Triggering the creation of biomass logistic centres by the agro-industry

SUCELLOG: IEE/13/638/SI2.675535

D4.3b
Summary of the current situation of Cooperativa Agraria San Miguel and feasibility study

07.04.2015

Co-funded by the Intelligent Energy Europe
Programme of the European Union

About SUCELLOG project

The SUCELLOG project - Triggering the creation of biomass logistic centres by the agro-industry - aims to widespread the participation of the agrarian sector in the sustainable supply of solid biofuels in Europe. SUCELLOG action focuses in an almost unexploited logistic concept: the implementation of agro-industry logistic centres in the agro-industry as a complement to their usual activity evidencing the large synergy existing between the agro-economy and the bio-economy. Further information about the project and the partners involved are available under www.sucellog.eu.

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About this document

This report corresponds to D4.3b of the SUCELLOG project - Summary of the current situation of Cooperativa Agraria San Miguel and feasibility study. It has been prepared by:

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This project is co-funded by the European Commission, contract N°: IEE/13/638/SI2.675535

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1. Introduction

This report includes a description of the current situation of the agro-industry Cooperativa Agraria San Miguel and an assessment of the techno-economic feasibility to become a logistic centre in addition to its usual activities. As part of other tasks (Task 4.2, 4.3, 4.4, 4.5) in the project, data has been gathered by the partner SPANISH COOPERATIVES through interviews with the cooperative's manager and other stakeholders. This information constitutes the basis for this report. The aim of the feasibility study is to investigate whether the production of solid biomass from agricultural residues in Cooperativa Agraria San Miguel - acting as a logistic centre - would be feasible and, most importantly, sustainable.

2. Company description

The cooperative has 1,700 associates, among which 450 are currently farmers. The cooperative does not offer special services or products, but tries to have a very close contact with its associates. The interest of becoming a logistic centre is to create a benefit for its associates by using their residues (cereal straw and maize stalks) in an efficient way. The managing board, composed of 12 members, is the one taking the decisions. The cooperative is located in Zaragoza, Spain, Camino Abarquillo, SN 50660 Tauste (Figure 1).

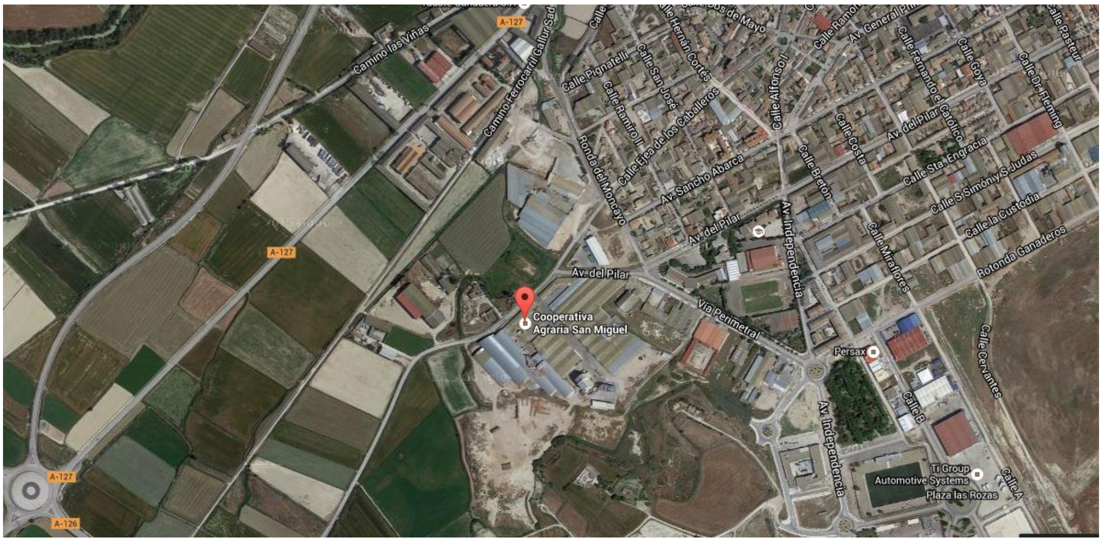

Figure 1: Location of Cooperativa Agraria San Miguel (Source: Google maps).

The current main activities of the company are the following:

a. Generation of fodder pellets and bales from alfalfa in 2 production lines from April to November.
b. Cereal drying (mainly maize) in 2 production lines from October to December.

c. Production of fodder pellets from agro-industrial food residues throughout the whole year.

3. Development of a new business line as an agro-industry logistic centre

The cooperative is interested in creating a biomass logistic centre from the agriculture residues of their associates, selling the final products to local consumers (even their own associates who own pig farms).

Additionally, the cooperative is currently consuming 1,000 t/yr of biomass for one of the alfalfa dehydration lines. The cooperative would like to explore the possibility of installing a biomass burner in the second alfalfa dehydration line so their consumption of biomass would increase. Currently, solid biomass consumed includes a mixture of olive pomace and olive pits, almond shell and grape marc, but the cooperative buys what is more accessible (in price) every year.

4. Biomass resources availability

In task 4.2 of the SUCELLOG project, a biomass procurement and competitiveness assessment has been made for an area considering a 30 km radio around the company location. The assessment showed that a considerable amount of agricultural residues are available for the production of solid biomass (no market competition), as it is shown in Figure 2.

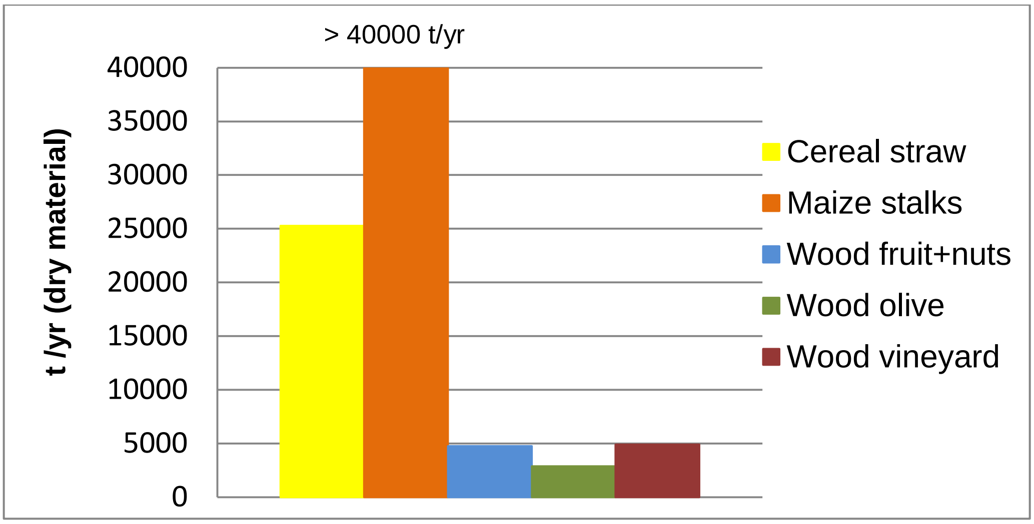

Figure 2: Amount and type of resources available in a 30 km radio.

Resources available can be divided into two groups: herbaceous (cereal straw and maize stalks) and woody (prunings). Comparing the two groups, the following remarks should be taken into consideration:

- As it can be observed, the quantity of herbaceous residues available for the logistic centre is much higher in comparison with woody residues, meaning that the risks of supply would be considerably lower with herbaceous residues.
- However, it should be pointed out that from the quality point of view, woody residues are less problematic for burning compared to herbaceous feedstock (less ash content, higher ash fusion temperature and less chlorine content among others).
- Additionally, it should be highlighted that prunings logistics chains do not exist in the area yet: there are no harvesting experiences or companies dedicated to the logistics of this residues, on the contrary to what happens with the herbaceous residues which have been developed long ago for supplying the cattle and pig farms demands.

As a second step, an evaluation of the amount of available resources coming only from the associates of the agro-industry has been done, based on data provided by the manager and associates. This considers a radio of 18 km and will imply less risk in supply to the logistic centre. The available quantities, moisture content (weight percentage in wet base, w-% ar), months of production and purchasing price including transport to the cooperative are shown in Table 1.

Table 1: Data on the available agricultural residues in 18 km distance.

Type of residue	Quantity available	Moisture content	Months of harvest	Purchasing price (transport included)
	t/yr	w-%, ar		€/t
Cereal straw	11,000	15	July-August	36 (baled)
Maize stalks	8,000	25	Oct-Nov	33 (loose)

The price of the cereal straw bales has been constant since many years: 36-40 €/t at the consumer's place. However, every year more and more straw is left on the soil since the main market for cattle feeding and bedding is decreasing considerably. For this feasibility study a price of 36 €/t has been considered.

Maize stalks market does not exist anymore for cattle feeding or it is very marginal. This means that most of it is left on the soil and therefore, a priori, could be available for the logistic centre. However, harvesting the stalks is not as easy as in the case of the straw: firstly a chopper has to pass, secondly a windrower and finally the baler, which can lead to a high compaction of the soil due to the number of machinery used. Therefore, sometimes the farmers would not accept to collect it depending on the weather conditions. This means that ensuring the supply is less feasible compared to straw. Nowadays the harvesting of maize is done more and more in October which could be a good solution to be able to harvest the stalks with less compaction of the soil, since it will be less wet than in November.

The maize stalks can be purchased both in bales or loose. Knowing that the price of loose stalks is cheaper, this last option would be more convenient for very short distances. The price of loose maize stalks at the agro-industry is on average 33 €/t.

5. Bioenergy market potential

In task 4.3 of the SUCELLOG project, an assessment of the bioenergy market in the vicinity of the cooperative has been conducted.

The potential consumers are expected to be pig farms which are numerous in the area and they need heat all the year (especially mother's pig farms). Consumption of biomass can reach up to 100 kg/yr per animal. In a radio of 50 km distance there is a total of 162,000 animals according to the statistics from 2013 of the regional government[1]. Some of the associates of the cooperative own pig farms, meaning that they can be both suppliers of the raw material and consumers of the solid biomass produced in their cooperative.

Other consumers could also be other dehydration facilities, sport centres and an elderly residence consuming biomass during winter, some during all the year (with a second gas burner for the peak of consumption) or other during their industrial process (dehydration from May until November). Currently, they are mainly consuming wood pellets, almond shells or wood chips.

The biomass market in the area has different suppliers with a wide range of variety products (mainly agro-industrial residues, which price fluctuates importantly from one year to another). Main feedstocks in the area, their price including transport (VAT excluded) and their ash content (weight percentage in dry base, w-% db; estimated value since suppliers sometimes cannot provide this data) are:

- Olive pomace: 110 €/t (ash content 5-7 w-% db)
- Olive pits: 150 €/t (ash content 1-4 w-% db)
- Almond shell: 70-130 €/t (ash content <1 w-% db)
- Grape marc: 70 €/t (ash content 3-4 w-% db)
- Wood chips: 73 €/t (ash content <3 w-% db)
- Wood pellets: 165 €/t (ash content <3 w-% db)

6. Technical assessment of the facility

The technical assessment will be conducted according to the logistical components which are needed for the new business line. In that sense, the different production lines have been evaluated reaching to the following conclusions:

[1] Dirección General de Aragón. Departamento deDesarrollo Rural y Sostenibilidad. Directorio Ganadero 2008-2013.

- None of the technical equipment used for the production of fodder pellets from agro-industrial food residues will be assessed as this line has no idle period.
- None of the 2 cereal drying lines owned by the cooperative can be used because of the technical incompatibility of the dryer to work with herbaceous feedstocks.
- Therefore only the logistical components used for the 2 lines of fodder production from alfalfa will be taken into consideration. From now, only these production lines will be considered for the feasibility study. These include: particle size reduction, drying, milling, pelletising and storage. Even if the alfalfa season last from April to November, it can be considered that from July to November 50 % of the facility (meaning a whole one line) could be available for the production of the biomass fuels in the logistic centre.

Figure 3 shows the flow diagram of the current alfalfa production facility. The equipment that will be used for the new business line as biomass logistic centre are highlighted in this diagram and explained in detail in the further sub-sections.

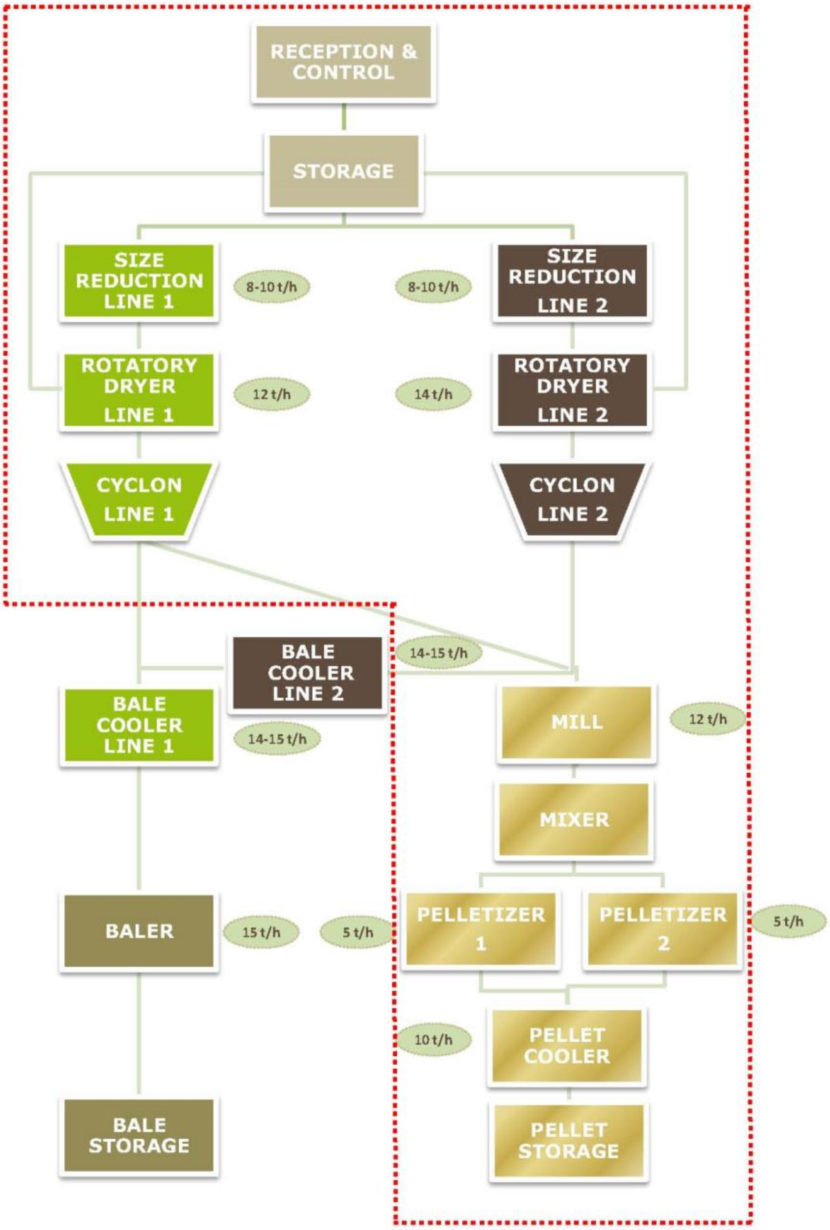

Figure 3: Flow diagram of the current alfalfa production lines (equipment proposed for the biomass logistic centre surrounded in red).

6.1. Particle size reduction

Currently the company has 2 rotary particle size reduction machines used to process the alfalfa fibres before the drying process.

6.2. Drying

The cooperative owns 2 dryers used for the dehydration of alfalfa, one operating on heat produced from combustion of almond shells, olive pits, and grape marc (“APYSA”, line 1) and the other from combustion of natural gas (“DUTCH DRYERS”, line 2). Both of them can be used in the logistic centre for drying maize stalks. In this study it has been considered that the cereal straw does not need to be dried as it is usually left on the fields to be dried naturally up to 15 % moisture content (w-%, ar).

6.3. Milling and pelletising

The cooperative owns 1 mill and 2 identical pelletising machines in order to pelletise the alfalfa. The same machines can be used to make the agro-pellets in the logistic centre. The pelletisers are equipped with a previous milling system and a subsequent cooling system.

6.4. Storage

The cooperative has an open area of 18,000 m^2 as a storage capacity and owns 10 silos of 3,602 m^3 to store cereal grains and fodder pellets. Additional storage may be needed during the months from July to November (the months when the alfalfa is processed and the biomass resources are available). Working under demand is therefore highly recommended in that period for the logistic centre.

6.5. Heat generation

For the 2 lines of alfalfa dehydration, 2 burners are used. One, which uses biomass (almond shells, olive pomace and pits and grape marc as powder), and one which uses natural gas.

The heat produced from the biomass burner goes to the APYSA dryer while the heat produced by the gas burner goes to the DUTCH DRYERS.

Several scenarios will be considered including the purchasing of a new biomass burner to replace the gas burner. The scenarios will be explained in section 7.2.

6.6. Maximum capacity for the logistic centre

The maximum capacity of each whole line for alfalfa is 10 t/h. It is important to highlight that the line does not work with the same capacity with another type of material different from alfalfa because of fibre structure and density.

According to the technical responsible of the alfalfa line, the capacity could reach:

- 7 t/h for cereal straw
- 7.5 t/h for maize stalks
- 5 t/h for wood

These are the flows that will be considered from now on for the logistic centre.

Additionally, it is important to clarify that only one line (either line 1 or line 2) will be used for the production of solid biomass, so the other one could be available for other purposes. The convenience of using one or the other one will be examined in section 7.2.3.

7. Feasibility of the new business line as an agro-industry logistic centre

The company is interested in starting a new business as a biomass logistic centre, producing the following solid biomass products:

a. Loose straw and maize stalks for own consumption
b. Cereal straw pellets for sale
c. Maize stalk pellets for sale

As a first step the cooperative wishes to produce solid biomass enough to cover 10 % of the heating demand of the pig farms in a radio of 50 km which, according to the data presented in section 5, this is equivalent to 1,626 t/yr of production. The cooperative requires a profit of 12 € per ton which makes a yearly profit of 19,512 €/yr. According to the consumers' satisfaction, the cooperative will further consider the possibility of increasing their production.

Moreover, the cooperative would like to explore the possibility of consuming loose straw and maize stalks in its own facility.

In order to check whether this would be economically and technically feasible and sustainable, different scenarios have been developed and the best case scenario will be chosen.

7.1. Quality assessment of the new products

As a first approach for this study, it is necessary to clarify the quality parameters for solid biomass which the company aims to produce.

Nowadays, there is an international standard ISO 17225 which normalizes every category of solid biomass.

ISO 17225 – 1: General requirements
ISO 17225 – 2: Graded Wood Pellets
ISO 17225 – 3: Graded Wood Briquettes
ISO 17225 – 4: Graded Wood Chips
ISO 17225 – 5: Graded Firewood
ISO 17225 – 6: Graded non-woody Pellets
ISO 17225 – 7: Graded non-woody Briquettes

In addition, it is necessary to remember that boilers are made in order to use specific types of solid biofuels. For instance, wood pellet boilers or wood pellet stoves can be constructed to burn only wood pellet graded ISO 17225 – 2 Class A1. If it is not the case and other type of fuel is used, the manufacturer may remove the guarantee of his product.

This study will focus on ISO 17225 – 6 for the quality of solid biomass to be studied but also on ISO 17225 – 4 and ISO 17225 – 2 in order to compare the quality with other solid biomass currently in the market. Quality requirements are shown in Table 2.

Table 2: Quality parameters for these 3 types of biofuels.

ISO 17225	Wood Pellets ISO 17225-2 A1	Wood Pellets ISO 17225-2 A2	Wood Pellets ISO 17225-2 B	Wood Chips ISO 17225-4 A1	Wood Chips ISO 17225-4 A2	Wood Chips ISO 17225-4 B	AGROPELLETS ISO 17225-6 A	AGROPELLETS ISO 17225-6 B
Moisture (w-% ar)	≤ 10	≤ 10	≤ 10	≤ 10 ≤ 25	≤ 35	be mentionned	≤ 12	≤ 15
LHV (kWh/kg, ar)	≥ 4,6	≥ 4,6	≥ 4,6	be mentionned	be mentionned	be mentionned	≥ 4	≥ 4
Ash (w-% db)	≤ 0,7	≤ 1,2	≤ 2	≤ 1	≤ 1,5	≤3	≤ 6	≤ 10
N (w-% db)	≤ 0,3	≤ 0,5	≤1	-	-	1,00	≤ 1,5	≤ 2
S (w-% db)	≤ 0,03	≤ 0,05	≤0,05	-	-	0,10	≤ 0,2	≤ 0,3
Cl (w-% db)	≤ 0,02	≤ 0,02	≤ 0,03	-	-	0,05	≤ 0,1	≤ 0,3
As (mg/kg)	≤ 1	≤ 1	≤ 1	-	-	1,0	≤ 1	≤ 1
Cd (mg/kg)	≤ 0,5	≤ 0,5	≤ 0,5	-	-	2,0	≤ 0,5	≤ 0,5
Cr (mg/kg)	≤ 10	≤ 10	≤ 10	-	-	10,0	≤ 50	≤ 50
Cu (mg/kg)	≤ 10	≤ 10	≤ 10	-	-	10,0	≤ 20	≤ 20
Pb (mg/kg)	≤ 10	≤ 10	≤ 10	-	-	10,0	≤ 10	≤ 10
Hg (mg/kg)	≤ 0,1	≤ 0,1	≤ 0,1	-	-	0,1	≤ 0,1	≤ 0,1
Ni (mg/kg)	≤ 10	≤ 10	≤ 10	-	-	10,0	≤ 10	≤ 10
Zn (mg/kg)	≤ 100	≤ 100	≤ 100	-	-	100,0	≤ 100	≤ 100
shrinkage starting temp. (°C)	be mentionned	be mentionned	be mentionned	-	-	-	be mentionned	be mentionned
deformation temp. (°C)	be mentionned	be mentionned	be mentionned	-	-	-	be mentionned	be mentionned
hemisphere temp. (°C)	be mentionned	be mentionned	be mentionned	-	-	-	be mentionned	be mentionned
flow temp. (°C)	be mentionned	be mentionned	be mentionned	-	-	-	be mentionned	be mentionned

The comparison of the quality parameters of raw material with respect to ISO 17225 – 6 standards is therefore essential. Indeed, possible limiting factors that prevent the use of the raw material to produce solid standardised agro-fuels should be identified.

It is necessary to precise that this comparison is just theoretical because the quality parameters of the raw material are from bibliography (Annex B, ISO 17225-1 or

RAGT database), since the exact raw material that Cooperativa Agraria San Miguel aims to gather was not really analysed at this stage of the project.

In the case of straw and wood, it is important to mention that some simple analyses of ash content and Chlorine were done to Cooperative's samples. The results showed in the case of straw important differences in comparison with the average value from ISO 17225-1. However, for this study the average value from the standard ISO 17225-1 corresponding to straw has been considered, since the sample analysed was not considered to be representative enough. In the case of wood, the values from the samples analysed have been used since they come from the most possible wood supplier.

The quality values considered for the maize stalks in this study come from RAGT database. A sample from 1 year ago that was taken by the cooperative was subject of a simple analysis and the values were within RAGT intervals. Therefore, in this study a minimum and maximum value of Chlorine coming from RAGT database will be subject of analysis in the scenarios.

Table 3 shows the different quality parameters of maize stalks, cereal straw and wood together with the standard guidelines for their comparison. The necessity with mixtures with wood to improve quality will be evaluated.

Table 3: Quality of possible raw materials and guidelines from ISO 17225 – 6 standard.

SPAIN CASE - Cooperativa Agraria San Miguel	Mais stalks			Cereal Straw			Wood			AGROPELLETS ISO 17 225-6 A	AGROPELLETS ISO 17 225-6 B
Data source	RAGT Bank of knowledge		Sample from last year	Sample from last year	Sample recently harvested DURUM Rainfed	Average value ISO 17225	Sample 1 wood	Sample 2 wood	AVERAGE value from wood sample 1 and 2		
	Mini.	Maxi.	Value	Value	Value	Value	Value	Value	Value		
Moisture (en %)	9,96	24,18	9,35	9,71	5,71	-	6,88	7,29	7,09	≤ 12	≤ 15
LHV (kWh/kg, ar)	3,89	4,28	4,07	4,23	-	4,33	4,48	4,55	4,51	≥ 4	≥ 4
Ash (w-% db)	5,46	10,45	6,07	4,97	9,69	5,00	2,73	1,53	2,13	≤ 6	≤ 10
N (w-% db)	0,50	1,55	-	-	-	0,50	1,00	1,00	1,00	≤ 1,5	≤ 2
S (w-% db)	0,01	0,12	-	-	-	0,10	0,05	0,05	0,05	≤ 0,2	≤ 0,3
Cl (w-% db)	0,12	0,40	-	-	0,89	0,40	0,03	0,03	0,03	≤ 0,1	≤ 0,3
As (mg/kg)	1,23	1,23	-	-	-	0,10	-	-		≤ 1	≤ 1
Cd (mg/kg)	0,56	0,56	-	-	-	0,10	-	-		≤ 0,5	≤ 0,5
Cr (mg/kg)	26,42	26,42	-	-	-	10,00	-	-		≤ 50	≤ 50
Cu (mg/kg)	6,90	6,90	-	-	-	2,00	-	-		≤ 20	≤ 20
Pb (mg/kg)	3,18	3,18	-	-	-	0,50	-	-		≤ 10	≤ 10
Hg (mg/kg)	0,07	0,07	-	-	-	0,02	-	-		≤ 0,1	≤ 0,1
Ni (mg/kg)	11,16	11,16	-	-	-	1,00	-	-		≤ 10	≤ 10
Zn (mg/kg)	21,51	21,51	-	-	-	10,00	-	-		≤ 100	≤ 100
Ash Softening Temperature (°C)	1049	1049	-	-	-	-	-	-		be mentionned	be mentionned

According to this table, it can be said that:

- Agro-pellets graded ISO 17225–6 A and ISO 17225–6 B cannot be produced with 100 % of cereal straw because the Chlorine content of this raw material is too high (0.4 w-% db).

Moreover, it is important to say that the sample analysed by the cooperative (taken immediately after harvesting) has a Chlorine content extremaly high (around 0.9 w-% db). This high content of Chlorine could be caused by the use of KCl fertilizers, which is a common practice in the area.
Consequently the only way to produce an agro-pellet graded ISO 17225 – 6 A is to use a blend with 80 % of wood with 20 % of cereal straw. A maximum limit of 20 % cereal straw is required to achieve quality Class A. In this case, the economic feasibility should be evaluated although a priori would not be the best scenario for the cooperative since production costs are presumed to be high due to the high amount of wood in the mixture.

- Concerning the maize stalks, the maximum value of Chorine is also a problem in order to produce agro-pellets ISO 17225 – 6 A. In addition, the contents of some heavy metals are also too high. The mixture with wood is therefore necessary. If the minimum value of Chlorine is considered, a share of 70 % maize stalks and 30 % wood is needed to reach Class A. A percentage higher than 70 % would mean not to fulfill quality Class A. On the contrary, if the maximum value of Chlorine is considered, to reach Class A, a share of maximum share of 20 % maize stalks (and 80 % wood) is required, which as happened with the straw, can make the unfeasible from the economic point of view.
- Regarding the production of agro-pellets graded ISO 17225 – 6 B, the use a blend of 30 % of wood and 70 % either of cereal straw or maize stalks is required. More than 70 % share of straw or stalks would mean not to satisfy quality Class B.

All these quality issues will be considered in the economic assessment in order to suggest the possible scenarios to be studied.

7.2. Economic assessment

At a first stage, an assessment of the investment costs for the new business and the related costs will be made. In a second stage, the purchasing costs of the agricultural residues, the pre-treatment, personnel and other costs will be determined. Since the market price of the mixed pellets is not known in the region, different scenarios will be considered.

7.2.1. Investment costs

In order to start the new business line, the only investment required would be the adaptation of the biomass burner in the production line 1 (“APYSA” dryer) in order to burn loose straw and maize stalks or the purchasing of a new biomass burner to replace the gas burner in the production line 2 ("DUTCH DRYERS" dryer). In other words, the options to be considered are the following:

<u>Line 1</u>

- Option 1.1: Biomass burner keeps running on almond shells, olive pomace and grape marc as now does.
- Option 1.2: The current biomass burner is adapted in order to burn loose straw and maize stalks as well.

After conversations with the manufacturer of the existing biomass burner, it was confirmed that option 1.2 is not technically possible. Therefore, in the line 1 only option 1.1 will be considered. No changes and investments will be undertaken for this line.

<u>Line 2</u>

- Option 2.1: Gas burner keeps running as now does. In this case, the solid biomass produced in the cooperative will not be used but will be all be sold. This option is studied since the dryer has a higher efficiency compared to the one in Line 1, although the fuel costs are higher than for the biomass.
- Option 2.2: A new biomass burner of 5 MW burning loose straw and maize stalks will be purchased. In this case the cooperative will be able to consume its own solid biomass both for the logistic centre or for the alfalfa process.

Therefore the 2 following scenarios will be considered:

- **Scenario GB**:
  - Line 2 - Option 2.1: Gas burner keep running on natural gas
- **Scenario BB**:
  - Line 2 - Option 2.2: Acquisition of a new biomass burner

In both scenarios Line 1 will include Option 1.1: Biomass burner running on almond shells, olive pits and grape marcs.

The investment costs for the 2 scenarios are illustrated in Table 4.

Table 4: Investment costs (€) for the new business.

Investment items	**Investment costs €**	**Capital-related costs €**	**Maintenance costs €**	**Total costs €**
Scenario GB				
Current status	0	0	0	0
Scenario BB				
Acquisition of a new biomass burner	434,190 (*)	0	0	439,190 (*)

(*) Costs of the biomass storage are not included.

In case of investment in a biomass burner (scenario BB), the payment will be made in cash incurring no capital related costs or maintenance costs.

7.2.2. Purchasing costs

The raw material needed for the new business activity will be purchased from the associates of the cooperative located in the vicinity of the company (maximum 18 km away). In the case of wood chips, they will be purchased for the production of the mixed pellets from a company that works in the area (being the owner an associate of the cooperative as well) at 73 €/t (moisture content at 17 w-% ar, ash content 3 w-% db and particle size distribution G30).

Based on the quality assessment in Section 7.1, a total of 5 scenarios will be considered related to the type and quality of agro-pellets produced :

- Scenario SWP-A: Production of mixed straw (20 %) and wood (80 %) pellets Class A
- Scenario MWP-A min: Production of mixed maize stalks (70 %) and wood (30 %) pellets Class A
- Scenario MWP-A max: Production of mixed maize stalks (20 %) and wood (80 %) pellets Class A
- Scenario SWP-B: Production of mixed straw (70 %) and wood (30 %) pellets Class B
- Scenario MWP-B: Production of mixed maize stalks (70 %) and wood (30 %) pellets Class B

It is important to mention that the proposed mixture of wood and maize stalks for agro-pellets Class A (containing the minimum tested value of chlorine, see Section 7.1) corresponds to the one for class B. So Scenario MWP-A min is the same as Scenario MWP-B. From now on, in the document, it will only be referred as MWP-B and MWP-A max will be referred as MWP-A.

In order to produce 1,626 t/yr of mixed pellets different ratios of straw to wood and maize stalks to wood are needed in order to reach Class A and B quality products. The cereal straw, maize stalks and wood are purchased at moisture content (w-% ar) of 15 %, 25 % and 17 %, respectively but for the final pellet produced, the moisture content needs to decrease to 10 % for all. Therefore, the quantity of straw, stalks and wood to be purchased should be higher so that the final quantity corresponds to 1,626 t/yr (at 10 w-% ar moisture content). Table 5 shows the quantity of raw material to be purchased and their percentage for the production of 1,626 t/yr in the 4 scenarios.

Table 5: Cost of raw material purchasing

Residue type	Mixture	Quantity for final product	Quantity of raw material	Unit price	Total price
	%	t	t	€/t	€
Scenario SWP-A					
Cereal straw (15% w)	20	325	344	36	12,392
Wood (17% w)	80	1,300	1,410	73	102,935
Total		1,626	1,754		**115,327**
Scenario MWP-A					
Maize stalks (25% w)	20	325	390	33	12,874
Wood (17% w)	80	1,300	1,410	73	102,935
Total		1,626	1,800		**115,809**
Scenario SWP-B					
Cereal straw (15% w)	70	1,138	1,205	36	43,372
Wood (17% w)	30	488	529	73	38,601
Total		1,626	1,734		**81,973**
Scenario MWP-B					
Maize stalks (25% w)	70	1,138	1,365	33	45,059
Wood (17% w)	30	488	529	73	38,601
Total		1,626	1,894		**83,660**

Prices of the raw material include the transport to the cooperative (VAT excluded).

7.2.3. Pre-treatment costs

After purchasing the residues, they need to be pre-treated before being sold as solid biomass products. The pre-treatment include: particle size reduction, drying, milling, and pelletisation. No storage costs will be considered in this study. All costs are expressed per ton of product at 10 % moisture content.

- Cereal straw purchased at 15 % moisture content does not need to be dried.
- Maize stalks available at 25 % moisture content need drying until they reach 13 % moisture content.
- Wood purchased at 17 % moisture content need to be dried until they reach 13 % moisture content.

During the particle size reduction process, cereal straw looses 2% in moisture content. During milling and pelletisation processes, the moisture content of the straw, maize stalks and wood will decrease to reach 10 % moisture content.

For the drying of the raw material, 2 scenarios will be considered:

- **Scenario L1:** using Line 1 (pulverised biomass burner) to dry wood and maize stalks
- **Scenario L2**: using Line 2 (gas burner) to dry wood and maize stalks

Considering the investments scenarios related to burners for heat production (see section 7.2.1), agro-pellets Class A/B scenarios related to raw material type (showed in section 7.2.2) and the drying scenarios related to type of biomass used for heat production (explained above), the pre-treatment costs will be calculated according to the following combined scenarios:

- **SWP-A, L1 and SWP-B, L1:** producing mixed straw and wood pellets using Line 1 (pulverised biomass burner) for pre-treatment. This means that almond shells, olive pits and grape marcs will be purchased for heat production.
- **SWP-A, L2, GB and SWP-B, L2, GB:** producing mixed straw and wood pellets using Line 2 (gas burner) for pre-treatment. This means that natural gas will be purchased for heat production
- **SWP-A, L2, BB and SWP-B, L2, BB:** producing mixed straw and wood pellets using Line 2 (New biomass burner) for pre-treatment. This means that loose straw and maize stalks will be used for heat production.
- **MWP-A, L1 and MWP-B, L1:** producing mixed maize stalks and wood pellets using Line 1 (pulverised biomass burner) for pre-treatment. This means that almond shells, olive pits and grape marcs will be purchased for heat production.
- **MWP-A, L2, GB and MWP-B, L2, GB:** producing mixed maize stalks and wood pellets using Line 2 (gas burner) for pre-treatment. This means that natural gas will be purchased for heat production.
- **MWP-A, L2, BB and MWP-B, L2, BB:** producing mixed maize stalks and wood pellets using Line 2 (New biomass burner) for pre-treatment. This means that loose straw and maize stalks will be used for heat production.

Pre-treatment costs have been calculated making an extrapolation of the costs incurred when the facility is working with alfalfa and when the facility has worked with wood (the facility has been hired by a biomass production company to make wood pellets in several occasions). For the estimation, the different capacities of the lines running with the different materials (mentioned in section 6.6) have been taken into consideration.

Maintenance costs include both the personnel costs and the costs of the devices which need to be replaced (for example knives in the milling system).

7.2.4. Personnel and other costs

The personnel costs were included in the pre-treatment costs. Therefore no additional costs will be considered in this section.

7.2.5. Production cost

If the purchasing costs and the pre-treatment costs are summed up knowing that the personnel costs are included in the pre-treatment costs, the production cost of one ton of produced agro-pellets has been identified. All costs are expressed per ton of product at 10 % moisture content. The production cost of the agro-pellets in the different scenarios is shown in Table 6.

Table 6: Production costs of agro-pellets in the different scenarios.

Type of Scenario	Quantity produced	Total costs		Production cost
		Purchasing cost	Pretreatment costs	
	t	€/t	€/t	€/t
SWP-A, L1	1,626	71	64	135.4
SWP-B, L1	1,626	50	44	94.5
SWP-A, L2, GB	1,626	71	66	136.8
SWP-B, L2, GB	1,626	50	45	95.1
SWP-A, L2, BB	1,626	71	57	128.3
SWP-B, L2, BB	1,626	50	41	91.9
MWP-A, L1	1,626	71	68	139.4
MWP-B, L1	1,626	51	57	108.5
MWP-A, L2, GB	1,626	71	70	141.1
MWP-B, L2, GB	1,626	51	58	109.9
MWP-A, L2, BB	1,626	71	60	131.0
MWP-B, L2, BB	1,626	51	50	101.2

Figure 4 illustrates the different share of purchasing and pre-treatment cost in the possible products generated in the production line 1. As it was expected, the production costs of maize stalks derived products is, for the same mixture percentage, slightly higher compared to straw derived products due to the necessity to dry the stalk before pelletising. Addittionally, it should be said that the production of Class A pellets, which implies high share of wood with respect to Class B products, increases the production price between 30 and 42 €/t. The trend is the same for the scenarios using line 2 GB or line 2 BB.

In Figure 5, it is shown the comparison of the costs of the same product with different lines (L1, L2 GB and L2 BB), being the same costs more or less using L1 or L2-GB and more interesting if the scenario L2-BB is considered (which as a disadvantage, requires an investment in a new burner). Although the figure shows only the results for the product SWP-A, the same trend is repeated for the rest (SWP-B, MWP-A and MWP-B).

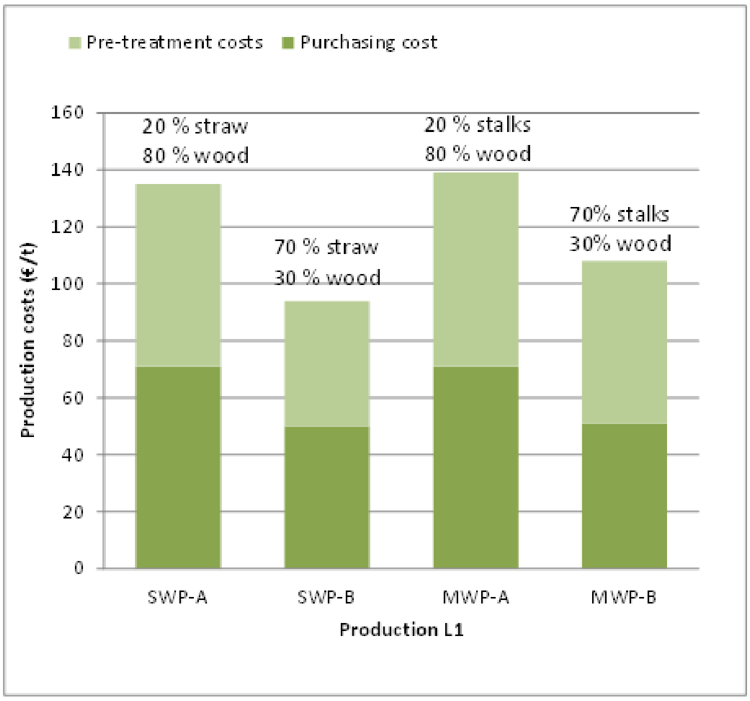

Figure 4: Production costs for the different product generated with production Line 1.

Figure 5: Production costs for SWP-A in the different lines.

7.2.6. Market price, revenue and profit

The cooperative states a minimum profit of 12 €/t of agro-pellets to mitigate possible risks when starting this new business line. It is important to mention that the selling price which defines the revenue should include also the transportation costs to consumers (maximum 10 €/t for a radio of 60 km distance) since the rest of market products include it.

As mentioned previously, there is no defined market price for the agro-pellets in the region. Table 7 shows the minimum selling price to cover the production cost and obtain a minimum profit of 12 €/t in each scenario. As it can be observed, the minimum selling price of all agro-pellets Class A is above 140 €/t, which as it will be mentioned in section 7.3, means a high price vs quality compared to market competitors. On the other hand the price of Class B agro-pellets lies within the range of 120-140 €/t which can be more suitable for the logistic centre.

Table 7: Minimum selling price of agro-pellets for a profit of 12 €/t in the different scenarios.

Type of Scenario	Quantity produced	Production cost	Transport cost	Minimum Profit	Min selling price	Min total revenue
	t	€/t	€/t	€/t	€/t	€
SWP-A, L1	1,626	**135.4**	10	12	**157**	**255,914**
SWP-B, L1	1,626	**94.5**	10	12	**117**	**189,440**
SWP-A, L2, GB	1,626	**136.8**	10	12	**159**	**258,171**
SWP-B, L2, GB	1,626	**95.1**	10	12	**117**	**190,286**
SWP-A, L2, BB	1,626	**128.3**	10	12	**150**	**244,285**
SWP-B, L2, BB	1,626	**91.9**	10	12	**114**	**185,079**
MWP-A, L1	1,626	**139.4**	10	12	**161**	**262,403**
MWP-B, L1	1,626	**108.5**	10	12	**131**	**212,151**
MWP-A, L2, GB	1,626	**141.1**	10	12	**163**	**265,076**
MWP-B, L2, GB	1,626	**109.9**	10	12	**132**	**214,454**
MWP-A, L2, BB	1,626	**131.0**	10	12	**153**	**248,629**
MWP-B, L2, BB	1,626	**101.2**	10	12	**123**	**200,283**

7.2.7. Total profit

As said in the previous section, Class A product will be difficult to be introduced in the market due to their high price vs quality. In this section only the scenarios regarding quality Class B will be analysed.

The total profit and revenues per year taking into consideration that the product is sold at the minimum selling price in the scenarios with no investments producing Class B agro-pellets (SWP-B, L1; SWP-B, L2, GB; MWP-B, L1; MWP-B, L2, GB) corresponds to the fixed profit of 12 €/t. Concrete results are shown in Table 8.

Table 8: Total profit and revenues for a minimum profit of 12 €/t in scenarios SWP-B, L1; SWP-B, L2, GB; MWP-B, L1; MWP-B, L2, GB.

		SWP-B, L1	SWP-B, L2, GB	MWP-B, L1	MWP-B, L2, GB
Expenses (€)	**Investment costs**	0	0	0	0
	Purchasing costs	81,973	81,973	83,660	83,660
	Pretreatment costs	71,706	72,553	92,730	95,034
	Transportation cost of sales	16,255	16255	16,255	16,255
Income (€)	**Sales revenue**	189,440	190,286	212,151	214,454
	Other revenue	0	0	0	0
Profit (€)		19,506	19,506	19,506	19,506

As for the scenarios incurring the investment in a new Biomass burner and producing Class B agro-pellets (SWP-B, L2, BB and MWP-B, L2, BB) the savings resulting from using loose straw and maize stalks for drying the alfalfa instead of natural gas were included. Assuming that the product is sold at the minimum price that cover costs and for a fixed profit of 12 €/t, the payback on the investment will be reached in the 6th year for as it is illustrated in Table 9 and Table 10. The results show a NPV (net present value) of 117,824 (considering a discount rate of 7 %) and a IRR (internal rate of return) of 13 %. If the price of the product in the market is higher than the minimum selling price, the payback of the investment will be shorter but the risks of selling the product will increase.

Table 9: Payback on investment in scenario SWP-B, L2, BB.

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Expenses (€)	**Investment costs**	434,190	0	0	0	0	0
	Purchasing costs	81,973	81,973	81,973	81,973	81,973	81,973
	Pretreatment costs	67,345	67,345	67,345	67,345	67,345	67,345
	Transportation cost of sales	16,255	16,255	16,255	16,255	16,255	16,255
Income (€)	**Sales revenue**	185,079	185,079	185,079	185,079	185,079	185,079
	Savings	59,088	59,088	59,088	59,088	59,088	59,088
Profit (€)		-355,596	78,594	78,594	78,594	78,594	78,594
Accumulated profit (€)		-355,596	-277,001	-198,407	-119,813	-41,218	37,376
Payback							**YEAR 6**

Table 10: Payback on investment in scenario MWP-B, L2, BB.

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Expenses (€)	Investment costs	434,190	0	0	0	0	0
	Purchasing costs	83,660	83,660	83,660	83,660	83,660	83,660
	Pretreatment costs	80,862	80,862	80,862	80,862	80,862	80,862
	Transportation cost of sales	16,255	16,255	16,255	16,255	16,255	16,255
Income (€)	Sales revenue	200,283	200,283	200,283	200,283	200,283	200,283
	Savings	59,088	59,088	59,088	59,088	59,088	59,088
Profit (€)		-355,596	78,594	78,594	78,594	78,594	78,594
Accumulated profit (€)		-355,596	-277,001	-198,407	-119,813	-41,218	37,376
Payback							YEAR 6

7.3. Risk assessment

The main risk for the new business line as biomass logistic centre would be the generation of products that do not satisfy consumers from the quality point of view. In the case of the scenarios where an investment is made, the risk is obviously higher and linked to the necessity to sell the product to be able to amortize it.

Although a theoretical assessment of quality has been performed in section 7.1, a further analysis of quality differences with competing products is proposed in this section. All possible products for the scenario L1 have been evaluated since it is the one selected by the cooperative as the most appealing one.

Being the price of the product fixed depending on its quality, it is therefore necessary not only the comparison in terms of €/t but in terms of price per energy and storage necessities. Table 11 and Table 12 show their prices regarding their quality characteristics as well as taking the ash content.

Table 11: Competing products main quality characteristics and prices

	Quality characteristics			Prices		
	LHV (kWh/kg ar)	Bulk density (kg/m^3)	Ash content (w-% db)	€/t	€/kWh	€/m^3
Forest wood chips	3.9	250	≤ 3	73	0.022	18
Forest wood pellets	4.7	650	≤ 2	165	0.035	107
Olive pomace	4.8	500	5-7	110	0.023	55
Olive Pits	4.84	500	1-4	150	0.031	75
Almond shell	4.78	500	< 1	70-130	0.015-0.027	35-65
Grape marc	3.60	500	3-4	70	0.019	35

Table 12: Products quality characteristics and prices

	Quality characteristics			Prices		
	LHV (kWh/kg ar)	Bulk density (kg/m^3)	Ash content (w-% db)	€/t	€/kWh	€/m^3
Mixed pellets of cereal straw (20%) and wood (80%) Class A	4.48	650	2.70	157	0.035	102
Mixed pellets of cereal straw (70%) and wood (30%) Class B	**4.39**	**650**	**4.14**	**117**	**0.027**	**76**
Mixed pellets of maize stalks (20 %) and wood (80 %) Class A	4.47	650	3.79	161	0.036	105
Mixed pellets of maize stalks (70 %) and wood (30 %) Class B	4.02	650	4.79	131	0.033	85

From the comparison of prices, the conclusions about possible risks that the agro-industry can face when selling the possible biomass products are the following:

- The final Agro-pellet Class B mixed 70 % of cereal straw and 30 % wood has the most convenient price per kWh of 0,027 €, which can compete with forestry wood pellets and olive pits. Compared with forest wood chips, the price is lightly higher but agro-pellets have the advantage of requiring less storage space (see Table 13). Only olive pomace have a better price per kWh (being 17 % cheaper).
- The agro-pellets mixed with maize stalks are difficult to use because the price per kWh is higher compared to the agro-pellets mixed with cereal straw. Only in the case of a lower price of the raw material or less drying requirements can be competitive with agro-pellet made from straw.

Table 13: Storage required for the same energy consumption.

	Biofuel characteristics		Quantity needed for boiler 50 kW (90,000 kWh / yr)			
	LHV (kWh/kg ar)	Bulk density (kg/m^3)	t	m^3	load factor (%)	m^3 final needed
Forest wood chips	3.90	250	23	92	60	154
Forest wood pellets	4.70	650	19	29	85	35
Olive pomace	4.80	500	19	38	70	54
Olive Pits	4.84	500	19	37	70	53
Mixed pellets of cereal straw (20%) and wood (80%) quality A	4.48	650	20	31	85	36
Mixed pellets of cereal straw (70%) and wood (30%) quality B	4.39	650	21	32	85	37
Mixed pellets of maize stalks (20 %) and wood (80 %) quality A	4.47	650	20	31	85	36
Mixed pellets of maize stalks (70 %) and wood (30 %) quality B	4.02	650	22	34	85	41

The following Figure shows the different minimum selling price along the straw share for the different lines. The straw share limits for quality A and B pellets together with the price limits are also illustrated, defining an area of comfort in which the production has sense. As it can be seen, the current situation is risky and purchasing or pre-treatment costs should be reduced if possible. On the contrary any minor decrease in the price of competitor products can make our pellet not appealing in the market.

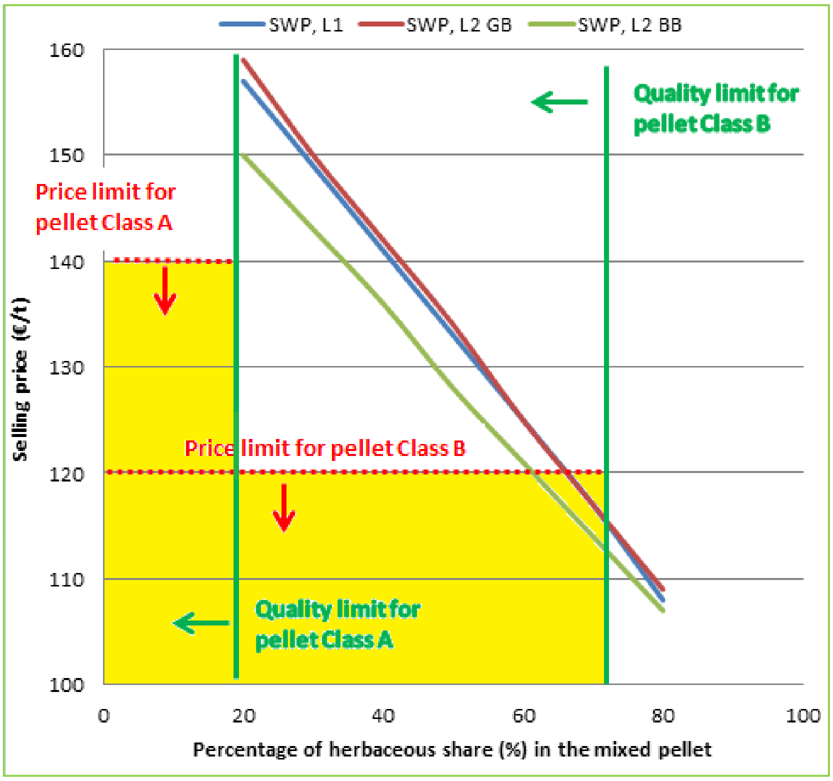

Figure 6: Limits in quality and price for Class A and Class B and confort zone.

Finally, it is essential to highlight two important things to bear in mind:

- As it has been shown in section 7.1, the quality values assumed for the study come from bibliography and previous experience. This means that an important sampling process and determination of quality values of representative material that will be used for the logistic centre is essential. This will avoid unexpected problems and customers dissatisfaction.
- For that reason, it is also important to make some previous tests in several boilers of target customers to check the technical viability of the product. These test results can make the share of the herbaceous and wood product change, helping therefore to agree on the final formula that can make change the previous cost calculations.

7.4. Social assessment

The Social Impact Assessment includes the process of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative of planned interventions (policies, programmes, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment[2]. The social impacts are generally monitored through a set of indicators. In this study, the main social impacts and the indicators which will be assessed are mentioned in Table 14.

Table 14: Impacts and indicators assessed in the study

Social impacts	Indicators
a. Contribution to local economy	Employment
b. Working conditions	Employment benefits
c. Working rights	Health and safety at work, Gender, discrimination,
d. Land rights	Land rights and conflicts
e. Food security	Land converted from staple crops

a. Contribution to local economy: The implementation of a logistic centre using agricultural residues for the production of solid biomass has a positive effect on the economy from the social point of view as it will create a new employment opportunity or more working hours for part time workers. In addition, buying a currently not used residue from local farmers and therefore giving them an additional income is a positive social impact. Around 320 hours were estimated to be required for the new business line. For the moment, no employees will be hired but the part time workers will have more working hours.

b. Working conditions: One of the main areas covered by EU labour law is working conditions. This includes provisions on working time, part-time, and fixed-term work, temporary workers, and the posting of workers. All of these areas are key to ensuring high levels of employment and social protection throughout the EU.

In Cooperativa Agraria San Miguel, the working conditions of the EU are applied. The part time workers have the same working conditions and employment benefits as the full time workers.

c. Working rights: In the EU, workers have certain minimum rights related to

- Health and safety at work: general rights and obligations, workplaces, work equipment, specific risks and vulnerable workers.

[2] http://www.iaia.org/publicdocuments/sections/sia/IAIA-SIA-International-Principles.pdf

- Equal opportunities for women and men: equal treatment at work, pregnancy, maternity leave, parental leave.
- Protection against discrimination based on sex, race, religion, age, disability and sexual orientation.

In Cooperativa Agraria San Miguel, the working rights are all reserved. When dealing with both the raw material and the biomass produced, the workers should wear masks as the risk of inhaling dust particles, which can cause severe health issues, is high.

d. Land rights: The issue of land rights is very relevant in light of the increasing practice of land-scarce countries leasing land in developing countries. This leased land could be primarily used for producing strategic food resources. Nevertheless and irrespective of whether food or fuel resources are grown; the issue of land deals or ‘land grabs’ exemplifies the effects of increased demand for land, to which bioenergy development contributes. The practice of land deals raises serious concerns about the respect of customary land rights of small holders.

The concept of SUCELLOG project will not enhance the leasing of new lands for the production of bioenergy as it will use the residues of agricultural products making this impact irrelevant to the case.

e. Food security: Bioenergy production might compete with agriculture on land use leading to possible jeopardising of food security.

The concept of the SUCELLOG project will not affect food security as it is using the residues of agricultural residues creating no competition with food but on the contrary contributing to synergies with the agricultural sector. The only threat that might evolve is the competition on feed as straw for example can be used for animal feeding, but during the biomass procurement study only residues which have no competition with other uses were taken into consideration.

7.5. Environmental assessment

The Environmental Impact Assessment (EIA) is the process of identifying, predicting, evaluating and mitigating the bio-physical, social, and other relevant effects (positive or negative) of development proposals prior to major decisions being taken and commitments made. In the environmental assessment, the impacts, mainly biodiversity, soil, water and air are usually studied.

In this study since we are dealing with agricultural residues, biodiversity and water are not considered to be affected neither positively nor negatively. Therefore impacts on soil and air will be only discussed.

a. Soil: Addition of crop residues to soils is important because they are a major source of organic carbon (C) and nutrients. Organic C positively impacts soil fertility, soil structure, water infiltration, water holding capacity, and bulk density, and it sustains microbial activity. Removing all residues like straw from the field will have therefore a negative impact on soil. In order to have a sustainable process for the production of solid biomass with no negative impact on the soil, it should be taken into consideration during harvesting to keep a percentage of the residues on the field (between 20-30 %). It is important to highlight that, when stating the amount of raw material available in the biomass assessment study (section 4), all these aspects have been already taken into consideration.

b. Air: two aspects should be taken into account when it comes to air pollution. If the residues are burned in the field, they will emit a lot of pollutants (CO, CH_4, CO_2, SO_2, non-methane volatile organic carbon and ammonia). Therefore using the residues for the production of solid biomass is a good alternative with positive impact.

The report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling (COM(2010)11), recommends that Member States which either have, or introduce, national sustainability schemes for solid and gaseous biomass used in electricity, heating and cooling, ensure that these in almost all respects are the same as those laid down in the Renewable Energy Directive. The directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 established the sustainability criteria for biofuels and bioliquids.

According to COM(2010)11, residues to produce solid biomass should fulfil the criteria of minimum greenhouse gas (GHG) saving values of 35 %, rising to 50 % on 1 January 2017 and to 60 % from 1 January 2018 for biomass produced in installations in which production started on or after 1 January 2017.

In order to check whether these values are fulfilled in the case of the production of mixed (straw and wood) pellets, BIOGRACE tool (developed by the project BIOGRACE II funded by the Intelligent Energy for Europe programme) has been used. The excel sheet allows the calculation of GHG emissions savings entering the case characteristics and the distance from supplier and final consumer.

In the case of the possible logistic centre to be developed by the Cooperative San Miguel, the GHG reduction is considerably higher than 35 %. For the calculation a 100 % wood pellet and a 100 % straw pellet has been used since the tool does not permit the calculation of mixed pellets, resulting both in GHG saving far higher than 35 %. The whole logistics chain of the raw material has been considered in the analysis: harvesting and transport of the raw material, pre-treatment, transport of the product and final conversion. The most adequate values from the ones reflected by the tool have been chosen in each case for the calculation.

8. Summary and Conclusions

Cooperativa Agraria San Miguel is an agro-industrial cooperative whose current activities are: production of fodder pellets and bales from alfalfa; cereal drying and production of fodder pellets from agro-industrial food residues. The cooperative is interested in creating a biomass logistic centre and producing solid biomass from the agriculture residues of their associates, so creating an added value for them.

An assessment of both the boundary conditions (biomass resources and market) and the company conditions (equipment and management) has shown that:

- The agrarian residues available for the logistic centre are cereal straw and maize stalks. Their yearly quantity produced by their associates, in a radio of 18 km, is significant.
- The current biomass market is varied and with many different types of quality and price. The potential consumers are expected to be pig farms mainly, which are numerous in the area and they need heat during all the year. Other consumers could also be other dehydration facilities, sport centres and an elderly residence consuming biomass (e.g. wood pellets, almond shells, wood chips).
- The 2 current alfalfa production lines can be used for the pre-treatment of the solid biomass: Line 1 (drying heat produced from burning almond shells, olive pomace and grape marc) and Line 2 (drying heat produced from burning natural gas; more efficient but with a higher fuel cost and environmental impacts). In the Line 2, the implementation of a new biomass boiler has been evaluated to be able to use the straw and stalks directly from the field to supply heat necessities to the agro-industrial activity.

The techno-economic feasibility study has shown that the most interesting raw material is straw. Although the purchasing price is higher compared to maize stalks, no drying is required before pelletization. Line 1 should be used for the production since the pre-treatment cost are cheaper compared to Line 2 unless a new biomass burner is installed (which will incur investment costs that will be payedback after 6 years).

Additionally, **the study has shown that a blend with wood is required and that the most competitive product to be generated by the logistic centre is agro-pellet Class B with a maximum share of straw 70 %.** This has been stated taking into consideration quality parameters from straw and stalks provided by the bibliography and previous experience. Therefore, a previous quality analysis (mainly determination of moisture content, calorific value, ash content and Chlorine percentage) of a representative sample of the straw to be used as raw material for the logistic centre is strongly advisable before starting the new business activity.

Intensive product quality evaluation will avoid unexpected dissatisfaction from consumers. Initial combustion tests with some target boilers are also highly recommended to test the viability of the product during conversion (evaluation of slagging formation for example). Both can therefore change the share of straw vs wood and the costs associated to the production.

The costs of production and the minimum profit stated by the cooperative set the minimum selling price for this agro-pellet in 117 €/t (0.027 €/kWh). In comparison with the large variety of market competitors, the product does not offer the best price-quality. The current situation is therefore risky and purchasing or pre-treatment costs should be reduced if possible. However, as highlighted before, the quality analysis of the material to be used can change the share of straw-wood and make it more appealing for the market. A business model has been developed by the SUCELLOG project with new proposals for the new activity as logistic centre producing Class B mixed agro-pellets (straw 70 %, wood 30 %) (see the document D4.4 available on the website).

The use of straw and wood for the production of Class B mixed agro-pellets has no social and environmental negative impacts. On the contrary, they contribute to the improvement of the society and the environment. This proves that the concept of the SUCELLOG project is sustainable from the 3 pillars point of view (economic, social and environmental).