance	→			C
Depreciation	→			D
General expenses	→			$E = 0,03 * (A+B+C+D+E)$
Farmer (Businessperson)	→			$F = 0,05 * (A+B+C+D+E+F)$

7. Results: crop accounts and investment costs

After the completion of the treatment, analysis, and elaboration process of the crops and investment accounts, the following result (cost/hectare) were reached:

Table 35: Results - crops and investment costs

RESULTS: CROP ACCOUNTS AND INVESTMENT COSTS				
CLASSIFICATION	IMPLEMENTED ACTIONS	SYSTEM/TYPE	MET ACHIEVED	COST/HECTARE
CROP ACCOUNTS	Annual soil-improving crop - Lupine	Direct seeding	Soil improvement	390,80 €
	Annual cover crop - Oat	Direct seeding	Erosion control and increased infiltration	394,30 €
INVESTMENT ACCOUNTS	Permanent pasture	Direct seeding	Permanent pasture	403,40 €
	Permanent pasture	Conventional tillage	Permanent pasture	523,90 €
	Small woodlots	-	Erosion control and increased infiltration	1.795,00 €
	Watercourse restoration	-	Watercourse restoration	1.795,00 €
	Regeneration protectors	Cactus type protector	Promotion of natural regeneration	266,20 €
		Galvanized steel type protector		188,10 €



Figure 5: Permanent pasture located in the Municipality of Mértola (Image provided by ADPM).



Figure 6: Implementation of a small woodlet in the Municipality of Mértola (Image provided by ADPM).

For direct seeding, it was also possible to establish a comparison considering two tractor powers, in this case, the tractor used in the field (Deutz-Fahr 9340 330 hp) and the tractor model used for the development of crop accounts (oats and lupine) and investment costs (permanent pasture) (New Holland T5 120 hp):

- Tractor 4 WD Deutz-Fahr 9340 330 hp (€381,220.00) + direct seeder 3.5 m width.
- Tractor 4 WD New Holland T5 120 hp (€61,020.00) + direct seeder 3 m width.

Table 36: Cost of agricultural machinery charges in euros per hectare - direct seeding

AGRICULTURAL MACHINERY COSTS (DIRECT SEEDING)	TRACTORS		INCREASE % 120 hp x 330 hp
	TRACTOR 120 hp + IMPLEMENT	TRACTOR 330 hp + IMPLEMENT	
Variable Costs (diesel, lubricants, and repairs)	29,85 €	90,94 €	204,7
Fixed Costs (operation, depreciation, and additional fixed costs)	58,17 €	101,07 €	73,7
TOTALS	88,02 €	192,01 €	118,1



Figure 7: Deutz-Fahr 9340 330 hp tractor set + direct seeder 3,5 m used for direct seeding (Image provided by ADPM).

It is necessary to clarify that the historical average¹⁰ precipitation in the Mértola region is 323.62 mm per year, according to calculations using data provided by the Sistema Nacional de Informação de Recursos Hídricos - SNIRH. However, during the implementation year, the precipitation was only 140.8 mm (Table 37). This adverse condition caused delays in fieldwork and data collection, directly interfering with the development of the seedlings (oats, permanent pasture, and lupine). Nevertheless, it was possible to make some projections, and including two extra operations (fertilization and harvest¹¹) and considering values of 1250 kg/ha of production for oats (grain) and 500 kg/ha for lupine (grain), as can be seen in Table 38. With this data, it was also possible to obtain critical values for production and price (Table 39).

¹⁰ The historical average precipitation of the region was calculated, considering a period comprising the last 15 non-consecutive years of measurement, from 1990 to 2021, carried out by the Mértola station (code: 28L/01UG). Retrieved from: https://snirh.apambiente.pt/snirh/_dadosbase/site/janela_verdados.php?Sites=920685472&pars=4237&tmin=01/09/1931&tmax=18/10/2023

¹¹ In this case, the harvest is carried out by a service provider, a common situation in the region. In this scenario, the locally charged value of 65.00 €/h was considered, using a combine harvester with a power of 130 hp.

Table 37: Total annual precipitation in Mértola for the hydrological year 2022/23

TOTAL ANNUAL PRECIPITATION IN MÉRTOLA (28L/01UG)													
HYDROLOGICAL YEAR 2022/23	MONTHS												TOTAL (mm)
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	
MONTHLY PRECIPITATION (mm)	30,6	20,0	62,9	-	-	8,4	-	-	0,5	-	-	18,4	140,8

Source: Sistema Nacional de Informação de Recursos Hídricos (SNIRH). Retrieved from: https://snirh.apambiente.pt/snirh/_dadosbase/site/janela_verdados.php?sites=920685472&pars=1436794570&tmin=01/10/2022&tmax=30/09/2023

Table 38: Average working hour (tractor + implements, labor and service provider) for direct seeding

AVERAGE WORKING TIME: TRACTOR + IMPLEMENT	
Rural operation	h/ha
Seeding	1,15
Fertilizer distribution	0,50
AVERAGE WORKING TIME : LABOR	
Rural operation	h/ha
Seeding - tractor driver labor	1,30
Seeding - Unskilled labor	0,30
Fertilizer distribution - tractor driver labor	0,75
AVERAGE WORKING TIME: SERVICE PROVIDER	
Rural operation	h/ha
Harvest (contract work)	1,00

Note: For fertilization, the Nitrolusal 26% fertilizer (13.5% NH₄ 13.5% NO₃ 12.8% CaO) was considered at a rate of 110 kg/ha and a cost of 0.70 €/kg.

Table 39: Projections for production, critical production, and critical price (direct seeding)

SEEDING	AREA (HECTARE)	PRODUCTION (t/ha)	CRITICAL PRODUCTION (t/ha)	CRITICAL PRICE (EUROS/ha)
OAT	1,0	1,250	0,960	0,27 €
LUPINE	1,0	0,500	0,288	0,35 €

8. Carbon footprint

With a view to deep decarbonization of the national economy, Portugal committed, in 2016, to achieve carbon neutrality by the end of the first half of this century. To this end, the Roadmap for Carbon Neutrality (RNC2050) was approved through Council of Ministers Resolution No. 107/2019 of July 1st¹². This strategic development roadmap aims, in the long term, to explore the feasibility of trajectories leading to carbon neutrality, identify the main decarbonization vectors, and estimate the potential for emissions reduction in various sectors of the national economy, which makes quantifying the carbon footprint a tool of great relevance for this process.

But what is a carbon footprint? There are several definitions presented for the concept of carbon footprint, but here we will consider the one presented by Wiedmann and Minx (2007), which infers that the carbon footprint is the measure of the total amount of carbon dioxide (CO₂) emissions generated, directly and indirectly, by an activity or accumulated over the life stages of a product.

The diagram below represents, in a simplified way, considering agricultural production, the phases of this process:

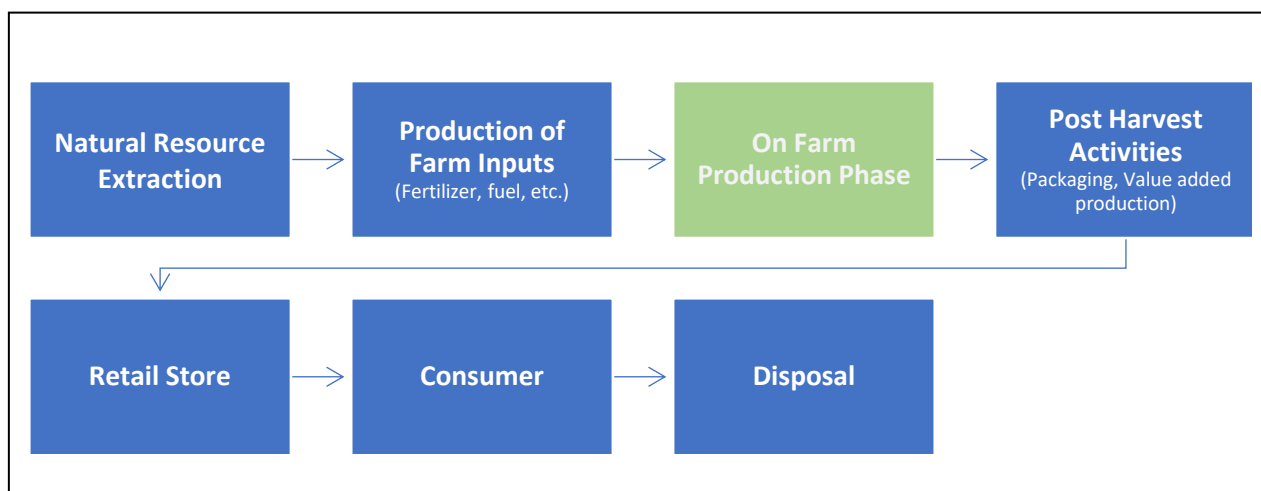


Figure 8: Cycle of life in agricultural systems. Source: Adapted from Life – Cycle Assessment in Agricultural Systems (2013, p. 2).

¹² Available at: <https://files.dre.pt/1s/2019/07/12300/0320803299.pdf>

It is possible to calculate the carbon footprint generated in all stages (Cradle to Cradle) or to calculate the carbon emissions generated in a single phase of the process. In this case, the carbon footprint generated by activities within a rural property was considered, as can be seen below:

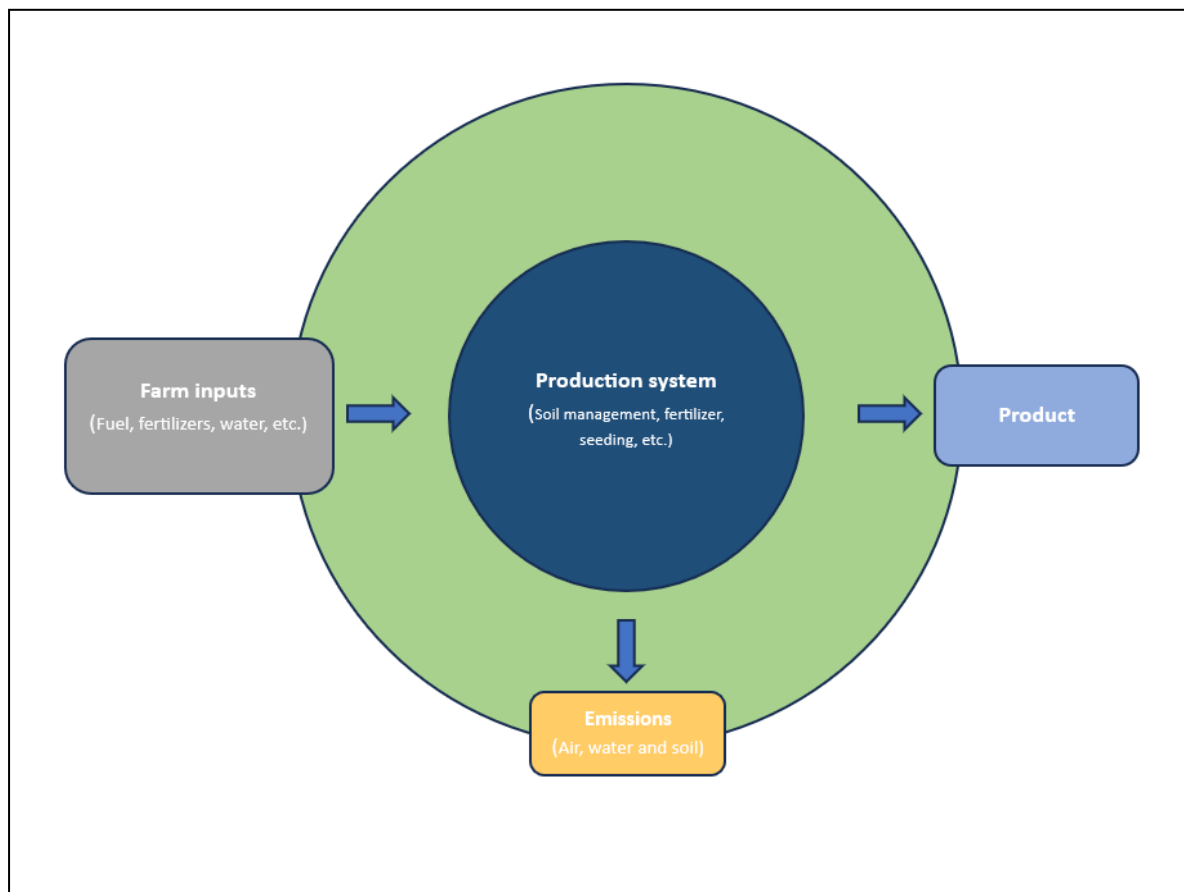


Figure 9: Life cycle in agricultural systems - Agricultural production phase. Source: Adapted from Life – Cycle Assessment in Agricultural Systems (2013, p. 11).

For the calculations, data already collected and treated previously were used, which allowed the survey of the carbon footprint referring to the following implemented actions: permanent pasture (direct and conventional), oats, lupine, and implementation of small woodlots and watercourse restoration. The results are presented in Table 40:

Table 40: Carbon and energy footprint, related to implemented actions

IMPLEMENTED ACTIONS	CARBON & ENERGY FOOTPRINT			
	ÁREA (ha/m ²)	PRODUCTION (t/ha)	CARBON (kg CO ₂ /ha)	ENERGY (MJ/ha)
OAT (Direct seeding)	1 ha	-	59,58	229,79
LUPINE (Direct seeding)	1 ha	-	59,58	229,79
PERMANENT PASTURE (Conventional tillage)	1 ha	-	296,28	279,90
PERMANENT PASTURE (Direct seeding)	1 ha	-	59,58	229,79
SMALL WOODLETS	500 m ²	-	157,85	201,14
WATERCOURSE RESTORATION	500 m ²	-	157,85	201,14

Note: Considering local values of production (local information) and harvest by contract for oat and lupine.

It was also possible to calculate the carbon footprint/kg for oat and lupine (table 41) considering the data in table 38, that includes all cycle, from seeding to production. In table 42, a comparison was established for the emissions generated during the implementation of permanent pasture through the direct seeding or conventional tillage.

Table 41: Carbon and energy footprint to oat and lupine (kg CO₂/t)

SEEDING	CARBON & ENERGY FOOTPRINT					
	AREA (HECTARE)	PRODUCTION (t/ha)	CARBON kg CO ₂ /ha	CARBON kg CO ₂ /t	ENERGY MJ/ha	ENERGY MJ/t
OAT	1,0	1,25	161,42	129,14	981,45	785,16
LUPINE	1,0	0,50	99,18	198,37	245,10	490,20

Note: Considering local values of production (local information) and harvest by contract for oat and lupine seedings.

Table 42: Comparison of carbon and energy footprint for permanent pasture in conventional tillage and direct seeding systems

PERMANENT PASTURE 1 HECTARE	GHGs (KgCO ₂ /Ton/ha)		Energy (MJ/Ton/ha)	
	CONVENTIONAL TILLAGE	DIRECT SEEDING	CONVENTIONAL TILLAGE	DIRECT SEEDING
Fertilizer	16,38	16,38	213,08	213,08
Pesticides	0,0	0,0	0,0	0,0
Agricultural machinery	279,90	43,20	66,82	16,70
Services (excluding electricity)	0,0	0,0	0,0	0,0
Labor	0,0	0,0	0,0	0,0
Irrigation (electricity)	0,0	0,0	0,0	0,0
TOTAL	296,28	59,58	279,90	229,79

It is also interesting to highlight here, as a consequence of this commitment assumed by Portugal to achieve carbon neutrality by the end of the first half of this century, the carbon credit market. The idea of carbon credit emerged on the world stage in 1997, during the 3rd Conference of the Parties to the United Nations Framework Convention on Climate Change (COP-3), during which the Kyoto Protocol was signed. During the conference, percentages of pollutant gas¹³ emissions were indicated for various countries, and given the discrepancy in emissions between these nations, some had minuscule pollution percentages (0 - 0.1%) while others (USA and Russia) had very high percentages (together totaling more than half of the emitted pollutant gases), which led to the idea of carbon credit being established. Each credit, which in practice consists of a unit of carbon dioxide (CO₂) emission reduction, corresponds to one ton of CO₂eq and can be traded on the international market. The "quantification" of nature, in this way, began to be carried out in measures of carbon tons emitted at any level of degradation.

In the case of Portugal, the legal framework for the implementation of the voluntary carbon market was created through the publication of Decree-Law No. 4/2024 on January 5th. The objective is to create conditions for the development of instruments that favor national commitments to combat climate change, which are in sync with the Paris¹⁴ Agreement and the European strategy to achieve carbon neutrality by 2050. Thus, according to IAPMEI (2024):

"The objective is to encourage the combination of efforts between the public and private sectors in the decarbonization of the economy, through a platform for trading certified carbon credits, generated from concrete actions that respond to climate priorities.

In practice, companies will have the opportunity, through the new regime, to acquire carbon credits as a way to offset the emissions of polluting gases that they cannot reduce or avoid, but also to valorize their investments in projects or solutions developed for the reduction or elimination of the carbon footprint.

Each carbon credit is equivalent to one ton of CO₂ equivalent and projects will be subject to specific eligibility criteria, emission accounting, and monitoring, reporting, and verification measures, by an independent entity qualified for this

¹³ The third article, item 1, of the Protocolo de Kyoto (United Nations, 1997, p. 4), indicates that aggregated anthropogenic emissions of gases such as Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons, Sulfur Hexafluoride, described in Annex A (1997, p. 29), should be expressed in carbon dioxide equivalent (CO₂ eq).

¹⁴ The goal of the Paris Agreement is to achieve the decarbonization of the global economies and includes a long-term objective to "limit the increase in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C, recognizing that this will significantly reduce the risks and impacts of climate change" (APA, 2021). The terms of the Paris Agreement can be found at the following link: <https://www.portugal.gov.pt/download-ficheiros/ficheiro.aspx?v=%3D%3DBQAAAB%2BLCAAAAAAABAAzNLA0tgQARA2cKgUAAAA%3D>

purpose.

The implementation of the market will be coordinated by the Portuguese Environment Agency - APA."

In 2023, for example, in the European market, the carbon credit for future¹⁵ emissions were worth €84.35 ± 13.48.

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¹⁵ Data regarding the carbon credit quotation for future emissions (period from 01/09/2023 to 12/09/2023) obtained through Investing, a financial market platform that provides real-time data (quotations, charts, financial tools, breaking news, and analysis) related to 250 stock exchanges worldwide. Retrieved from: <https://pt.investing.com/commodities/carbon-emissions-historical-data>

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Attachments

Figure 1: Oat account

CROP ACCOUNT: ANNUAL COVER CROP SEEDING (OAT - <i>Avena Sativa</i>)														YEAR: 2023	
DIRECT SEEDING														1 ha	
	AVERAGE	OPPORTUNITY	LABOR			TRACTION				SUPPLIES			TOTAL		
	OPERATION	COSTS	HOURS	UNIT	VALUE	TRACTOR HOURS (h/ha)	OTHER	UNIT	VALUE	QUANTITY WT./VOL./LEN.	UNIT	VALUE	IMPORTANCE	[C X N]	
	DATE	(MONTHS)		PRICE	(EUROS)		MACHINERY	PRICE	(EUROS)		PRICE	(EUROS)			PER OPERATION
1 - DIRECT SEEDING															
1.1- Land preparation, Seed and Fertilizer distribution															
Superfosfato 18%	November	12								175	0,46	81,03	81,03	972,30	
Oat	November	12								150	0,85	127,20	127,20	1.526,40	
Operating costs (traction)	November	12				1,2		29,85	35,82				35,82	429,84	
Unskilled labor	November	12	0,3	6,46	2,15								2,15	25,86	
(Trac. 120 hp+direct seeder towed) - Tractor driver	November	12	1,3	10,63	13,82								13,82	165,83	
SUB-TOTAL			1,6		15,97	1,2			35,82	325,0		208,23	260,02	3.120,22	
6 - CROP INSURANCE			August	12									0,00	0,00	
7- DEPRECIATION													49,44	0,00	
8- GENERAL EXPENSES (3% Previous expenses)													9,28	0,00	
9- FARMER (Businessperson) RETURN (5% Previous expenses)													15,94		
TOTAL			1,6		15,97	1,2			85,26	325,0		217,51	334,68	3.120,22	
PERCENTAGES					4,77%				25,48%			64,99%			

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			334,7
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Working capital)	1,0%	260,0	2,6
Fixed capital investment (Machinery)	Calculated in attachment		20,4
Fixed capital investment (other capital goods)	2,5%		
Land rental value			30,0
Uninsurable risk reserve	2%	334,7	6,7
Total Costs			394,3

Figure 2: Oat account with harvest

CROP ACCOUNT: ANNUAL COVER CROP SEEDING WITH HARVEST (OAT - <i>Avena Sativa</i>)														YEAR: 2023	
DIRECT SEEDING														1 ha	
	AVERAGE OPERATION DATE	OPPORTUNITY COSTS (MONTHS)	LABOR			TRACTION				SUPPLIES			TOTAL		
			HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN.	UNIT PRICE	VALUE (EUROS)	IMPORTANCE PER OPERATION	[C X N]	
1 - DIRECT SEEDING															
1.1- Land preparation, Seed and Fertilizer distribution															
Superfosfato 18%	November	7								175	0,46	81,03	81,03	567,18	
Oat	November	7								150	0,85	127,20	127,20	890,40	
Operating costs (traction)	November	7				1,2		29,85	35,82				35,82	250,74	
Unskilled labor	November	7	0,3	6,46	2,15								2,15	15,08	
(Trac. 120 hp+direct seeder towed) - Tractor driver	November	7	1,3	10,63	13,82								13,82	96,73	
SUB-TOTAL			1,6		15,97	1,2			35,82	325,0		208,23	260,02	1.820,13	
2 - FERTILIZATION															
Nitrolusal 26%	February	4								110	0,75	82,50	82,50	330,00	
Operating costs (traction)	February	4				0,5		25,06	12,53				12,53	50,12	
(Trac. 120 hp+Centrifugal Spreader 14 m) - Tractor driver	February	4	0,8	10,63	7,97								7,97	31,89	
SUB-TOTAL			0,8		7,97	0,5			12,53	110,0		82,50	103,00	412,01	
3 - HARVEST															
Harvest (contract work)	June	0	0,00			1		65,00	65,00				65,00	0,00	
Operating costs (traction)															
(Combine harvester Class 132 hp) - Tractor driver															
SUB-TOTAL			0,0		0,00	0,0	1,0	65,00	65,00	0,0		0,00	65,00	0,00	
6 - CROP INSURANCE			August	12								0,00			0,00
7- DEPRECIATION													54,06		0,00
8- GENERAL EXPENSES (3% Previous expenses)										14,46			14,46		0,00
9- FARMER (Businessperson) RETURN (5% Previous expenses)													24,83		
TOTAL			2,4		23,95	1,7			167,41	435,0		305,19	521,38	2.232,14	
PERCENTAGES			4,59%			32,11%				58,54%					

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			521,4
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Working capital)	1,0%	186,0	1,9
Fixed capital investment (Machinery)	Calculated in attachment		22,5
Fixed capital investment (other capital goods)	2,5%		
Land rental value			30,0
Uninsurable risk reserve	2%	521,4	10,4
Total Costs			586,1

GROSS INCOME			
	(qty.)	(price)	(value)
Grain	1250,0	0,35	437,5
Straw	2500,0	0,1	250,0
Total:			687,5

GROSS MARGIN (€)	
Gross Margin = Gross Financial Result - Variable Costs	159,0
NET FINANCIAL MARGIN (€)	
Net Financial Margin = Gross Financial Result - Total Charges	101,4

Figure 3: Lupine account

CROP ACCOUNT: ANNUAL SOIL - IMPROVING CROP (LUPINE - <i>Lupinus luteus</i>)												YEAR: 2023				
DIRECT SEEDING												1 ha				
	AVERAGE OPERATION DATE	OPPORTUNITY COSTS (MONTHS)	LABOR			TRACTION				SUPPLIES			TOTAL			
			HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN.	UNIT PRICE	VALUE (EUROS)	IMPORTANCE PER OPERATION	[C X N]		
1 - DIRECT SEEDING																
1.1- Land preparation, Seed and Fertilizer distribution																
Superfosfato 18 %	November	12								175	0,46	81,03	81,03	972,30		
Lupine	November	12								60,0	2,07	124,02	124,02	1.488,24		
Operating costs (traction)	November	12				1,20		29,85	35,82				35,82	429,84		
Unskilled labor	November	12	0,33	6,46	2,15								2,15	25,86		
(Trac. 120 hp+direct seeder (towed) - Tractor driver	November	12	1,30	10,63	13,82								13,82	165,83		
SUB-TOTAL			1,6		15,97	1,2			35,82	235,0		205,05	256,84	3.082,06		
6 - CROP INSURANCE			Agosto	12											0,00	0,00
7- DEPRECIATION													49,44	0,00		
8- GENERAL EXPENSES (3% Previous expenses)													9,19	0,00		
9- FARMER (Businessperson) RETURN (5% Previous expenses)													15,77			
TOTAL			1,6		15,97	1,2			85,26	235,0		214,23	331,24	3.082,06		
PERCENTAGES					4,82%				25,74%			64,68%				

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			331,2
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Working capital)	1,0%	256,8	2,6
Fixed capital investment (Machinery)	Calculated in attachment		20,4
Fixed capital investment (other capital goods)	2,5%		
Land rental value			30,0
Uninsurable risk reserve	2%	331,2	6,6
Total Costs			390,8

Figure 4: Lupine account with harvest

YEAR: 2023														
CROP ACCOUNT: ANNUAL SOIL - IMPROVING CROP (LUPINE - <i>Lupinus luteus</i>)														
DIRECT SEEDING														
1 ha														
	AVERAGE OPERATION DATE	OPPORTUNITY COSTS (MONTHS)	LABOR			TRACTION				SUPPLIES			TOTAL	
			HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN.	UNIT PRICE	VALUE (EUROS)	IMPORTANCE PER OPERATION	[C X N]
1 - DIRECT SEEDING														
1.1- Land preparation, Seed and Fertilizer distribution														
Superfosfato 18 %	November	7								175	0,46	81,03	81,03	567,18
Lupine	November	7								60,0	2,07	124,02	124,02	868,14
Operating costs (traction)	November	7				1,2		29,85	35,82				35,82	250,74
Unskilled labor	November	7	0,3	6,46	2,15								2,15	15,08
(Trac. 120 hp+direct seeder towed) - Tractor driver	November	7	1,3	10,63	13,82								13,82	96,73
SUB-TOTAL			1,6		15,97	1,2		35,82		235,0		205,05	256,84	1.797,87
5 - HARVEST														
Harvest (contract work)	June	0	0,00			1 65,00 65,00							65,00	0,00
Operating costs (traction)	June	0											0,00	0,00
(Combine harvester Class 132 hp) - Tractor driver	June	0											0,00	0,00
SUB-TOTAL			0,0		0,00	1,0 65,00				0,0		0,00	65,00	0,00
6 - CROP INSURANCE			August	12								0,00 0,00		
7- DEPRECIATION										49,44			49,44	0,00
8- GENERAL EXPENSES (3% Previous expenses)										11,14			11,14	0,00
9- FARMER (Businessperson) RETURN (5% Previous expenses)													19,12	
TOTAL			1,6		15,97	1,2		150,26		235,0		216,18	401,54	1.797,87
PERCENTAGES			3,98%			37,42%				53,84%				

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			401,5
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Working capital)	1,0%	149,8	1,5
Fixed capital investment (Machinery) Calculated in attachment			20,4
Fixed capital investment (other capital good: 2,5%			
Land rental value			30,0
Uninsurable risk reserve	2%	401,5	8,0
Total Costs			461,4

GROSS INCOME			
	(qty.)	(price)	(value)
Grain	500,0	1,5	750,0
Straw	1,0	30,0	30,0
Total:			780,0

GROSS MARGIN (€)	
Gross Margin= Gross Financial Result - Variable Costs	362,6
NET FINANCIAL MARGIN (€)	
Net Financial Margin= Gross Financial Result - Total Charges	318,6

Figure 5: Permanent pasture (conventional tillage) – Investment account

INVESTMENT COSTS - PERMANENT PASTURE												YEAR: 2023
CONVENTIONAL TILLAGE												1ha
AVERAGE OPERATION DATE	LABOR			TRACTION				SUPPLIES			TOTAL	
	HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN.	UNIT PRICE	VALUE (EUROS)	IMPORTANCE PER OPERATION	
1 - CONVENTIONAL TILLAGE												
1.1- Land preparation												
Operating costs (traction)	November			2,5		24,18	60,45				60,45	
(Trac. 120 hp+Disc harrow) - Tractor driver	November	2,5	10,63	26,58							26,58	
SUB-TOTAL		2,5		26,58	2,5		60,45	0,0		0,00	87,03	
1.2 - Seed and Fertilizer distribution												
Superfosfato 18 %	November							175	0,46	81,03	81,03	
Pasture mixture	November							25	5,51	137,80	137,80	
Unskilled labor	November											
Operating costs (traction)	November				1,1	25,06	27,57				27,57	
(Trac. 120 hp+Centrifugal Spreader 14 m) - Tractor driver	November	1,5	10,63	15,95							15,95	
SUB-TOTAL		1,5		15,95	1,1		27,57	200,0		218,83	262,34	
1.3 - Seed burial												
Unskilled labor	November	0,3	6,46	2,15							2,15	
Operating costs (traction)	November				1,2	23,84	28,61				28,61	
(Trac. 120 hp+Scarifier) - Tractor driver	November	1,3	10,63	13,82							13,82	
SUB-TOTAL		1,6		15,97	1,2		28,61	0,0		0,00	44,58	
6 - CROP INSURANCE												
August											0,00	
7- DEPRECIATION												
							37,91				37,91	
8- GENERAL EXPENSES (3% Previous expenses)												
										12,96	12,96	
9- FARMER (Businessperson) RETURN (5% Previous expenses)												
											22,24	
TOTAL												
		5,6		58,49	4,8		154,54	200,0		231,78	467,05	
PERCENTAGES												
				12,52%			33,09%			49,63%		

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			467,0
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Machinery)	Calculated in attachment		17,5
Fixed capital investment (other capital goods)	2,5%		
Land rental value			30,0
Uninsurable risk reserve	2%	467,0	9,3
Total Costs			523,9

Figure 6: Permanent pasture (direct seeding) – Investment account

INVESTMENT COSTS - PERMANENT PASTURE												YEAR: 2023
DIRECT SEEDING												1 ha
	AVERAGE OPERATION DATE	LABOR			TRACTION				SUPPLIES			TOTAL
		HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN	UNIT PRICE	VALUE (EUROS)	IMPORTANCE PER OPERATION
1 - DIRECT SEEDING												
1.1- Land preparation, Seed and Fertilizer distribution												
Superfosfato 18%	November								175,0	0,46	81,03	81,03
Pasture mixture	November								25,0	5,51	137,80	137,80
Operating costs (traction)	November				1,20		29,85	35,82				35,82
Unskilled labor	November	0,33	6,46	2,15								2,15
(Trac. 120 hp+direct seeder (towed) - Tractor driver	November	1,30	10,63	13,82								13,82
SUB-TOTAL		1,6		15,97	1,2			35,82	200,0		218,83	270,62
6 - CROP INSURANCE												0,00
7- DEPRECIATION					49,44							49,44
8- GENERAL EXPENSES (3% Previous expenses)									9,60			9,60
9- FARMER (Businessperson) RETURN (5% Previous expenses)												16,48
TOTAL		1,6		15,97	1,2			85,26	200,0		228,43	346,14
PERCENTAGES				4,61%				24,63%			65,99%	

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			346,1
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Machinery) Calculated in attachment			20,4
Fixed capital investment (other capital good	2,5%		
Land rental value			30,0
Uninsurable risk reserve	2%	346,1	6,9
Total Costs			403,4

Figure 7: Small woodlets – Investment account

INVESTMENT COSTS - SMALL WOODLETS												YEAR: 2023
	AVERAGE OPERATION	LABOR			TRACTION				SUPPLIES			500 m ² TOTAL
		HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN.	UNIT PRICE	VALUE (EUROS)	IMPORTANCE PER OPERATION
	DATE											
1 - SMALL WOODLETS												
1.1- Land clearing and Land preparation												
Operating costs (traction)	May				1,5		26,91	40,23				40,23
(Trac. 120hp+brush hog 1,25 m) - Tractor driver	May	1,5	10,63	15,89								15,89
Operating costs (traction)	May				2,6		26,03	68,85				68,85
(Trac. 120hp+Ripper 1,4 m) - Tractor driver	May	2,6	10,63	28,12								28,12
SUB-TOTAL		4,1		44,01	4,1			109,08	0,0		0,00	153,09
1.2 - Digging of holes, Fertilization/mulching, Planting and Installation of protectors												
Seedlings	May								115	0,52	59,80	59,80
Organic compound (URSA/EDIA)	May								345	0,07	24,15	24,15
Mulch (Pine wood chips)	May								172,5	0,01	1,73	1,73
Protectors (Inical phase)	May								115	0,50	57,50	57,50
Unskilled labor	May	14,4	8,92	128,23								128,23
Technical labor	May	14,4	11,51	165,46								165,46
SUB-TOTAL		28,8		293,68	0,0			0,00	747,5		143,18	436,86
1.3- Installation of irrigation system and Installation of fence												
Irrigation system (material)	May								1	461,57	461,57	461,57
Unskilled labor (Installation of irrigation system)	May	8,0	8,92	71,36								71,36
Fence (material)	May								1	316,01	316,01	316,01
Unskilled labor (Installation of fence)	May	16,0	8,92	142,72								142,72
SUB-TOTAL		24,0		214,08	0,0			0,00	2,0		777,58	991,66
6 - CROP INSURANCE												
												0,00
7- DEPRECIATION												
								31,10				31,10
8- GENERAL EXPENSES (3% Previous expenses)												
											48,38	48,38
9- FARMER (Businessperson) RETURN (5% Previous expenses)												
												83,05
TOTAL												
		56,9		551,77	4,1			140,18	749,5		969,14	1.744,14
PERCENTAGES												
				31,64%				8,04%			55,57%	

Note: A 15% value was added for replacement, in this case considering that a mortality rate is expected among the new seedlings.

15% replacement 1,15

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			1744,1
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Machinery)	Calculated in attachment		14,5
Fixed capital investment (other capital goods)	2,5%		
Land rental value			1,5
Uninsurable risk reserve	2%	1744,1	34,9
Total Costs			1795,0

Figure 8: Watercourse restoration – Investment account

INVESTMENT COSTS - WATERCOURSE RESTORATION											YEAR: 2023
AVERAGE OPERATION DATE	LABOR			TRACTION				SUPPLIES			500 m ² TOTAL IMPORTANCE
	HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN.	UNIT PRICE	VALUE (EUROS)	PER OPERATION
1 - WATERCOURSE RESTORATION											
1.1- Land clearing and Land preparation											
Operating costs (traction)	May			1,5		26,91	40,23				40,23
(Trac. 120hp+brush hog 1,25 m) - Tractor driver	May	1,5	10,63	15,89							15,89
Operating costs (traction)	May			2,6		26,03	68,85				68,85
(Trac. 120hp+Ripper 1,4 m) - Tractor driver	May	2,6	10,63	28,12							28,12
SUB-TOTAL		4,1		44,01	4,1		109,08	0,0		0,00	153,09
1.2 - Digging of holes, Fertilization/mulching, Planting and Installation of protectors											
Seedlings	May							115	0,52	59,80	59,80
Organic compound (URSA/EDIA)	May							345	0,07	24,15	24,15
Mulch (Pine wood chips)	May							172,5	0,01	1,73	1,73
Protectors (Initial phase)	May							115	0,50	57,50	57,50
Unskilled labor	May	14,4	8,92	128,23							128,23
Technical labor	May	14,4	11,51	165,46							165,46
SUB-TOTAL		28,8		293,68	0,0		0,00	747,5		143,18	436,86
1.3- Installation of irrigation system and Installation of fence											
Irrigation system (material)	May							1	461,57	461,57	461,57
Unskilled labor (Installation of irrigation system)	May	8,0	8,92	71,36							71,36
Fence (material)	May							1	316,01	316,01	316,01
Unskilled labor (Installation of fence)	May	16,0	8,92	142,72							142,72
SUB-TOTAL		24,0		214,08	0,0		0,00	2,0		777,58	991,66
6 - CROP INSURANCE											
7- DEPRECIATION											
8- GENERAL EXPENSES (3% Previous expenses)											
9- FARMER (Businessperson) RETURN (5% Previous expenses)											
TOTAL		56,9		551,77	4,1		140,18	749,5		969,14	1.744,14
PERCENTAGES				31,64%			8,04%			55,57%	

Note: A 15% value was added for replacement, in this case considering that a mortality rate is expected among the new seedlings.

15% replacement	1,15
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TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			1744,1
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Machinery)	Calculated in attachment		14,5
Fixed capital investment (other capital goods)	2,5%		
Land rental value			1,5
Uninsurable risk reserve	2%	1744,1	34,9
Total Costs			1795,0

Figure 9: Regeneration protectors (galvanized) – Investment account

YEAR: 2023													
INVESTMENT COSTS - REGENERATION PROTECTOR (GALVANIZED STEEL TYPE)													
	AVERAGE OPERATION DATE	LABOR			TRACTION				SUPPLIES			TOTAL	
		HOURS	UNIT PRICE	VALUE (EUROS)	TRACTOR HOURS (h/ha)	OTHER MACHINERY	UNIT PRICE	VALUE (EUROS)	QUANTITY WT./VOL./LEN.	UNIT PRICE	VALUE (EUROS)	IMPORTANCE PER OPERATION	
1 - REGENERATION PROTECTOR													
1.1- Installation of Protectors													
Regeneration protector - galvanized steel type	August								10,0	10,88	108,80	108,80	
Technical labor (Inst. of protector)	August	3,0	11,51	34,53								34,53	
SUB-TOTAL		3,0		34,53	0,0			0,00	10,0		108,80	143,33	
6 - CROP INSURANCE		August											0,00
7- DEPRECIATION					0,00							0,00	
8- GENERAL EXPENSES (3% Previous expenses)									4,30			4,30	
9- FARMER (Businessperson) RETURN (5% Previous expenses)												7,38	
TOTAL		3,0		34,53	0,0			0,00	10,0		113,10	155,01	
PERCENTAGES		22,28%			0,00%				72,96%				

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			155,0
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Machinery)	Calculated in attachment		0,0
Fixed capital investment (other capital goods)	2,5%		
Land rental value			30,0
Uninsurable risk reserve	2%	155,0	3,1
Total Costs			188,1

Spreadsheet 10: Regeneration protectors (cactus) – Investment account

INVESTMENT COSTS - REGENERATION PROTECTOR (CACTUS TYPE)												YEAR: 2023
	AVERAGE	LABOR			TRACTION				SUPPLIES			TOTAL
	OPERATION	HOURS	UNIT	VALUE	TRACTOR HOURS (h/ha)	OTHER	UNIT	VALUE	QUANTITY WT./VOL./LEN.	UNIT	VALUE	IMPORTANCE
	DATE		PRICE	(EUROS)		MACHINERY	PRICE	(EUROS)		PRICE	(EUROS)	PER OPERATION
1 - REGENERATION PROTECTOR												
1.1- Installation of Protectors												
Regeneration protector - cactus type	August								10,0	17,96	179,60	179,60
Technical labor (Inst. of protector)	August	3,0	11,51	34,53								34,53
SUB-TOTAL		3,0		34,53	0,0			0,00	10,0		179,60	214,13
6 - CROP INSURANCE												0,00
7- DEPRECIATION					0,00							0,00
8- GENERAL EXPENSES (3% Previous expenses)									6,42			6,42
9- FARMER (Businessperson) RETURN (5% Previous expenses)												11,03
TOTAL		3,0		34,53	0,0			0,00	10,0		186,02	231,58
PERCENTAGES		14,91%			0,00%				80,33%			

TOTAL COSTS			
COST OF OPERATIONS (D.E.E.)			231,6
Income			0,0
Interest rate	(rate)	(inv. capital)	(value)
Fixed capital investment (Machinery)	Calculated in attachment		0,0
Fixed capital investment (other capital goods)	2,5%		
Land rental value			30,0
Uninsurable risk reserve	2%	231,6	4,6
Total Costs			266,2